ENCYCLOPÆDIA BRITANNICA

NINTH EDITION

THE

ENCYCLOPÆDIA BRITANNICA

A

DICTIONARY

OF

ARTS, SCIENCES, AND GENERAL LITERATURE

NINTH EDITION

VOLUME I

EDINBURGH: ADAM AND CHARLES BLACK

MDCCCLXXV

First Edition, 1771; Second Edition, 1777-84; Third Edition, 1788-97;
Fourth Edition, 1800-10; Fifth Edition, 1817; Sixth Edition,
1823; Seventh Edition, 1830-42;
Eighth Edition, 1853-61; Reprinted, 1862, 1866,
1868, 1870, 1872;
Ninth Edition, 1875-89; Reprinted, 1890,
1892, 1895, 1896, 1898.

PREFATORY NOTICE.

THE ENCYCLOPÆDIA BRITANNICA has long deservedly held a foremost place amongst English Encyclopædias. It secured this position by its plan and method of treatment, the plan being more comprehensive, and the treatment a happier blending of popular and scientific exposition than had previously been attempted in any undertaking of the kind. The distinctive feature of the work was that it gave a connected view of the more important subjects under a single heading, instead of breaking them up into a number of shorter articles. This method of arrangement had a twofold advantage. The space afforded for extended exposition helped to secure the services of the more independent and productive minds who were engaged in advancing their own departments of scientific inquiry. As a natural result, the work, while surveying in outline the existing field of knowledge, was able at the same time to enlarge its boundaries by embodying, in special articles, the fruits of original observation and research. The Encyclopædia Britannica thus became, to some extent at least, an instrument as well as a register of scientific progress.

This characteristic feature of the work will be retained and made even more prominent in the New Edition, as the list of contributors already published sufficiently indicates. In some other respects, however, the plan will be modified, to meet the multiplied requirements of advancing knowledge. In the first place, the rapid progress of science during the last quarter of a century necessitates many changes, as well as a considerable increase in the number of headings devoted to its exposition. In dealing with vast wholes, such as Physics and Biology, it is always a difficult problem how best to distribute the parts under an alphabetical arrangement, and perhaps impossible to make such a distribution perfectly consistent and complete. The difficulty of distribution is increased by the complexity of divisions and multiplication of details, which the progress of science involves, and which constitute indeed the most authentic note of advancing knowledge. This sign of progress is reflected in extensive changes of terminology and nomenclature, vague general headings once appropriate and sufficient, such as *Animalcule*, being of necessity abandoned for more precise and significant equivalents.

But, since the publication of the last edition, science, in each of its main divisions, may

be said to have changed as much in substance as in form. The new conceptions introduced into the Biological Sciences have revolutionised their points of view, methods of procedure, and systems of classification In the light of larger and more illuminating generalisations, sections of the subject, hitherto only partially explored, have acquired new prominence and value, and are cultivated with the keenest interest. It is enough to specify the researches into the ultimate structures, serial gradations, and progressive changes of organic forms, into the laws of their distribution in space and time, and into the causes by which these phenomena have been brought about. The results of persistent labour in these comparatively new fields of inquiry will largely determine the classifications of the future. Meanwhile the whole system of grouping, and many points of general doctrine, are in a transition state; and what is said and done in these directions must be regarded, to a certain extent at least, as tentative and provisional. In these circumstances, the really important thing is, that whatever may be said on such unsettled questions should be said with the authority of the fullest knowledge and insight, and every effort has been made to secure this advantage for the New Edition of the Encyclopædia.

The recent history of Physics is marked by changes both of conception and classification almost equally great. In advancing from the older dynamic to the newer potential and kinetic conceptions of power, this branch of science may be said to have entered on a fresh stage, in which, instead of regarding natural phenomena as the result of forces acting between one body and another, the energy of a material system is looked upon as determined by its configuration and motion, and the ideas of configuration, motion, and force are generalised to the utmost extent warranted by their definitions. This altered point of view, combined with the far reaching doctrines of the correlation of forces and the conservation of energy, has produced extensive changes in the nomenclature and classification of the various sections of physics; while the fuller investigations into the ultimate constitution of matter, and into the phenomena and laws of light, heat, and electricity, have created virtually new sections, which must now find a place in any adequate survey of scientific progress. The application of the newer principles to the mechanical arts and industries has rapidly advanced during the same period, and will require extended illustration in many fresh directions. Mechanical invention has, indeed, so kept pace with the progress of science, that in almost every department of physics improved machines and processes have to be described, as well as fresh discoveries and altered points of view. In recent as in earlier times, invention and discovery have acted and reacted on each other to a marked extent, the instruments of finer measurement and analysis having directly contributed to the finding out of physical properties and laws. The spectroscope is a signal instance of the extent to which in our day scientific discovery is indebted to appropriate instruments of observation and analysis.

These extensive changes in Physics and Biology involve corresponding changes in the method of their exposition. Much in what was written about each a generation ago is now of comparatively little value. Not only therefore does the system of grouping in these

sciences require alteration and enlargement; the articles themselves must, in the majority of instances, be written afresh rather than simply revised. The scientific department of the work will thus be to a great extent new. In attempting to distribute the headings for the new edition, so as fairly to cover the ground occupied by modern science, I have been largely indebted to Professor Huxley and Professor Clerk Maxwell, whose valuable help in the matter I am glad to have an opportunity of acknowledging.

Passing from Natural and Physical Science to Literature, History, and Philosophy, it may be noted that many sections of knowledge connected with these departments display fresh tendencies, and are working towards new results, which, if faithfully reflected, will require a new style of treatment. Speaking generally, it may be said that human nature and human life are the great objects of inquiry in these departments. Man, in his individual powers, complex relationships, associated activities, and collective progress, is dealt with alike in Literature, History, and Philosophy. In this wider aspect, the rudest and most fragmentary records of savage and barbarous races, the earliest stories and traditions of every lettered people, no less than their developed literatures, mythologies, and religions, are found to have a meaning and value of their own. As yet the rich materials thus supplied for throwing light on the central problems of human life and history have only been very partially turned to account. It may be said, indeed, that their real significance is perceived and appreciated, almost for the first time, in our own day. But under the influence of the modern spirit, they are now being dealt with in a strictly scientific manner The available facts of human history, collected over the widest areas, are carefully co-ordinated and grouped together, in the hope of ultimately evolving the laws of progress, moral and material, which underlie them, and which, when evolved, will help to connect and interpret the whole onward movement of the race. Already the critical use of the comparative method has produced very striking results in this new and stimulating field of research. Illustrations of this are seen in the rise and rapid development of the comparatively modern science of Anthropology, and the successful cultivation of the assistant sciences, such as Archæology, Ethnography, and Philology, which directly contribute materials for its use. The activity of geographical research in both hemispheres, and the large additions recently made to our knowledge of older and newer continents by the discoveries of eminent travellers and explorers, afford the anthropologist additional materials for his work. Many branches of mental philosophy, again, such as Ethics, Psychology, and Æsthetics, while supplying important elements to the new science, are at the same time very largely interested in its results, and all may be regarded as subservient to the wider problems raised by the philosophy of history. In the new edition of the Encyclopædia full justice will, it is hoped, be done to the progress made in these various directions.

It may be well, perhaps, to state at the outset the position taken by the Encyclopædia Britannica in relation to the active controversies of the time—Scientific, Religious, and Philosophical. This is the more necessary, as the prolific activity of modern science has naturally stimulated speculation, and given birth to a number of somewhat crude conjec-

tures and hypotheses. The air is full of novel and extreme opinions, arising often from a hasty or one-sided interpretation of the newer aspects and results of modern inquiry. The higher problems of philosophy and religion, too, are being investigated afresh from opposite sides in a thoroughly earnest spirit, as well as with a directness and intellectual power, which is certainly one of the most striking signs of the times. This fresh outbreak of the inevitable contest between the old and the new is a fruitful source of exaggerated hopes and fears, and of excited denunciation and appeal. In this conflict a work like the Encyclopædia is not called upon to take any direct part. It has to do with knowledge rather than opinion, and to deal with all subjects from a critical and historical, rather than a dogmatic, point of view. It cannot be the organ of any sect or party in Science, Religion, or Philosophy. Its main duty is to give an accurate account of the facts and an impartial summary of results in every department of inquiry and research. This duty will, I hope, be faithfully performed.

T. S. BAYNES.

ST ANDREWS, 1st *January* 1875.

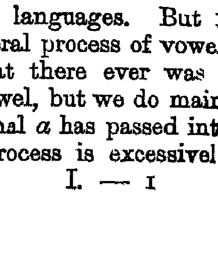
ENCYCLOPÆDIA BRITANNICA.

A

A, THE first symbol of every Indo-European alphabet, denotes also the primary vowel sound. This coincidence is probably only accidental. The alphabets of Europe, and perhaps of India also, were of Semitic origin, and in all the Semitic alphabets except one, this same symbol (in modified forms) holds the first place; but it represents a peculiar breathing, not the vowel *a*,—the vowels in the Semitic languages occupying a subordinate place, and having originally no special symbols. When the Greeks, with whom the vowel sounds were much more important, borrowed the alphabet of Phœnicia, they required symbols to express those vowels, and used for this purpose the signs of breathings which were strange to them, and therefore needed not to be preserved; thus the Phœnician equivalent of the Hebrew *aleph* became *alpha;* it denoted, however, no more a guttural breathing, but the purest vowel sound. Still, it would be too much to assume that the Greeks of that day were so skilled in phonetics that they assigned the first symbol of their borrowed alphabet to the *a*-sound, *because* they knew that sound to be the most essential vowel.

This primary vowel-sound (the sound of *a* in *father*) is produced by keeping the passage through which the air is vocalised between the glottis and the lips in the most open position possible. In sounding all other vowels, the air-channel is narrowed by the action either of the tongue or the lips. But here neither the back of the tongue is raised (as it is in sounding *o* and other vowels), so that a free space is left between the tongue and the uvula, nor is the front of the tongue raised (as in sounding *e*), so that the space is clear between the tongue and the palate. Again, no other vowel is pronounced with a wider opening of the lips; whereas the aperture is sensibly reduced at each side when we sound *o*, and still more when we sound *u* (that is, *yoo*). The whole channel, therefore, from the glottis, where the breath first issues forth to be modified in the oral cavity, to the lips, where it finally escapes, is thoroughly open. Hence arises the great importance of the sound, by reason of its thoroughly non-consonantal character. All vowels may be defined as open positions of the speech-organs, in which the breath escapes without any stoppage, friction, or sibilation arising from the contact of those organs, whereas consonants are heard when the organs open after such contact more or less complete. Now, all vowels except *a* are pronounced with a certain contraction of the organs; thus, in sounding the *i* (the English *e*-sound), the tongue is raised so as almost to touch the palate, the passage left being so close, that if the tongue were suffered for a second to rest on the palate, there would be heard not *i* but *y;* and a similar relation exists between *u* and *w*. This is commonly expressed by calling *y* and *w* semi-vowels. We might more exactly call *i* and *u* consonantal-vowels; and as an historic fact, *i* does constantly pass into *y*, and *u* into *w*, and *vice versa*. But no consonant has this relation to the *a*-sound; it has absolutely no affinity to any consonant; it is, as we have called it, the one primary essential vowel.

The importance of this sound may be shown by historical as well as by physiological evidence. We find by tracing the process of phonetic change in different languages, that when one vowel passes into another, it is the pure *a*-sound which thus assumes other forms, whereas other vowels do not pass into the *a*-sound, though sometimes the new sound may have this symbol. Roughly speaking, we might express the general character of vowel change by drawing two lines from a common point, at which *a* is placed. One of these lines marks the progress of an original *a* (*ah*-sound) through *e* (*a*-sound), till it sinks finally to *i* (*e*-sound); the other marks a similar degradation, through *o* to *u* (*oo*-sound). This figure omits many minor modifications, and is subject to some exceptions in particular languages. But it represents fairly in the main the general process of vowel-change. Now, we do not assert that there ever was a time when *a* was the only existing vowel, but we do maintain that in numberless cases an original *a* has passed into other sounds, whereas the reverse process is excessively



rare. Consequently, the farther we trace back the history of language, the more instances of this vowel do we find; the more nearly, if not entirely, does it become the one starting point from which all vowel-sound is derived.

It is principally to the effort required to keep this sound pure that we must attribute the great corruption of it in all languages, and in none more than our own. Indeed, in English, the short *a*-sound is never heard pure; it is heard in Scotland, *e.g.*, in *man*, which is quite different from the same word on English lips. We have it, however, long in *father*, &c., though it is not common. It has passed into a great many other sounds, all of which are denoted in a most confusing way by the original symbol, and some by other symbols as well. Thus *a* denotes—(1.) The English vowel-sound in *man*, perhaps the most common of all the substitutes, dating from the 17th century. (2.) It appears in *want;* for this sound *o* is also employed, as in *on*. (3.) A more open sound is heard in *all* (also denoted by *au* in *auk*, and *aw* in *awl*). (4.) Very commonly it represents the continental *e*, as in *ale* (here also we have the symbol *ai* in *ail*). (5.) It is found in *dare* and many similar words, where the sound is really the *e* of *den*, prolonged in the utterance; here also *ai* is sometimes an equivalent, as in *air*. Then (6) there is a sound which is not that of *a* either in *man* or in *father*, but something between the two. It is heard in such words as *ask, pass, grant*, &c. All these may be, and often are, pronounced with the sound either of *man* or of *father;* still, we do often hear in them a clearly distinguishable intermediate sound, which ought to have a special symbol. Lastly (7), there is the dull sound heard in final unaccentuated syllables, *e.g.*, in the word *final* itself. It is that to which all unaccentuated syllables tend; but it is also often heard even in monosyllables, where it is represented by every other vowel-symbol in the language, *e.g.*, in *her, sir, son, sun.* This Protean sound is commonly called the neutral vowel; it occurs in all languages, but perhaps in none so frequently as in English. This great variety of sounds, which are all denoted among us by one symbol, clearly shows the insufficiency of our written alphabet.

As in English, so in Sanskrit, the short *ah*-sound was lost, and was replaced regularly by the neutral sound. This was regarded by the grammarians as inherent in every consonant, and therefore was only written at the beginning of a word; in fact, it is the smallest amount of vowel-sound requisite to float a consonant. Long *a*, however, kept its sound pure, and does so still in the vernaculars of India. In Latin the sound was probably pure, both short and long, and it has been preserved so in the Romance languages down to the present day. In Greek there was considerable variation, proved in one case at least by a variation of symbol; in Ionic α commonly passed into η, a symbol which probably denoted the modern Italian open *e;* but possibly the close *e*, that is, the English *a* in *ale*. On the other hand, it is probable that the Doric α approximated to an *o*, being sounded as *a* in our word *want;* and it is likely that this variation was the πλατειασμός which the grammarians attribute to the Dorians. This is commonly supposed to have been the retention of α where the Ionic had η; but that was not peculiar to the Dorians, being common to all the Greeks except the Ionians. In the north of Europe we find a similar tendency to give to *a* an *o*-sound; thus in Norse, *aa* is sounded as an open *o*. By a further extension in the north of England, at least in such parts as have been specially exposed to Norwegian influence, *au* has the sound of *o;* *e.g.*, *law* is pronounced *lo*.

A is frequently used as a prefix in lieu of some fuller form in old English. Thus it stands for the preposition *on* (O.E. *an*) in *away, again, afoot, asleep;* for *off* in *adown* (O.E. *of-dune*); and seems to be intensive in *athirst* (O.E. *of-thirst*). Sometimes, especially with verbs, it represents the old English *á*, which in old High German appears as *ur* or *er*, and in modern German as *er*, which signifies the completion of an action, as in *erwachen*, to which *awake* corresponds. Frequently no special force seems to be added by the prefix, as in *abide, arise*, &c. Sometimes *a* appears as the representative of the prefix commonly used in past participles, which has the form *ge* in German, and *ge* and *y* in old English, *e.g.*, in *ago* or *agone;* compare *aware* (O.E. *gewaere*), *among* (O.E. *gemang*), &c. *A* also stood for the preposition *an* (*on*) in such expressions (now obsolete) as *a-doing, a-making*, where *doing* and *making* are verbal nouns. Lastly, it represents the prepositions *on* or *of* in the phrases *now-a-days, Jack-a-lantern*, and others.

The place that A occupies in the alphabet accounts for its being much employed as a mark or symbol. It is used, for instance, to name the sixth note of the gamut in music; in some systems of notation it is a numeral (see ARITHMETIC); and in Logic it denotes a universal affirmative proposition (see LOGIC). In algebra, *a* and the first letters of the alphabet are employed to represent known quantities. A1 marks the best class of vessels in Lloyd's Register of British and Foreign Shipping. In the old poets, "*A per se*" is found, meaning the highest degree of excellence; as when Chaucer calls Creseide "the floure and *A per se* of Troye and Grece."

A was the first of the eight *literæ nundinales* at Rome, and on this analogy it stands as the first of the seven Dominical letters.

It is often used as an abbreviation, as in A.D. for *anno domini*, A.M. for *ante meridiem*, A.B. and A.M. for *artium baccalaureus* and *artium magister*. In commerce A stands for *accepted*. (J. P.)

AA, the name of about forty small European rivers. The word is derived from the old German *aha*, cognate to the Latin *aqua*, water. The following are the more important streams of this name:—a river of Holland, in North Brabant, which joins the Dommel at Bois-le-Duc; two rivers in the west of Russia, both falling into the Gulf of Livonia, near Riga, which is situated between them; a river in the north of France, falling into the sea at Gravelines, and navigable as far as St Omer; and a river of Switzerland, in the cantons of Lucerne and Aargau, which carries the waters of Lakes Baldeker and Hallwyler into the Aar.

AACHEN. See AIX-LA-CHAPELLE.

AALBORG, a city and seaport of Denmark, is situated on the Liimfiord, about 15 miles from its junction with the Cattegat. It is the capital of the district of the same name, one of the subdivisions of the province of Jütland. The city is a place of considerable commercial importance, and contains a cathedral and a school of navigation. Soap, tobacco, and leather are manufactured; there are several distilleries; and the herring fishery is extensively prosecuted. Grain and herring are largely exported, as are also to a smaller extent wool, cattle, skins, tallow, salt provisions, and spirits. The harbour, which is good and safe, though difficult of access, is entered by about 800 vessels annually, and there is direct steam communication with Copenhagen. The district is celebrated for its breed of horses. Population (1870), 11,953.

AALEN, a walled town of Würtemberg, pleasantly situated on the Kocher, at the foot of the Swabian Alps, about 50 miles E. of Stuttgart. Woollen and linen goods are manufactured, and there are ribbon looms and tanneries in the town, and large iron works in the neighbourhood. Aalen was a free imperial city from 1360 till 1802, when it was annexed to Würtemberg. Population (1871), 5552.

AAR, or AARE, the most considerable river in Switzerland, after the Rhine and Rhone. It rises in the glaciers

of the Finster-aarhorn, Schreckhorn, and Grimsel, in the canton of Bern; and at the Handeck in the valley of Hasli forms a magnificent water-fall of above 150 feet in height. It then falls successively into the lakes Brienz and Thun, and, emerging from the latter, flows through the cantons of Bern, Soleure, and Aargau, emptying itself into the Rhine, opposite Waldshut, after a course of about 170 miles. Its principal tributary streams are the Kander, Saane, and Thiele on the left, and the Emmen, Surin, Aa, Reuss, and Limmat, on the right. On its banks are situated Unterseen, Thun, Bern, Soleure or Solothurn, Aarburg, and Aarau. The Aar is a beautiful silvery river, abounding in fish, and is navigable from the Rhine as far as the Lake of Thun. Several small rivers in Germany have the same name.

AARAU, the chief town of the canton of Aargau in Switzerland, is situated at the foot of the Jura mountains, on the right bank of the river Aar, 41 miles N.E. of Bern. It is well built, and contains a town-hall, barracks, several small museums, and a library rich in histories of Switzerland. There is a cannon foundry at Aarau, and among the principal manufactures are silk, cotton, and leather; also cutlery and mathematical instruments, which are held in great repute. The slopes of the neighbouring mountains are partially covered with vines, and the vicinity of the town is attractive. About ten miles distant along the right bank of the Aar are the famous baths of Schinznach. Population, 5449.

AARD-VARK (*earth-pig*), an animal very common in South Africa, measuring upwards of three feet in length, and having a general resemblance to a short-legged pig. It feeds on ants, and is of nocturnal habits, and very timid and harmless. Its flesh is used as food, and when suitably preserved is considered a delicacy. The animal is the only known species of its genus (*Orycteropus*), and belongs to the order *Edentata* of the mammalia. The same prefix *Aard* appears in the name of the AARD-WOLF (*Proteles Lalandii*), a rare animal found in Caffraria, which is said to partake of the characters of the dog and civet. See MAMMALIA.

AARGAU (French, ARGOVIE), one of the cantons of Switzerland, derives its name from the river which flows through it, Aar-gau being the province or district of the Aar. It is bounded on the north by the Rhine, which divides it from the duchy of Baden, on the east by Zurich and Zug, on the south by Lucerne, and on the west by Bern, Soleure or Solothurn, and Basel. It has an area of 502½ square miles. By the census of 1870, the number of inhabitants was 198,873, showing an increase during the preceding ten years of 4665. Aargau stands sixth among the Swiss cantons in density of population, having 395 inhabitants to the square mile. The statistics of 1870 show that of the inhabitants 107,703 were Protestants, 89,180 Catholics, and 1541 Jews. German is the language almost universally spoken.

Aargau is the least mountainous canton of Switzerland. It forms part of a great table-land to the north of the Alps and the east of the Jura, having a general elevation of from 1200 to 1500 feet. The hills do not rise to any greater height than 1800 feet above this table-land, or 3000 feet above the level of the sea. The surface of the country is beautifully diversified, undulating tracts and well-wooded hills alternating with fertile valleys watered by the Aar and its numerous tributaries, and by the rivulets which flow northward into the Rhine. Although moist and variable, the climate is milder than in most parts of Switzerland.

The minerals of Aargau are unimportant, but remarkable palæontological remains are found in its rocks. The soil to the left of the Aar is a stiff clay, but to the right it is light and productive. Agriculture is in an advanced state, and great attention is given to the rearing of cattle. There are many vineyards, and much fruit is grown. The canton is distinguished by its industry and its generally diffused prosperity. Many of the inhabitants are employed in the fishings on the Aar, and in the navigation of the river. In the villages and towns there are considerable manufactures of cotton goods, silk, and linen. The chief exports are cattle, hides, cheese, timber, raw cotton, yarn, cotton cloths, silk, machinery, and wooden wares; and the imports include wheat, wine, salt, leather, and iron. The most important towns are Aarau, Baden, Zofingen, and Laufenburg, and there are mineral springs at Baden, Schinznach, Leerau, and Niederweil. The Swiss Junction Railway crosses the Rhine near Waldshut, and runs south through the canton to Turgi, whence one line proceeds S.E. to Zurich, and another S.W. to Aarau and Olben.

Until 1798, Aargau formed part of the canton of Bern, but when the Helvetic Republic was proclaimed, it was erected into a separate canton. In 1803 it received a considerable accession of territory, in virtue of the arrangement under which the French evacuated Switzerland. According to the law whereby the cantons are represented in the National Council by one member for every 20,000 inhabitants, Aargau returns ten representatives to that assembly. The internal government is vested in a legislative council elected by the body of the people, while a smaller council of seven members is chosen by the larger body for the general administration of affairs. The resources of Aargau are stated to amount to about a million sterling; its revenue in 1867 was nearly £82,000, and the expenditure slightly greater. There is a public debt of about £40,000. The canton is divided into eleven districts, and these again are subdivided into forty-eight circles. There is a court of law for each district, and a superior court for the whole canton, to which cases involving sums above 160 francs can be appealed. Education is compulsory; but in the Roman Catholic districts the law is not strictly enforced. By improved schools and other appliances great progress has been made in education within the last thirty or forty years.

AARHUUS, a city and seaport of Denmark, situated on the Cattegat, in lat. 56° 9′ N., long. 10° 12′ E. It is the chief town of a fertile district of the same name, one of the subdivisions of Jutland. The cathedral of Aarhuus is a Gothic structure, and the largest church in Denmark. The town also contains a lyceum, museum, and library. Aarhuus is a place of extensive trade. It has a good and safe harbour, has regular steam communication with Copenhagen, and is connected by rail with Viborg and the interior of the country. Agricultural produce, spirits, leather, and gloves are exported, and there are sugar refineries, and manufactures of wool, cotton, and tobacco. Population (1870), 15,020.

AARON, the first high-priest of the Jews, eldest son of Amram and Jochebed, of the tribe of Levi, and brother of Moses and Miriam. When Moses was commissioned to conduct the Israelites from Egypt to Canaan, Aaron was appointed to assist him, principally, it would appear, on account of his possessing, in a high degree, persuasive readiness of speech. On the occasion of Moses' absence in Mount Sinai (to which he had gone up to receive the tables of the law), the Israelites, regarding Aaron as their leader, clamorously demanded that he should provide them with a visible symbolic image of their God for worship. He weakly complied with the demand, and out of the ornaments of gold contributed for the purpose cast the figure of a calf, this form being doubtless chosen in recollection of the idols of Egypt. In obedience to instructions given by God to Moses, Aaron was appointed high-priest; his sons and descendants, priests; and his tribe was set apart as the sacerdotal caste. The office of high-priest was held by Aaron for nearly forty years, till the time of his

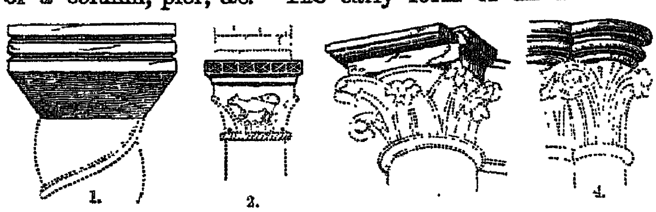
death, which took place on Mount Hor, when he was 123 years old.

AARSSENS, FRANCIS VAN (1572-1641), one of the greatest diplomatists of the United Provinces. He represented the States-General at the Court of France for many years, and was also engaged in embassies to Venice, Germany, and England. His great diplomatic ability appears from the memoirs he wrote of his negotiations in 1624 with Richelieu, who ranked him among the three greatest politicians of his time. A deep stain rests on the memory of Aarssens from the share he had in the death of Barneveldt, who was put to death by the States-General, after the semblance of a trial, in 1619.

ABABDE, an African tribe occupying the country between the Red Sea and the Nile, to the S. of Kosseir, nearly as far as the latitude of Derr. Many of the race have settled on the eastern bank of the Nile, but the greater part still live like Bedouins. They are a distinct race from the Arabs, and are treacherous and faithless in their dealings. They have few horses; when at war with other tribes, they fight from camels, their breed of which is famed. They possess considerable property, and trade in senna, and in charcoal made from acacia wood, which they send as far as Cairo.

ABACA or ABAKA, a name given to the *Musa textilis*, the plant that produces the fibre called Manilla Hemp, and also to the fibre itself.

ABACUS, an architectural term (from the Gr. ἄβαξ, a tray or flat board) applied to the upper part of the capital of a column, pier, &c. The early form of an abacus is



Forms of the Abacus.

simply a square flat stone, probably derived from the Tuscan order. In Saxon work it is frequently simply chamfered, but sometimes grooved, as in the crypt at Repton (fig. 1), and in the arcade of the refectory at Westminster. The abacus in Norman work is square where the columns are small; but on larger piers it is sometimes octagonal, as at Waltham Abbey. The square of the abacus is often sculptured, as at the White Tower and at Alton (fig. 2). In early English work the abacus is generally circular, and in larger work a continuation of circles (fig. 4), sometimes octagonal, and occasionally square. The mouldings are generally rounds, which overhang deep hollows. The abacus in early French work is generally square, as at Blois (fig. 3). The term is applied in its diminutive form (Abaciscus) to the chequers or squares of a tessellated pavement.

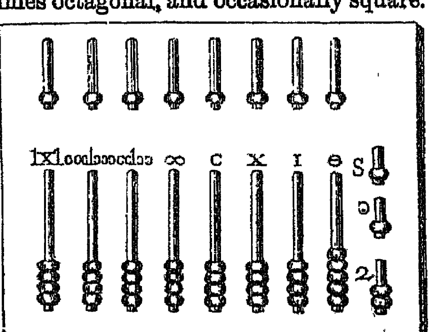


Fig. 5.—Roman Abacus.

ABACUS also signifies an instrument employed by the ancients for arithmetical calculations; pebbles, bits of bone, or coins, being used as counters. The accompanying figure (5) of a Roman abacus is taken from an ancient monument. It contains seven long and seven shorter rods or bars, the former having four perforated beads running on them, and the latter one. The bar marked I indicates units, X tens, and so on up to millions. The beads on the shorter bars denote fives,—five units, five tens, &c. The rod Θ and corresponding short rod are for marking ounces; and the short quarter rods for fractions of an ounce.

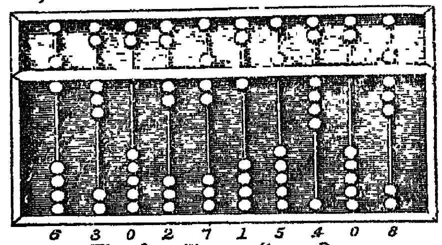


Fig. 6.—Chinese Swan-Pan.

The *Swan-Pan* of the Chinese (fig. 6) closely resembles the Roman abacus in its construction and use. Computations are made with it by means of balls of bone or ivory running on slender bamboo rods similar to the simpler board, fitted up with beads strung on wires, which is employed in teaching the rudiments of arithmetic in elementary schools.

ABÆ, a town of ancient Greece in the E. of Phocis, famous for a temple and oracle of Apollo. The temple was plundered and burned by the Persians (B.C. 480), and again by the Bœotians (B.C. 346), and was restored on a smaller scale by Hadrian. Remains of the temple and town may still be traced on a peaked hill near Exarkho. See Leake's *Northern Greece*.

ABAKANSK, a fortified town of Siberia, in the government of Yeniseisk, on the river Abakan, near its confluence with the Yenisei. Lat. 54° N.; long. 91° 14′ E. This is considered the mildest and most salubrious place in Siberia, and is remarkable for the tumuli in its neighbourhood, and for some statues of men from seven to nine feet high, covered with hieroglyphics. Population about 1000.

ABANA and PHARPAR, "rivers of Damascus" (2 Kings v. 12), are now generally identified with the Barada and the Awaj respectively. The former flows through the city of Damascus; the Awaj, a smaller stream, passes eight miles to the south. Both run from west to east across the plain of Damascus, which owes to them much of its fertility, and lose themselves in marshes, or lakes, as they are called, on the borders of the great Arabian desert. Mr Macgregor, who gives an interesting description of these rivers in his *Rob Roy on the Jordan*, affirms that "as a work of hydraulic engineering, the system and construction of the canals by which the Abana and Pharpar are used for irrigation, may be still considered as the most complete and extensive in the world."

ABANCAY, a town of Peru, in the department of Cuzco, 65 miles W.S.W. of the town of that name. It lies on the river Abancay, which is here spanned by one of the finest bridges in Peru. Rich crops of sugar-cane are produced in the district, and the town has extensive sugar refineries. Hemp is also cultivated, and silver is found in the mountains. Population, 1200.

ABANDONMENT, in *Marine Assurance*, is the surrendering of the ship or goods insured to the insurers, in the case of a constructive total loss of the thing insured. There is an absolute total loss entitling the assured to recover the full amount of his insurance wherever the thing insured has ceased to exist to any useful purpose,—and in such a case abandonment is not required. Where the thing assured continues to exist in specie, yet is so damaged that there is no reasonable hope of repair, or it is not worth the expense of bringing it, or what remains of it, to its destination, the insured may treat the case as one of a total loss (in this case called constructive total loss), and demand the full sum insured. But, as the contract of insurance is one of indemnity, the insured must, in such a case, make an express cession of all his right to the recovery of the subject insured to the underwriter by abandonment. The insured must intimate his intention to abandon, within a

reasonable time after receiving correct information as to the loss; any unnecessary delay being held as an indication of his intention not to abandon. An abandonment when once accepted is irrevocable; but in no circumstances is the insured obliged to abandon. After abandonment, the captain and crew are still bound to do all in their power to save the property for the underwriter, without prejudice to the right of abandonment; for which they are entitled to wages and remuneration from the insurers, at least so far as what is saved will allow. See Arnould, Marshall, and Park, on the *Law of Insurance*, and the judgment of Lord Abinger in Roux *v.* Salvador, 3 Bing. N.C. 266, Tudor's *Leading Cases*, 139.

Abandonment has also a legal signification in the law of railways. Under the Acts 13 and 14 Vict. c. 83, 14 and 15 Vict. c. 64, 30 and 31 Vict. c. 126, and 32 and 33 Vict. c. 114, the Board of Trade may, on the application of a railway company, made by the authority and with the consent of the holders of three-fifths of its shares or stock, and on certain conditions specified in the Acts, grant a warrant authorising the abandonment of the railway or a portion of it. After due publication of this warrant, the company is released from all liability to make, maintain, or work the railway, or portion of the railway, authorised to be abandoned, or to complete any contracts relating to it, subject to certain provisions and exceptions.

Abandoning a young child under two years of age, so that its life shall be endangered, or its health permanently injured, or likely to be so, is in England a misdemeanour, punishable by penal servitude or imprisonment, 24 and 25 Vict. c. 100, § 273. In Scotland abandoning or exposing an infant is an offence at common law, although no evil consequences should happen to the child.

ABANO, a town of Northern Italy, 6 miles S.W. of Padua. There are thermal springs in the neighbourhood, which have been much resorted to by invalids for bathing, both in ancient and modern times. They were called by the Romans *Aponi Fons*, and also *Aquæ Patavinæ*. Population of Abano, 3000.

ABANO, Pietro d', known also as *Petrus de Apono* or *Aponensis*, a distinguished physician and philosopher, was born at the Italian town from which he takes his name in 1250, or, according to others, in 1246. After visiting the east in order to acquire the Greek language, he went to study at Paris, where he became a doctor of medicine and philosophy. In Padua, to which he returned when his studies were completed, he speedily gained a great reputation as a physician, and availed himself of it to gratify his avarice by refusing to visit patients except for an exorbitant fee. Perhaps this as well as his meddling with astrology caused the charge to be brought against him of practising magic, the particular accusations being that he brought back into his purse, by the aid of the devil, all the money he paid away, and that he possessed the philosopher's stone. He was twice brought to trial by the Inquisition; on the first occasion he was acquitted, and he died (1316) before the second trial was completed. He was found guilty, however, and his body was ordered to be exhumed and burned; but a friend had secretly removed it, and the Inquisition had, therefore, to content itself with the public proclamation of its sentence and the burning of Abano in effigy. In his writings he expounds and advocates the medical and philosophical systems of Averrhoes and other Arabian writers. His best known works are the *Conciliator differentiarum quæ inter philosophos et medicos versantur* (Mantua, 1472, Venice, 1476), and *De venenis eorumque remediis* (1472), of which a French translation was published at Lyons in 1593.

ABARIS, the Hyperborean, a celebrated sage of antiquity, who visited Greece about 570 B.C., or, according to others, a century or two earlier. The particulars of his history are differently related by different authors, but all accounts are more or less mythical. He is said to have travelled over sea and land, riding on an arrow given him by Apollo, to have lived without food, to have delivered the whole earth from a plague, &c. Various works in prose and verse are attributed to Abaris by Suidas and others, but of these we have no certain information.

ABATEMENT, Abate, from the French *abattre, abater*, to throw down, demolish. The original meaning of the word is preserved in various legal phrases. The abatement of a nuisance is the remedy allowed by law to a person injured by a public nuisance of destroying or removing it by his own act, provided he commit no breach of the peace in doing so. In the case of private nuisances abatement is also allowed, provided there be no breach of the peace, and no damage be occasioned beyond what the removal of the nuisance requires.

Abatement of freehold takes place where, after the death of the person last seised, a stranger enters upon lands before the entry of the heir or devisee, and keeps the latter out of possession. It differs from intrusion, which is a similar entry by a stranger on the death of a tenant for life, to the prejudice of the reversioner, or remainder man; and from disseisin, which is the forcible or fraudulent expulsion of a person seised of the freehold.

Abatement among legatees (*defalcatis*) is a proportionate deduction which their legacies suffer when the funds out of which they are payable are not sufficient to pay them in full.

Abatement in pleading is the defeating or quashing of a particular action by some matter of fact, such as a defect in form or personal incompetency of the parties suing, pleaded by the defendant. Such a plea is called a plea in abatement; and as it does not involve the merits of the cause, it leaves the right of action subsisting. Since 1852 it has been competent to obviate the effect of such pleas by amendment, so as to allow the real question in controversy between the parties to be tried in the same suit.

In litigation an action is said to abate or cease on the death of one of the parties.

Abatement, or Rebate, is a discount allowed for prompt payment; it also means a deduction sometimes made at the custom-house from the fixed duties on certain kinds of goods, on account of damage or loss sustained in warehouses. The rate and conditions of such deductions are regulated by Act 16 and 17 Vict. c. 107.

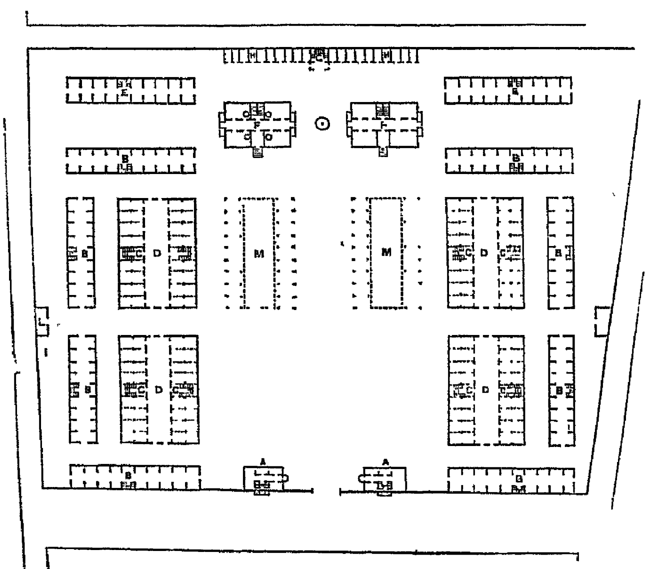
ABATI, or Dell'Abbato, Niccolo, a celebrated fresco-painter of Modena, born in 1512. His best works are at Modena and Bologna, and have been highly praised by Zanotti, Algarotti, and Lanzi. He accompanied Primaticcio to France, and assisted in decorating the palace at Fontainbleau (1552-1571). His pictures exhibit a combination of skill in drawing, grace, and natural colouring. Some of his easel pieces in oil are in different collections; one of the finest, now in the Dresden Gallery, represents the martyrdom of St Peter and St Paul. Abati died at Paris in 1571.

ABATTOIR, from *abattre*, primarily signifies a slaughter-house proper, or place where animals are killed as distinguished from *boucheries* and *étaux publics*, places where the dead meat is offered for sale. But the term is also employed to designate a complete meat market, of which the abattoir proper is merely part.

Perhaps the first indication of the existence of abattoirs may be found in the system which prevailed under the Emperors in ancient Rome. A corporation or guild of butchers undoubtedly existed there, which delegated to its officers the duty of slaughtering the beasts required to supply the city with meat. The establishments requisite

for this purpose were at first scattered about the various streets, but were eventually confined to one quarter, and formed the public meat market. This market, in the time of Nero, was one of the most imposing structures in the city, and some idea of its magnificence has been transmitted to us by a delineation of it preserved on an ancient coin. As the policy and customs of the Romans made themselves felt in Gaul, the Roman system of abattoirs, if it may be so called, was introduced there in an imperfect form. A clique of families in Paris long exercised the special function of catering for the public wants in respect of meat. But as the city increased in magnitude and population, the necessity of keeping slaughter-houses as much as possible apart from dwelling-houses became apparent. As early as the time of Charles IX., the attention of the French authorities was directed to the subject, as is testified by a decree passed on the 25th of February 1567. But although the importance of the question was frequently recognised, no definite or decided step seems to have been taken to effect the contemplated reform until the time of Napoleon I. The evil had then reached a terribly aggravated form. Slaughter-houses abutted on many of the principal thoroughfares; the traffic was impeded by the constant arrival of foot-sore beasts, whose piteous cries pained the ear; and rivulets of blood were to be seen in the gutters of the public streets. The constant accumulation of putrid offal tainted the atmosphere, and the Seine was polluted by being used as a common receptacle for slaughter-house refuse. This condition of things could not be allowed to continue, and on the 9th of February 1810, a decree was passed authorising the construction of abattoirs in the outskirts of Paris, and appointing a Commission, to which was committed the consideration of the entire question.

The result of the appointment of this Commission was the construction of the five existing abattoirs, which were formally opened for business on the 15th of September 1818. The Montmartre abattoir occupies $8\frac{3}{4}$ English acres;



1. Menilmontant Abattoir.

A. Residence of Officials.
B. Sheep and Cattle Sheds.
C. Slaughter-Houses.
D. Yards to do.
E. Stores.
F. Tallow-melting Houses.
G. Steam Engine.
H. Stable with Water Tanks above.
I. Dung Pits.
L. Privies.
M. Layers for Cattle.

Ménilmontant, $10\frac{1}{4}$ acres; Grenelle, $7\frac{3}{4}$; Du Roule, $5\frac{3}{4}$; and Villejuif, $5\frac{1}{2}$. The first two contain each 64 slaughter-houses and the same number of cattle-sheds; the third, 48; and each of the others 32. The dimensions of each of the slaughter-houses is about $29\frac{1}{2}$ feet by 13. The general arrangement of the abattoirs will be understood from the preceding plan of that of Ménilmontant.

The component parts of a French abattoir are—1. *Echaudoirs*, which is the name given by the Paris butcher to the particular division allotted to him for the purpose of knocking down his beasts; 2. *Bouveries et Bergeries*, the places set apart for the animals waiting to be slaughtered, where the animals, instead of being killed at once, after a long and distressing journey, when their blood is heated and their flesh inflamed, are allowed to cool and rest till the body is restored to its normal healthy condition; 3. *Fondeurs*, or boiling-down establishments; and, 4. *Triperies*, which are buildings set apart for the cleaning of the tripe of bullocks, and the fat, heads, and tripe of sheep and calves. Besides these, a Paris abattoir contains *Logements des agens*, *Magasins*, *Réservoirs*, *Voiries*, *Lieux d'aisance*, *Voûtes*, *Remises et écuries*, *Parcs aux Bœufs*, &c., and is provided with an abundant supply of water. All the abattoirs are under the control of the municipal authorities, and frequent inspections are made by persons regularly appointed for that purpose.

The abattoirs are situated within the barriers, each at a distance of about a mile and three-quarters from the heart of the city, in districts where human habitations are still comparatively few. There are two principal markets from which the abattoirs at Paris are supplied,—the one at Poissy, about 13 miles to the north-west, and the other at Sceaux, about 5 miles and a quarter to the south of the city. There are also two markets for cows and calves, namely, La Chapelle and Les Bernadins.

The Paris abattoirs were until recently the most perfect specimens of their class; and even now, although in some of their details they have been surpassed by the new Islington meat market, for their complete and compact arrangement they remain unrivalled.

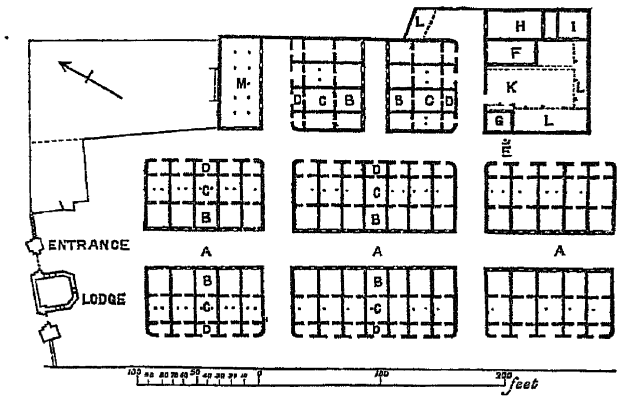
The example set by Paris in this matter has been followed in a more or less modified form by most of the principal Continental towns, and the system of abattoirs has become almost universal in France.

The condition of London in this important sanitary respect was for a long period little more endurable than that of Paris before the adoption of its reformed system. Smithfield market, situated in a very populous neighbourhood, continued till 1852 to be an abomination to the town and a standing reproach to its authorities. No fewer than 243,537 cattle and 1,455,249 sheep were sold there in 1852, to be afterwards slaughtered in the crowded courts and thoroughfares of the metropolis. But public opinion at length forced the Legislature to interfere, and the corporation was compelled to abandon Smithfield market and to provide a substitute for it elsewhere.

The site selected was in the suburb of Islington, and the designs for the work were prepared by Mr Bunning. The first stone was laid March 24, 1854, and the market was opened by Prince Albert, June 15, 1855. The Islington market is undoubtedly the most perfect of its kind. It occupies a space of some 20 acres on the high land near the Pentonville prison, and is open to both native and foreign cattle, excepting beasts from foreign countries under quarantine.

In connection with the Islington cattle market are a few slaughter-houses, half of which were originally public, and half rented to private individuals; but at present they are all practically private, and the majority of the cattle sold are driven away and killed at private slaughter-houses. In this respect the London system differs from that of Paris; and it may be said for the former that the meat is less liable to be spoiled by being carted to a distance, and is therefore probably delivered in better condition; but the latter secures that great desideratum, the practical extinction of isolated slaughter-houses.

The Edinburgh abattoir, erected in 1851 by the corporation, from designs prepared by Mr David Cousin, the city architect, is the best as regards both construction and management in the United Kingdom. It occupies an area of four acres and a quarter, surrounded by a screen-wall, from which, along the greater part of its length, the buildings are separated by a considerable open space. Opposite



2. Edinburgh Slaughter-Houses.

A. Central Roadway.
B. Slaughtering Booths.
C. Cattle Sheds.
D. Enclosed Yards.
E. Well.
F. Steam-Engine.
G. Raised Water Tank.
H. Tripery.
I. Pig-slaughtering House.
K. Court for Cattle.
L. Sheds.
M. Blood House, now Albumen Factory.

the principal gateway is a double row of buildings, extending in a straight line to about 376 feet in length, with a central roadway (marked AA in the annexed plan), 25 feet wide. There are three separate blocks of building on each side of the roadway, the central one being 140 feet in length, and the others 100 feet each—cross-roads 18 feet wide separating the blocks. These ranges of building, as well as two smaller blocks that are placed transversely behind the eastern central block, are divided into compartments, numbering 42 in all, and all arranged on the same plan. Next the roadway is the slaughtering-booth (BB), 18 feet by 24, and 20 feet in height, and behind this is a shed (CC) 18 feet by 22, where the cattle are kept before being slaughtered. All the cattle are driven into these sheds by a back-entrance, through the small enclosed yards (DD). The large doors of the booths are hung by balance weights, and slide up and down, so as to present no obstruction either within the booth or outside. By a series of large ventilators along the roof, and by other contrivances, the slaughtering-booths are thoroughly ventilated. Great precautions have been used to keep rats out of the buildings. To effect this, the booths are laid with thick well-dressed pavement, resting on a stratum of concrete 12 inches thick, and the walls, to the height of 7 feet, are formed of solid ashlar; the roadways, too, are laid with concrete, and causewayed with dressed whinstone pavement; and the drainage consists entirely of glazed earthenware tubes.

The ground on which the abattoir is built was previously connected with a distillery, and contains a well 100 feet deep (E), which, with the extensive system of tunnels attached to it, provides the establishment with an abundant supply of pure water. By means of a steam-engine (F), introduced in 1872, the water is pumped up into a raised tank (G), whence it is distributed to the different booths and sheds, as well as for scouring the roadways and drains. The steam from the engine is utilised in heating water for the numerous cast-iron tanks required in the operations of cleansing and dressing the tripery (H) and pig slaughtering-house (I). By an ingenious arrangement of rotary brushes driven by the steam-engine,—the invention of Mr Rutherford, the superintendent,—the tripe is dressed in a superior manner, and at greatly less cost than by the tedious and troublesome method of hand-cleaning.

By the Edinburgh Slaughter-Houses Act of 1850, the management is vested in the city authorities. Booths are let at a statutory rent of £8 each per annum, and, in addition to this, gate-dues are payable for every beast entering the establishment. The present rates for tenants of booths are $1\frac{1}{2}$d. for an ox or cow, $\frac{3}{4}$d. for a calf or pig, and $\frac{1}{4}$d. for a sheep. Common booths are provided for butchers who are not tenants, on payment of double gate-dues. The city claims the blood, gut, and manure. The tripe and feet are dressed for the trade without extra charge.

The blood was formerly collected in large casks, and disposed of for manufacturing purposes. This necessitated the storage of it for several days, causing in warm weather a very offensive effluvium. It even happened at times, when there was little demand for the commodity, that the blood had to be sent down the drains. All nuisance is now avoided, and the amount received annually for the blood has risen from between £200 and £450 to from £800 to £1200, by a contract into which Messrs Smith and Forrest of Manchester have entered with the city authorities, to take over the whole blood at a fixed price per beast. They have erected extensive premises and apparatus at their own cost, for extracting from the blood the albumen, for which there is great demand in calico-printing, and for converting the clot into manure.

In connection with the establishment is a boiling-house, where all meat unfit for human food is boiled down and destroyed. The number of carcases seized by the inspector, and sent to the boiling-house, during the $5\frac{1}{2}$ years ending with the close of 1872, amounted to 1449, giving a weight of upwards of 400,000 pounds.

Before the erection of these buildings, private slaughter-houses were scattered all over the city, often in the most populous districts, where, through want of drainage and imperfect ventilation, they contaminated the whole neighbourhood. Since the opening of the public abattoir, all private slaughtering, in the city or within a mile of it, is strictly prohibited.

Few of the provincial towns in Great Britain have as yet followed the example of London and Edinburgh. In some instances improvements on the old system have been adopted, but Great Britain is still not only far behind her foreign neighbours in respect of abattoirs, but has even been excelled by some of her own dependencies. In America abattoirs are numerous, and at Calcutta and other towns in British India, the meat markets present a very creditable appearance from their cleanliness and systematic arrangement. (C. N. B.)

ABAUZIT, Firmin, a learned Frenchman, was born of Protestant parents at Uzès, in Languedoc, in 1679. His father, who was of Arabian descent, died when he was but two years of age; and when, on the revocation of the Edict of Nantes in 1685, the authorities took steps to have him educated in the Roman Catholic faith, his mother contrived his escape. For two years his brother and he lived as fugitives in the mountains of the Cevennes, but they at last reached Geneva, where their mother afterwards joined them on escaping from the imprisonment in which she was held from the time of their flight. Abauzit's youth was spent in diligent study, and at an early age he acquired great proficiency in languages, physics, and theology. In 1698 he travelled into Holland, and there became acquainted with Bayle, Jurieu, and Basnage. Proceeding to England, he was introduced to Sir Isaac Newton, who found in him one of the earliest defenders of the great truths his discoveries disclosed to the world.

Sir Isaac corrected in the second edition of his *Principia* an error pointed out by Abauzit. The high estimate Newton entertained of his merits appears from the compliment he paid to Abauzit, when, sending him the *Commercium Epistolicum*, he said, "You are well worthy to judge between Leibnitz and me." The reputation of Abauzit induced William III. to request him to settle in England, but he did not accept the king's offer, preferring to return to Geneva. There from 1715 he rendered valuable assistance to a society that had been formed for translating the New Testament into French. He declined the offer of the chair of philosophy in the University in 1723, but accepted, in 1727, the sinecure office of librarian to the city of his adoption. Here he died at a good old age, in 1767. Abauzit was a man of great learning and of wonderful versatility. The varied knowledge he possessed was so well digested and arranged in his retentive mind as to be always within his reach for immediate use. Whatever chanced to be discussed, it used to be said of Abauzit, as of Professor Whewell of our own times, that he seemed to have made it a subject of particular study. Rousseau, who was jealously sparing of his praises, addressed to him, in his *Nouvelle Héloïse*, a fine panegyric; and when a stranger flatteringly told Voltaire he had come to see a great man, the philosopher asked him if he had seen Abauzit. Little remains of the labours of this intellectual giant, his heirs having, it is said, destroyed the papers that came into their possession, because their religious opinions differed from those of Abauzit. A few theological, archæological, and astronomical articles from his pen appeared in the *Journal Helvétique* and elsewhere, and he contributed several papers to Rousseau's *Dictionary of Music*. A work he wrote throwing doubt on the canonical authority of the Apocalypse was answered—conclusively, as Abauzit himself allowed—by Dr Leonard Twells. He edited, and made valuable additions to Spon's *History of Geneva*. A collection of his writings was published at Geneva in 1770, and another at London in 1773. Some of them were translated into English by Dr Harwood (1770, 1774). Information regarding Abauzit will be found in Senebier's *Histoire Littéraire de Genève*, Harwood's *Miscellanies*, and Orme's *Bibliotheca Biblica*, 1834.

ABB, a town of Yemen in Arabia, situated on a mountain in the midst of a very fertile country, 73 miles N.E. of Mocha. Lat. 13° 58′ N., long. 44° 15′ E. It contains about 800 houses, and is surrounded by a strong wall; the streets are well paved; and an aqueduct from a neighbouring mountain supplies it with water, which is received in a reservoir in front of the principal mosque. The population is about 5000.

ABBADIE, James, an eminent Protestant divine, was born at Nay in Bern about 1657. His parents were poor, but through the kindness of discerning friends, he received an excellent education. He prosecuted his studies with such success, that on completing his course at Sedan, though only seventeen years of age, he had conferred on him the degree of doctor in theology. After spending some years in Berlin as minister of a French Protestant church, he accompanied Marshal Schomberg, in 1688, to England, and became minister of the French church in the Savoy, London. His strong attachment to the cause of King William appears in his elaborate defence of the Revolution, as well as in his history of the conspiracy of 1696, the materials of which were furnished, it is said, by the secretaries of state. The king promoted him to the deanery of Killaloe in Ireland. He died in London in 1727. Abbadie was a man of great ability and an eloquent preacher, but is best known by his religious treatises, several of which were translated from the original French into other languages, and had a wide circulation all over Europe. The most important of these are *Traité de la Vérité de la Religion Chrétienne*; its continuation, *Traité de la Divinité de Jésus-Christ*; and *L'Art de se connaître Soi-même*.

ABBAS I., surnamed The Great, one of the most celebrated of the sovereigns of Persia, was the youngest son of Shah Mohammed Khodabendeh. After heading a successful rebellion against his father, and causing one of his brothers (or, as some say, both) to be assassinated, he obtained possession of the throne at the early age of eighteen (1585). Determined to raise the fallen fortunes of his country, he first directed his efforts against the predatory Uzbeks, who occupied and harassed Khorasan. After a long and severe struggle, he defeated them in a great battle near Herat (1597), and drove them out of his dominions. In the wars he carried on with the Turks during nearly the whole of his reign, his successes were numerous, and he acquired or regained a large extent of territory. By the victory he gained at Bassorah (1605), he extended his empire beyond the Euphrates; Achmed I. was forced to cede Shirwan and Kurdistan in 1611; the united armies of the Turks and Tartars were completely defeated near Sultanieh in 1618, and Abbas made peace on very favourable terms; and on the Turks renewing the war, Baghdad fell into his hands after a year's siege (1623). In the same year he took the island of Ormuz from the Portuguese, by the assistance of the British. When he died in 1628, his dominions reached from the Tigris to the Indus. Abbas distinguished himself, not only by his successes in arms, and by the magnificence of his court, but also by his reforms in the administration of his kingdom. He encouraged commerce, and, by constructing highways and building bridges, did much to facilitate it. To foreigners, especially Christians, he showed a spirit of tolerance; two Englishmen, Sir Anthony and Sir Robert Shirley, were admitted to his confidence, and seem to have had much influence over him. His fame is tarnished, however, by numerous deeds of tyranny and cruelty. His own family, especially, suffered from his fits of jealousy; his eldest son was slain, and the eyes of his other children were put out, by his orders.

ABBAS MIRZA (*b.* 1785, *d.* 1833), Prince of Persia, third son of the Shah Feth Ali, was destined by his father to succeed him in the government, because of his mother's connection with the royal tribe of the Khadjars. He led various expeditions against the Russians, but generally without success (1803, 1813, 1826). By a treaty made between Russia and Persia in 1828, the right of Abbas to the succession was recognised. When the Russian deputies were murdered by the Persian populace in 1829, Abbas was sent to St Petersburg, where he received a hearty welcome from the Czar, and made himself a favourite by his courtesy and literary taste. He formed a design against Herat, but died shortly after the siege had been opened by his son, who succeeded Feth Ali as the Shah Mohammed Mirza. He was truthful—a rare quality in an Eastern—plain in dress and style of living, and fond of literature.

ABBASSIDES, the caliphs of Baghdad, the most famous dynasty of the sovereigns of the Mahometan or Saracen empire. They derived their name and descent from Abbas (*b.* 566, *d.* 652 A.D.), the uncle and adviser of Mahomet, and succeeded the dynasty of the Ommiads, the caliphs of Damascus. Early in the 8th century the family of Abbas had acquired great influence from their near relationship to the Prophet; and Ibrahim, the fourth in descent from Abbas, supported by the province of Khorasan, obtained several successes over the Ommiad armies, but was captured and put to death by the Caliph Merwan (747). Ibrahim's brother, Abul-Abbas, whom he

had named his heir, assumed the title of caliph, and, by a decisive victory near the river Zab (750), effected the overthrow of the Ommiad dynasty. Merwan fled to Egypt, but was pursued and put to death, and the vanquished family was treated with a severity which gained for Abul-Abbas the surname of Al-Saffah, the Blood-shedder. From this time the house of Abbas was fully established in the government, but the Spanish provinces were lost to the empire by the erection of an independent caliphate of Cordova, under Abderrahman.

On the death of Abul-Abbas, Almansur succeeded to the throne, and founded Baghdad as the seat of empire. He and his son Mohdi waged war successfully against the Turkomans and Greeks of Asia Minor; but from this time the rule of the Abbassides is marked rather by the development of the liberal arts than by extension of territory. The strictness of the Mohammedan religion was relaxed, and the faithful yielded to the seductions of luxury. The caliphs Harun Al-Rashid (786-809) and Al-Mamun (813 833) attained a world-wide celebrity by their gorgeous palaces, their vast treasures, and their brilliant and numerous equipages, in all which their splendour contrasted strikingly with the poverty of European sovereigns. The former is known as one of the heroes of the *Arabian Nights;* the latter more worthily still as a liberal patron of literature and science. It is a mistake, however, to look in the rule of these caliphs for the lenity of modern civilisation. "No Christian government," says Hallam, "except perhaps that of Constantinople, exhibits such a series of tyrants as the caliphs of Baghdad, if deeds of blood, wrought through unbridled passion or jealous policy, may challenge the name of tyranny."

The territory of the Abbassides soon suffered dismemberment, and their power began to decay. Rival sovereignties (Ashlabites, Edrisites, &c.) arose in Africa, and an independent government was constituted in Khorasan (820), under the Taherites. In the West, again, the Greeks encroached upon the possessions of the Saracens in Asia Minor. Ruin, however, came from a less civilised race. The caliphs had continually been waging war with the Tartar hordes of Turkestan, and many captives taken in these wars were dispersed throughout the empire. Attracted by their bravery and fearing rebellion among his subjects, Motassem (833-842), the founder of Samarah, and successful opponent of the Grecian forces under Theophilus, formed body-guards of the Turkish prisoners, who became from that time the real governors of the Saracen empire. Motawakkel, son of Motassem, was assassinated by them in the palace (861); and succeeding caliphs became mere puppets in their hands. Radhi (934-941) was compelled by the disorganised condition of his kingdom to delegate to Mohammed ben Rayek (936 A.D.), under the title of *Emir-al-Omara*, commander of the commanders, the government of the army and the other functions of the caliphate. Province after province proclaimed itself independent; the caliph's rule became narrowed to Baghdad and its vicinity; and the house of Abbas lost its power in the East for ever, when Hulagu, prince of the Mongols, set Baghdad on fire, and slew Motassem, the reigning caliph (20th Feb. 1258). The Abbassides continued to hold a semblance of power in the merely nominal caliphate of Egypt, and feebly attempted to recover their ancient seat. The last of them, Motawakkel III., was taken by Sultan Selim I., the conqueror of Egypt, to Constantinople, and detained there for some time as a prisoner. He afterwards returned to Egypt, and died at Cairo a pensionary of the Ottoman government, in 1538.

ABBÉ is the French word corresponding to ABBOT, but, from the middle of the sixteenth century to the time of the French Revolution, the term had a wider application. The assumption by a numerous class of the name and style of abbé appears to have originated in the right conceded to the King of France, by a concordat between Pope Leo X. and Francis I., to appoint *abbés commendataires* to 225 abbeys, that is, to most of the abbeys in France. This kind of appointment, whereby the living was *commended* to some one till a proper election could take place, though ostensibly provisional, really put the nominee in full and permanent possession of the benefice. He received about one-third of the revenues of the abbey, but had no share in its government, the charge of the house being intrusted to a resident officer, the *prieur claustral.* The *abbés commendataires* were not necessarily priests; the papal bull required indeed that they should take orders within a stated time after their appointment, but there seems to have been no difficulty in procuring relief from that obligation. The expectation of obtaining these sinecures drew young men towards the Church in considerable numbers, and the class of abbés so formed—*abbés de cour* they were sometimes called, and sometimes (ironically) *abbés de sainte espérance,* abbés of St Hope—came to hold a recognised position, that perhaps proved as great an attraction as the hope of preferment. The connection many of them had with the Church was of the slenderest kind, consisting mainly in adopting the name of abbé, after a remarkably moderate course of theological study; practising celibacy; and wearing a distinctive dress—a short dark-violet coat with narrow collar. Being men of presumed learning and undoubted leisure, many of the class found admission to the houses of the French nobility as tutors or advisers. Nearly every great family had its abbé. As might be imagined from the objectless sort of life the class led, many of the abbés were of indifferent character; but there are not a few instances of abbés attaining eminence, both in political life and in the walks of literature and science. The Abbé Sieyès may be taken as a prominent example of the latter type.

ABBEOKUTA, or ABEOKUTA, a town of West Africa in the Yoruba Country, situated in N. lat. 7° 8′, and E. long. 3° 25′, on the Ogun River, about 50 miles north of Lagos, in a direct line, or 81 miles by water. It lies in a beautiful and fertile country, the surface of which is broken by masses of grey granite. Like most African towns, Abbeokuta is spread over an extensive area, being surrounded by mud walls, 18 miles in extent. The houses are also of mud, and the streets mostly narrow and filthy. There are numerous markets in which native products and articles of European manufacture are exposed for sale. Palm-oil and shea-butter are the chief articles of export, and it is expected that the cotton of the country will become a valuable article of commerce. The slave trade and human sacrifices have been abolished; but notwithstanding the efforts of English and American missionaries, the natives are still idle and degraded. The state called Egbaland, of which Abbeokuta is the capital, has an area of about 3000 square miles. Its progress has been much hindered by frequent wars with the king of Dahomey. Population of the town, about 150,000; of the state or adjacent territory, 50,000. (See Burton's *Abbeokuta and the Cameroon Mountains*, 2 vols.)

ABBESS, the female superior of an abbey or convent of nuns. The mode of election, position, rights, and authority of an abbess, correspond generally with those of an abbot. The office was elective, the choice being by the secret votes of the sisters from their own body. The abbess was solemnly admitted to her office by episcopal benediction, together with the conferring of a staff and pectoral, and held it for life, though liable to be deprived for misconduct. The Council of Trent fixes the qualifying age at forty, with eight years of profession. Abbesses had

a right to demand absolute obedience of their nuns, over whom they exercised discipline, extending even to the power of expulsion, subject, however, to the bishop. As a female an abbess was incapable of performing the spiritual functions of the priesthood belonging to an abbot. She could not ordain, confer the veil, nor excommunicate. In the eighth century abbesses were censured for usurping priestly powers by presuming to give the veil to virgins, and to confer benediction and imposition of hands on men. In England they attended ecclesiastical councils, *e.g.* that of Becanfield in 694, where they signed before the presbyters.

By Celtic usage abbesses presided over joint-houses of monks and nuns. This custom accompanied Celtic monastic missions to France and Spain, and even to Rome itself. At a later period, A.D. 1115, Robert, the founder of Fontevraud, committed the government of the whole order, men as well as women, to a female superior.

Martene asserts that abbesses formerly confessed nuns, but that their undue inquisitiveness rendered it necessary to forbid the practice.

The dress of an English abbess of the 12th century consisted of a long white tunic with close sleeves, and a black overcoat as long as the tunic, with large and loose sleeves, the hood covering the head completely. The abbesses of the 14th and 15th centuries had adopted secular habits, and there was little to distinguish them from their lay sisters. (E. V.)

ABBEVILLE, a city of France, in the department of the Somme, is situated on the River Somme, 12 miles from its mouth in the English Channel, and 25 miles N.W. of Amiens. It lies in a pleasant and fertile valley, and is built partly on an island, and partly on both sides of the river. The streets are narrow, and the houses are mostly picturesque old structures, built of wood, with many quaint decaying gables and dark archways. The town is strongly fortified on Vauban's system. It has a tribunal and chamber of commerce. The most remarkable edifice is the Church of St Wolfran, which was erected in the time of Louis XII. Although the original design was not completed, enough was built to give a good idea of the splendid structure it was intended to erect. The façade is a magnificent specimen of the flamboyant Gothic style, and is adorned by rich tracery, while the western front is flanked by two Gothic towers. A cloth manufactory was established here by Van Robais, a Dutchman, under the patronage of the minister Colbert, as early as 1669; and since that time Abbeville has continued to be one of the most thriving manufacturing towns in France. Besides black cloths of the best quality, there are produced velvets, cottons, linens, serges, sackings, hosiery, packthread, jewellery, soap, and glass-wares. It has also establishments for spinning wool, print-works, bleaching-works, tanneries, a paper manufactory, &c.; and being situated in the centre of a populous district, it has a considerable trade with the surrounding country. Vessels of from 200 to 300 tons come up to the town at high-water. Abbeville is a station on the Northern Railway, and is also connected with Paris and Belgium by canals. Fossil remains of gigantic mammalia now extinct, as well as the rude flint weapons of pre-historic man, have been discovered in the geological deposits of the neighbourhood. A treaty was concluded here in 1259 between Henry III. of England and Louis IX. of France, by which the province of Guienne was ceded to the English. Population, 20,058.

ABBEY, a monastery, or conventual establishment, under the government of an ABBOT or an ABBESS. A *priory* only differed from an abbey in that the superior bore the name of *prior* instead of *abbot*. This was the case in all the English conventual cathedrals, *e.g.*, Canterbury, Ely, Norwich, &c., where the archbishop or bishop occupied the abbot's place, the superior of the monastery being termed prior. Other priories were originally offshoots from the larger abbeys, to the abbots of which they continued subordinate; but in later times the actual distinction between abbeys and priories was lost. Abbey.

Reserving for the article MONASTICISM the history of the rise and progress of the monastic system, its objects, benefits, evils, its decline and fall, we propose in this article to confine ourselves to the structural plan and arrangement of conventual establishments, and a description of the various buildings of which these vast piles were composed.

The earliest Christian monastic communities with which we are acquainted consisted of groups of cells or huts collected about a common centre, which was usually the abode of some anchorite celebrated for superior holiness or singular asceticism, but without any attempt at orderly arrangement. The formation of such communities in the East does not date from the introduction of Christianity. The example had been already set by the Essenes in Judea and the Therapeutæ in Egypt, who may be considered the prototypes of the industrial and meditative communities of monks. Cells.

In the earliest age of Christian monasticism the ascetics were accustomed to live singly, independent of one another, at no great distance from some village, supporting themselves by the labour of their own hands, and distributing the surplus after the supply of their own scanty wants to the poor. Increasing religious fervour, aided by persecution, drove them further and further away from the abodes of men into mountain solitudes or lonely deserts. The deserts of Egypt swarmed with the cells or huts of these anchorites. Antony, who had retired to the Egyptian Thebaid during the persecution of Maximin, A.D. 312, was the most celebrated among them for his austerities, his sanctity, and his power as an exorcist. His fame collected round him a host of followers, emulous of his sanctity. The deeper he withdrew into the wilderness, the more numerous his disciples became. They refused to be separated from him, and built their cells round that of their spiritual father. Thus arose the first monastic community, consisting of anchorites living each in his own little dwelling, united together under one superior. Antony, as Neander remarks (*Church History*, vol. iii. p. 316, Clark's Trans.), "without any conscious design of his own, had become the founder of a new mode of living in common, Cœnobitism." By degrees order was introduced in the groups of huts. They were arranged in lines like the tents in an encampment, or the houses in a street. From this arrangement these lines of single cells came to be known as *Lauræ*, Λαῦραι, "streets" or "lanes."

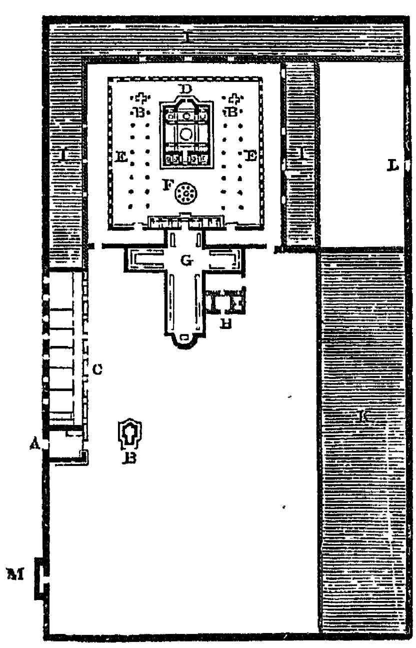
The real founder of cœnobian monasteries in the modern sense was Pachomius, an Egyptian of the beginning of the 4th century. The first community established by him was at Tabennæ, an island of the Nile in Upper Egypt. Eight others were founded in his lifetime, numbering 3000 monks. Within 50 years from his death his societies could reckon 50,000 members. These cœnobia resembled villages, peopled by a hard-working religious community, all of one sex. The buildings were detached, small, and of the humblest character. Each cell or hut, according to Sozomen (H. E. iii. 14), contained three monks. They took their chief meal in a common refectory at 3 P.M., up to which hour they usually fasted. They ate in silence, with hoods so drawn over their faces that they could see nothing but what was on the table before them. The monks spent all the time, not devoted to religious services or study, in manual labour. Palladius, who visited the Egyptian monasteries about the close of the 4th century, found among the 300 Cœnobi

Cœnobia. members of the Cœnobium of Panopolis, under the Pachomian rule, 15 tailors, 7 smiths, 4 carpenters, 12 camel-drivers, and 15 tanners. Each separate community had its own *œconomus*, or steward, who was subject to a chief *œconomus* stationed at the head establishment. All the produce of the monks' labour was committed to him, and by him shipped to Alexandria. The money raised by the sale was expended in the purchase of stores for the support of the communities, and what was over was devoted to charity. Twice in the year the superiors of the several *cœnobia* met at the chief monastery, under the presidency of an Archimandrite ("the chief of the fold," from μάνδρα, a fold), and at the last meeting gave in reports of their administration for the year.

The *cœnobia* of Syria belonged to the Pachomian institution. We learn many details concerning those in the vicinity of Antioch from Chrysostom's writings. The monks lived in separate huts, κάλυβαι, forming a religious hamlet on the mountain side. They were subject to an abbot, and observed a common rule. (They had no refectory, but ate their common meal, of bread and water only, when the day's labour was over, reclining on strewn grass, sometimes out of doors.) Four times in the day they joined in prayers and psalms.

The necessity for defence from hostile attacks, economy of space, and convenience of access from one part of the community to another, by degrees dictated a more compact and orderly arrangement of the buildings of a monastic cœnobium. Large piles of building were erected, with strong outside walls, capable of resisting the assaults of an enemy, within which all the necessary edifices were ranged round one or more open courts, usually surrounded with cloisters. The usual Eastern arrangement is exemplified

Santa Laura, Mt. Athos. in the plan of the convent of Santa Laura, Mt. Athos (*Laura*, the designation of a monastery generally, being converted into a female saint).

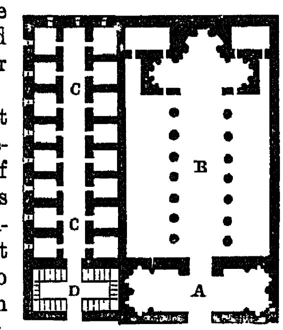


A. Gateway.
B. Chapels.
C. Guest-house.
D. Church.
E. Cloister.
F. Fountain.
G. Refectory
H. Kitchen.
I. Cells.
K. Storehouses.
L. Postern Gate.
M. Tower.

Monastery of Santa Laura, Mount Athos (Lenoir).

This monastery, like the Oriental monasteries generally is surrounded by a strong and lofty blank stone wall, enclosing an area of between 3 and 4 acres. The longer side extends to a length of about 500 feet. There is only one main entrance, on the north side (A), defended by three separate iron doors. Near the entrance is a large tower (M), a constant feature in the monasteries of the Levant. There is a small postern gate at (L.) The *enceinte* comprises two large open courts, surrounded with buildings connected with cloister galleries of wood or stone. The outer court, which is much the larger, contains the granaries and storehouses (K), and the kitchen (H), and other offices connected with the refectory (G). Immediately adjacent to the gateway is a two-storeyed guest-house, opening from a cloister (C). The inner court is surrounded by a cloister (EE), from which open the monks' cells (II). In the centre of this court stands the catholicon or conventual church, a square building with an apse of the cruciform domical Byzantine type, approached by a domed narthex. In front of the church stands a marble fountain (F), covered by a dome supported on columns. Opening from the western side of the cloister, but actually standing in the outer court, is the refectory (G), a large cruciform building, about 100 feet each way, decorated within with frescoes of saints. At the upper end is a semicircular recess, recalling the Triclinium of the Lateran Palace at Rome, in which is placed the seat of the *Hegumenos* or abbot. This apartment is chiefly used as a hall of meeting, the Oriental monks usually taking their meals in their separate cells. St Laura is exceeded in magnitude by the Convent of Vatopede, also on Mount Athos. This Vatopede.
enormous establishment covers at least 4 acres of ground, and contains so many separate buildings within its massive walls that it resembles a fortified town. It lodges above 300 monks, and the establishment of the Hegumenos is described as resembling the court of a petty sovereign prince. The immense refectory, of the same cruciform shape as that of St Laura, will accommodate 500 guests at its 24 marble tables.

The annexed plan of a Coptic monastery, from Lenoir shows us a church of three aisles, with cellular apses, and two ranges of cells on either side of an oblong gallery.



Plan of Coptic Monastery.

A. Narthex.
B. Church.
C. Corridor, with cells on each side.
D. Staircase.

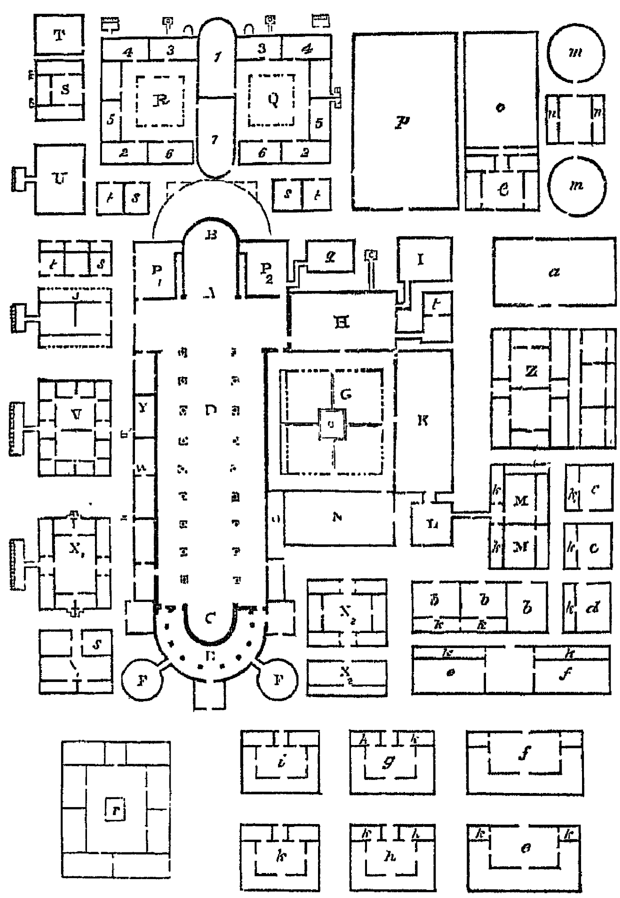
Monasticism in the West owes its extension and development to Benedict of Nursia (born A.D. 480). His rule was diffused with miraculous rapidity from the parent foundation on Monte Cassino through the whole of Western Europe, and every country witnessed the erection of monasteries far exceeding anything that had yet been seen in spaciousness and splendour. Few great towns in Italy were without their Benedictine convent, Benedictine.
and they quickly rose in all the great centres of population in England, France, and Spain. The number of these monasteries founded between A.D. 520 and 700 is amazing. Before the Council of Constance, A.D. 1415, no fewer than 15,070 abbeys had been established of this order alone. The Benedictine rule, spreading with the vigour of a young and powerful life, absorbed into itself the older monastic foundations, whose discipline had too usually become disgracefully relaxed. In the words of Milman (*Latin Christianity*, vol. i. p. 425, note x.), "The Benedictine rule was universally received, even in the older monasteries of Gaul, Britain, Spain, and throughout the West, not as that of a rival order (all rivalry was of later date), but as a more full and perfect rule of the monastic life." Not only, therefore, were new monasteries founded, but those already existing were pulled down, and rebuilt to adapt them to the requirements of the new rule.

The buildings of a Benedictine abbey were uniformly arranged after one plan, modified where necessary (as at

Durham and Worcester, where the monasteries stand close to the steep bank of a river), to accommodate the arrangement to local circumstances.

St Gall.

We have no existing examples of the earlier monasteries of the Benedictine order. They have all yielded to the ravages of time and the violence of man. But we have fortunately preserved to us an elaborate plan of the great Swiss monastery of St Gall, erected about A.D. 820, which puts us in possession of the whole arrangements of a monastery of the first class towards the early part of the 9th century. This curious and interesting plan has been made the subject of a memoir both by Keller (Zurich, 1844) and by Professor Willis (*Arch. Journal*, 1848, vol. v. pp. 86–117). To the latter we are indebted for the



Ground-plan of St Gall.

CHURCH.

A. High Altar.
B Altar of St Paul.
C Altar of St Peter.
D. Nave.
E. Paradise.
FF. Towers.

MONASTIC BUILDINGS.

G. Cloister.
H. Calefactory, with Dormitory over.
I. Necessary.
J. Abbot's house.
K. Refectory.
L. Kitchen.
M. Bakehouse and Brewhouse.
N. Cellar.
O. Parlour.
P_1 Scriptorium, with Library over.
P_2. Sacristy and Vestry.
Q. House of Novices—1. Chapel; 2. Refectory; 3. Calefactory; 4. Dormitory; 5. Master's Room; 6. Chambers.
R. Infirmary—1–6 as above in the House of Novices.
S. Doctor's House.
T. Physic Garden.
U. House for blood-letting.
V. School.
W. Schoolmaster's Lodgings.
X_1X_1. Guest-house for those of superior rank.
X_2X_2. Guest-house for the poor.
Y. Guest-chamber for strange monks.

MENIAL DEPARTMENT.

Z. Factory.
a. Threshing-floor.
b. Workshops.
c, *c*. Mills.
d. Kiln.
e. Stables.
f. Cowsheds.
g. Goatsheds.
h. Pig-sties. *i*. Sheep-folds.
k, *k*, *k*. Servants' and workmen's sleeping chambers.
l. Gardener's house.
m, *m*. Hen and Duck house.
n. Poultry-keeper's house.
o. Garden.
p. Cemetery.
q. Bakehouse for Sacramental Bread.
r. Unnamed in Plan.
s, *s*, *s*. Kitchens.
t, *t*, *t*. Baths.

substance of the following description, as well as for the above woodcut, reduced from his elucidated transcript of the original preserved in the archives of the convent. The general appearance of the convent is that of a town of isolated houses with streets running between them. It is evidently planned in compliance with the Benedictine rule, which enjoined that, if possible, the monastery should contain within itself every necessary of life, as well as the buildings more intimately connected with the religious and social life of its inmates. It should comprise a mill, a bakehouse, stables and cow-houses, together with accommodation for carrying on all necessary mechanical arts within the walls, so as to obviate the necessity of the monks going outside its limits. The general distribution of the buildings may be thus described:—The church, with its cloister to the south, occupies the centre of a quadrangular area, about 430 feet square. The buildings, as in all great monasteries, are distributed into groups. The church forms the nucleus, as the centre of the religious life of the community. In closest connection with the church is the group of buildings appropriated to the monastic life and its daily requirements—the refectory for eating, the dormitory for sleeping, the common room for social intercourse, the chapter-house for religious and disciplinary conference. These essential elements of monastic life are ranged about a cloister court, surrounded by a covered arcade, affording communication sheltered from the elements, between the various buildings. The infirmary for sick monks, with the physician's house and physic garden, lies to the east. In the same group with the infirmary is the school for the novices. The outer school, with its head-master's house against the opposite wall of the church, stands outside the convent enclosure, in close proximity to the abbot's house, that he might have a constant eye over them. The buildings devoted to hospitality are divided into three groups,—one for the reception of distinguished guests, another for monks visiting the monastery, a third for poor travellers and pilgrims. The first and third are placed to the right and left of the common entrance of the monastery,—the hospitium for distinguished guests being placed on the north side of the church, not far from the abbot's house; that for the poor on the south side next to the farm buildings. The monks are lodged in a guest-house built against the north wall of the church. The group of buildings connected with the material wants of the establishment is placed to the south and west of the church, and is distinctly separated from the monastic buildings. The kitchen, buttery, and offices, are reached by a passage from the west end of the refectory, and are connected with the bakehouse and brewhouse, which are placed still further away. The whole of the southern and western sides is devoted to workshops, stables, and farm-buildings. The buildings, with some exceptions, seem to have been of one story only, and all but the church were probably erected of wood. The whole includes thirty-three separate blocks. The church (D) is cruciform, with a nave of nine bays, and a semicircular apse at either extremity. That to the west is surrounded by a semicircular colonnade, leaving an open "Paradise" (E) between it and the wall of the church. The whole area is divided by screens into various chapels. The high altar (A) stands immediately to the east of the transept, or ritual choir; the altar of St Paul (B) in the eastern, and that of St Peter (C) in the western apse. A cylindrical campanile stands detached from the church on either side of the western apse (FF).

The "cloister court" (G) on the south side of the nave of the church has on its east side the "pisalis" or "calefactory" (H), the common sitting-room of the brethren, warmed by flues beneath the floor. On this side in later monasteries we invariably find the chapter-house, the absence of which in this plan is somewhat surprising. It appears, however from the inscriptions on the plan itself, that the

north walk of the cloisters served for the purposes of a chapter-house, and was fitted up with benches on the long sides. Above the calefactory is the "dormitory" opening into the south transept of the church, to enable the monks to attend the nocturnal services with readiness. A passage at the other end leads to the "necessarium" (I), a portion of the monastic buildings always planned with extreme care. The southern side is occupied by the "refectory" (K), from the west end of which by a vestibule the kitchen (L) is reached. This is separated from the main buildings of the monastery, and is connected by a long passage with a building containing the bakehouse and brewhouse (M), and the sleeping-rooms of the servants. The upper story of the refectory is the "vestiarium," where the ordinary clothes of the brethren were kept. On the western side of the cloister is another two story building (N). The cellar is below, and the larder and store-room above. Between this building and the church, opening by one door into the cloisters, and by another to the outer part of the monastery area, is the "parlour" for interviews with visitors from the external world (O). On the eastern side of the north transept is the "scriptorium" or writing-room (P_1), with the library above.

To the east of the church stands a group of buildings comprising two miniature conventual establishments, each complete in itself. Each has a covered cloister surrounded by the usual buildings, *i.e.*, refectory, dormitory, &c., and a church or chapel on one side, placed back to back. A detached building belonging to each contains a bath and a kitchen. One of these diminutive convents is appropriated to the "oblati" or novices (Q), the other to the sick monks as an "infirmary" (R).

The "residence of the physicians" (S) stands contiguous to the infirmary, and the physic garden (T) at the north-east corner of the monastery. Besides other rooms, it contains a drug store, and a chamber for those who are dangerously ill. The "house for blood-letting and purging" adjoins it on the west (U).

The "outer school," to the north of the convent area, contains a large school-room divided across the middle by a screen or partition, and surrounded by fourteen little rooms, termed the dwellings of the scholars. The head-master's house (W) is opposite, built against the side wall of the church. The two "hospitia" or "guest-houses" for the entertainment of strangers of different degrees (X_1 X_2) comprise a large common chamber or refectory in the centre, surrounded by sleeping apartments. Each is provided with its own brewhouse and bakehouse, and that for travellers of a superior order has a kitchen and store-room, with bed-rooms for their servants, and stables for their horses. There is also an "hospitium" for strange monks, abutting on the north wall of the church (Y).

Beyond the cloister, at the extreme verge of the convent area to the south, stands the "factory" (Z), containing workshops for shoemakers, saddlers (or shoemakers, *sellarii*); cutlers and grinders, trencher-makers, tanners, curriers, fullers, smiths, and goldsmiths, with their dwellings in the rear. On this side we also find the farm-buildings, the large granary and threshing-floor (*a*), mills (*c*), malthouse (*d*). Facing the west are the stables (*e*), ox-sheds (*f*), goat-stables (*g*), piggeries (*h*), sheep-folds (*i*), together with the servants' and labourers' quarters (*k*). At the south-east corner we find the hen and duck house, and poultry-yard (*m*), and the dwelling of the keeper (*n*). Hard by is the kitchen garden (*o*), the beds bearing the names of the vegetables growing in them, onions, garlic, celery, lettuces, poppy, carrots, cabbages, &c., eighteen in all. In the same way the physic garden presents the names of the medicinal herbs, and the cemetery (*p*) those of the trees, apple, pear, plum, quince, &c., planted there.

It is evident, from this most curious and valuable document, that by the 9th century monastic establishments had become wealthy, and had acquired considerable importance, and were occupying a leading place in education, agriculture, and the industrial arts. The influence such an institution would diffuse through a wide district would be no less beneficial than powerful.

The curious bird's eye view of Canterbury Cathedral and its annexed conventual buildings, taken about 1165, preserved in the Great Psalter in the library of Trinity College, Cambridge, as elucidated by Professor Willis with such admirable skill and accurate acquaintance with the existing remains,[1] exhibits the plan of a great Benedictine monastery in the 12th century, and enables us to compare it with that of the 9th, as seen at St Gall. We see in both the same general principles of arrangement, which indeed belong to all Benedictine monasteries, enabling us to determine with precision the disposition of the various buildings, when little more than fragments of the walls exist. From some local reasons, however, the cloister and monastic buildings are placed on the north, instead, as is far more commonly the case, on the south of the church. There is also a separate chapter-house, which is wanting at St Gall. Canterbury.

The buildings at Canterbury, as at St Gall, form separate groups. The church forms the nucleus. In immediate contact with this, on the north side, lie the cloister and the group of buildings devoted to the monastic life. Outside of these, to the west and east, are the "halls and chambers devoted to the exercise of hospitality, with which every monastery was provided, for the purpose of receiving as guests persons who visited it, whether clergy or laity, travellers, pilgrims, or paupers." To the north a large open court divides the monastic from the menial buildings, intentionally placed as remote as possible from the conventual buildings proper, the stables, granaries, barn, bakehouse, brewhouse, laundries, &c., inhabited by the lay servants of the establishment. At the greatest possible distance from the church, beyond the precinct of the convent, is the eleemosynary department. The *almonry* for the relief of the poor, with a great hall annexed, forms the pauper's hospitium.

The most important group of buildings is naturally that devoted to monastic life. This includes two cloisters, the great cloister surrounded by the buildings essentially connected with the daily life of the monks,—the church to the south, the refectory or frater-house here as always on the side opposite to the church, and furthest removed from it, that no sound or smell of eating might penetrate its sacred precincts, to the east the dormitory, raised on a vaulted undercroft, and the chapter-house adjacent, and the lodgings of the cellarer to the west. To this officer was committed the provision of the monks' daily food, as well as that of the guests. He was, therefore, appropriately lodged in the immediate vicinity of the refectory and kitchen, and close to the guest-hall. A passage under the dormitory leads eastwards to the smaller or infirmary cloister, appropriated to the sick and infirm monks. Eastward of this cloister extend the hall and chapel of the infirmary, resembling in form and arrangement the nave and chancel of an aisled church. Beneath the dormitory, looking out into the green court or herbarium, lies the "pisalis" or "calefactory," the common room of the monks. At its north-east corner access was given from the dormitory to the *necessarium*, a portentous edifice in the form of a Norman hall, 145 feet long by 25 broad, containing fifty-five seats. It was, in common with all such offices in ancient monasteries, constructed with the most careful regard to cleanliness and

[1] *The Architectural History of the Conventual Buildings of the Monastery of Christ Church in Canterbury.* By the Rev. Robert Willis. Printed for the Kent Archæological Society, 1869.

health, a stream of water running through it from end to end. A second smaller dormitory runs from east to west for the accommodation of the conventual officers, who were bound to sleep in the dormitory. Close to the refectory, but outside the cloisters, are the domestic offices connected with it; to the north, the kitchen, 47 feet square, surmounted by a lofty pyramidal roof, and the kitchen court; to the west, the butteries, pantries, &c. The infirmary had a small kitchen of its own. Opposite the refectory door in the cloister are two lavatories, an invariable adjunct to a monastic dining-hall, at which the monks washed before and after taking food.

The buildings devoted to hospitality were divided into three groups. The prior's group "entered at the south-east angle of the green court, placed near the most sacred part of the cathedral, as befitting the distinguished ecclesiastics or nobility who were assigned to him." The cellarer's buildings, were near the west end of the nave, in which ordinary visitors of the middle class were hospitably entertained. The inferior pilgrims and paupers were relegated to the north hall or almonry, just within the gate, as far as possible from the other two.

Westminster

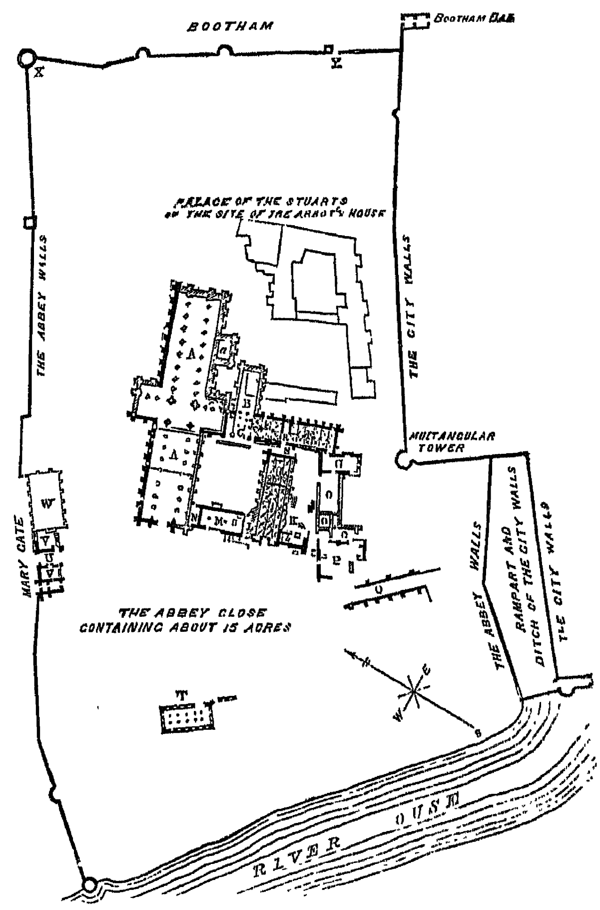
Westminster Abbey is another example of a great Benedictine abbey, identical in its general arrangements, so far as they can be traced, with those described above. The cloister and monastic buildings lie to the south side of the church. Parallel to the nave, on the south side of the cloister, was the refectory, with its lavatory at the door. On the eastern side we find the remains of the dormitory, raised on a vaulted substructure, and communicating with the south transept. The chapter-house opens out of the same alley of the cloister. The small cloister lies to the south-east of the larger cloister, and still farther to the east we have the remains of the infirmary, with the *table hall*, the refectory of those who were able to leave their chambers. The abbot's house formed a small court-yard at the west entrance, close to the inner gateway. Considerable portions of this remain, including the abbot's parlour, celebrated as "the Jerusalem Chamber," his hall, now used for the Westminster King's scholars, and the kitchen and butteries beyond.

York.

St Mary's Abbey, York, of which the ground-plan is annexed, exhibits the usual Benedictine arrangements. The precincts are surrounded by a strong fortified wall on three sides, the river Ouse being sufficient protection on the fourth side. The entrance was by a strong gateway (U) to the north. Close to the entrance was a chapel, where is now the church of St Olaf (W), in which the new comers paid their devotions immediately on their arrival. Near the gate to the south was the guest's-hall or hospitium (T). The buildings are completely ruined, but enough remains to enable us to identify the grand cruciform church (A), the cloister-court with the chapter-house (B), the refectory (I), the kitchen-court with its offices (K, O, O), and the other principal apartments. The infirmary has perished completely.

Some Benedictine houses display exceptional arrangements, dependent upon local circumstances, *e.g.*, the dormitory of Worcester runs from east to west, from the west walk of the cloister, and that of Durham is built over the west, instead of as usual, over the east walk; but, as a general rule, the arrangements deduced from the examples described may be regarded as invariable.

The history of Monasticism is one of alternate periods of decay and revival. With growth in popular esteem came increase in material wealth, leading to luxury and worldliness. The first religious ardour cooled, the strictness of the rule was relaxed, until by the 10th century the decay of discipline was so complete in France that the monks are said to have been frequently unacquainted with the rule of St Benedict, and even ignorant that they were bound by any rule at all. (Robertson's *Church History*, ii. p. 538.) These alternations are reflected in the monastic buildings and the arrangements of the establishment.



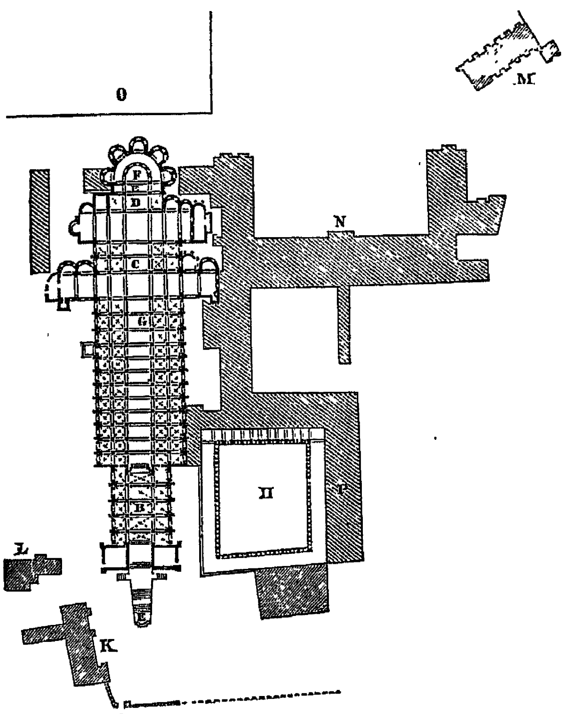
St Mary's Abbey, York (Benedictine).—Churton's Monastic Ruins.

A. Church.	O. Offices
B. Chapter-house.	P. Cellars.
C. Vestibule to do.	Q. Uncertain
E. Library or Scriptorium.	R. Passage to Abbot's House.
F. Calefactory.	S. Passage to Common House.
G. Necessary.	T. Hospitium.
H. Parlour.	U. Great Gate.
I. Refectory.	V. Porter's Lodge.
K. Great Kitchen and Court.	W. Church of St Olaf.
L. Cellarer's Office.	X. Tower.
M. Cellars.	Y. Entrance from Bootham
N. Passage to Cloister.	

The reformation of these prevalent abuses generally took the form of the establishment of new monastic orders, with new and more stringent rules, requiring a modification of the architectural arrangements. One of the earliest of these reformed orders was the *Cluniac*. This order took its name from the little village of Clugny, 12 miles N.W. of Macon, near which, about A.D. 909, a reformed Benedictine abbey was founded by William, Duke of Auvergne, under Berno, abbot of Beaume. He was succeeded by Odo, who is often regarded as the founder of the order. The fame of Clugny spread far and wide. Its rigid rule was adopted by a vast number of the old Benedictine abbeys, who placed themselves in affiliation to the mother society, while new foundations sprang up in large numbers, all owing allegiance to the "archabbot," established at Clugny. By the end of the 12th century the number of monasteries affiliated to Clugny in the various countries of Western Europe amounted to 2000. The monastic establishment of Clugny was one of the most extensive and magnificent in France. We may form some idea of its enormous dimensions from the fact recorded, that when, A.D. 1245, Pope Innocent IV., accompanied by twelve

Clugny.

cardinals, a patriarch, three archbishops, the two generals of the Carthusians and Cistercians, the king (St Louis), and three of his sons, the queen mother, Baldwin, Count of Flanders and Emperor of Constantinople, the Duke of Burgundy, and six lords, visited the abbey, the whole party, with their attendants, were lodged within the monastery without disarranging the monks, 400 in number. Nearly the whole of the abbey buildings, including the magnificent church, were swept away at the close of the last century. When the annexed ground-plan was taken, shortly before its destruction, nearly all the monastery, with the exception of the church, had been rebuilt. The church, the ground-plan of which bears a remarkable resemblance to that of Lincoln Cathedral, was of vast dimensions. It was 656 feet by 130 feet wide. The nave was 102 feet, and the aisles 60 feet high. The nave (G) had double



Abbey of Clugny, from Viollet le Duc.

A. Gateway.	F. Tomb of St Hugh.	M. Bakehouse.
B. Narthex.	G. Nave.	N. Abbey Buildings.
C. Choir.	H. Cloister.	O. Garden.
D. High-Altar.	K. Abbot's House.	P. Refectory.
E. Retro-Altar.	L. Guest-House.	

vaulted aisles on either side. Like Lincoln, it had an eastern as well as a western transept, each furnished with apsidal chapels to the east. The western transept was 213 feet long, and the eastern 123 feet. The choir terminated in a semicircular apse (F), surrounded by five chapels, also semicircular. The western entrance was approached by an ante-church, or *narthex* (B), itself an aisled church of no mean dimensions, flanked by two towers, rising from a stately flight of steps bearing a large stone cross. To the south of the church lay the cloister-court (H), of immense size, placed much further to the west than is usually the case. On the south side of the cloister stood the refectory (P), an immense building, 100 feet long and 60 feet wide, accommodating six longitudinal and three transverse rows of tables. It was adorned with the portraits of the chief benefactors of the abbey, and with Scriptural subjects. The end wall displayed the Last Judgment. We are unhappily unable to identify any other of the principal buildings (N). The abbot's residence (K), still partly standing, adjoined the entrance-gate. The guest-house (L) was close by. The bakehouse (M), also remaining, is a detached building of immense size. The first English house of the Cluniac order was that of Lewes, founded by the Earl of Warren, *cir.* A.D. 1077. Of this only a few fragments of the domestic buildings exist. The best preserved Cluniac houses in England are Castle Acre, Norfolk, and Wenlock, in Shropshire. Ground-plans of both are given in Britton's *Architectural Antiquities*. They show several departures from the Benedictine arrangement. In each the prior's house is remarkably perfect. All Cluniac houses in England were French colonies, governed by priors of that nation. They did not secure their independence nor become "abbeys" till the reign of Henry VI. The Cluniac revival, with all its brilliancy, was but short lived. The celebrity of this, as of other orders, worked its moral ruin. With their growth in wealth and dignity the Cluniac foundations became as worldly in life and as relaxed in discipline as their predecessors, and a fresh reform was needed. The next great monastic revival, the Cistercian, arising in the last years of the 11th century, had a wider diffusion, and a longer and more honourable existence. Owing its real origin, as a distinct foundation of reformed Benedictines, in the year 1098, to a countryman of our own, Stephen Harding (a native of Dorsetshire, educated in the monastery of Sherborne), and deriving its name from Citeaux (*Cistercium*), a desolate and almost inaccessible forest solitude, on the borders of Champagne and Burgundy, the rapid growth and wide celebrity of the order is undoubtedly to be attributed to the enthusiastic piety of St Bernard, abbot of the first of the monastic colonies, subsequently sent forth in such quick succession by the first Cistercian houses, the far-famed abbey of Clairvaux (de Clara Valle), A.D. 1116.

English Cluniac.

Cistercian.

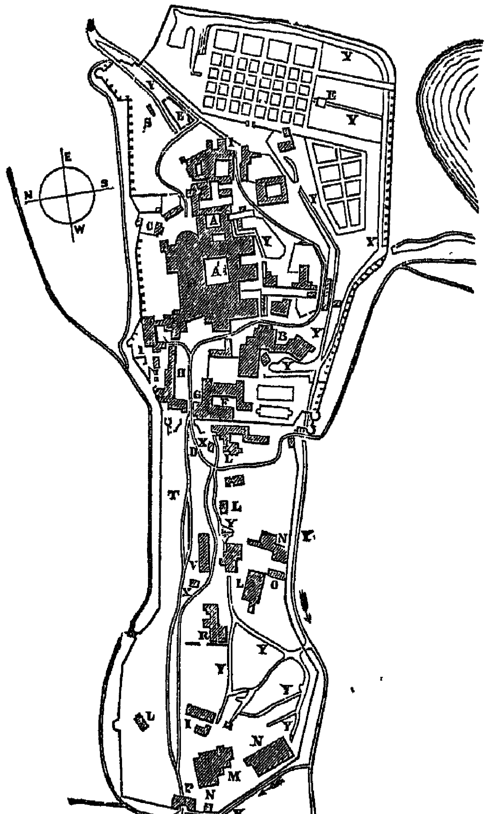
The rigid self-abnegation, which was the ruling principle of this reformed congregation of the Benedictine order, extended itself to the churches and other buildings erected by them. The characteristic of the Cistercian abbeys was the extremest simplicity and a studied plainness. Only one tower—a central one—was permitted, and that was to be very low. Unnecessary pinnacles and turrets were prohibited. The triforium was omitted. The windows were to be plain and undivided, and it was forbidden to decorate them with stained glass. All needless ornament was proscribed. The crosses must be of wood; the candlesticks of iron. The renunciation of the world was to be evidenced in all that met the eye. The same spirit manifested itself in the choice of the sites of their monasteries. The more dismal, the more savage, the more hopeless a spot appeared, the more did it please their rigid mood. But they came not merely as ascetics, but as improvers. The Cistercian monasteries are, as a rule, found placed in deep well-watered valleys. They always stand on the border of a stream; not rarely, as at Fountains, the buildings extend over it. These valleys, now so rich and productive, wore a very different aspect when the brethren first chose them as the place of their retirement. Wide swamps, deep morasses, tangled thickets, wild impassable forests, were their prevailing features. The "Bright Valley," *Clara Vallis* of St Bernard, was known as the "Valley of Wormwood," infamous as a den of robbers. "It was a savage dreary solitude, so utterly barren that at first Bernard and his companions were reduced to live on beech leaves."—(Milman's *Lat. Christ.* vol. iii. p. 335.)

All Cistercian monasteries, unless the circumstances of the locality forbade it, were arranged according to one plan. The general arrangement and distribution of the various buildings, which went to make up one of these vast establishments, may be gathered from that of St Bernard's own Abbey of Clairvaux, which is here given.

Clairvaux.

It will be observed that the abbey precincts are surrounded by a strong wall, furnished at intervals with watch-

Clairvaux. towers and other defensive works. The wall is nearly encircled by a stream of water, artificially diverted from the small rivulets which flow through the precincts, furnishing the establishment with an abundant supply in every part, for the irrigation of the gardens and orchards, the sanitary requirements of the brotherhood, and for the use of the offices and workshops. The precincts are divided across the centre by a wall, running from N. to S., into an outer and inner ward,—the former containing the menial, the latter the monastic buildings. The precincts are entered by a gateway (P), at the extreme western extremity, giving admission to the lower ward. Here the barns, granaries, stables, shambles, workshops, and workmen's lodgings were placed, without any regard to sym-

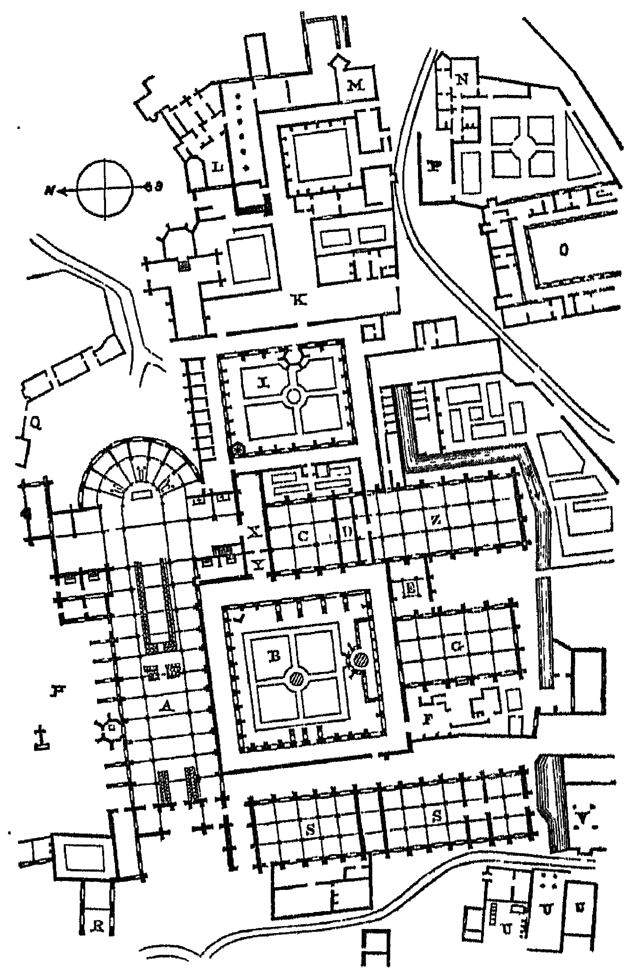


Clairvaux, No. 1 (Cistercian), General Plan.

A. Cloisters.	H. Stables.	O. Public Presse
B Ovens, and Corn and Oil-mills.	I. Wine-press and Hay-chamber.	P. Gateway
C. St Bernard's Cell.	K. Parlour.	R. Remains of Old Monastery.
D. Chief Entrance.	L. Workshops and workmen's Lodgings.	S. Oratory.
E. Tanks for Fish.	M. Slaughter-house.	V. Tile-works.
F. Guest House.	N. Barns and Stables.	X. Tile-kiln.
G. Abbot's House.		Y. Water-courses.

metry, convenience being the only consideration. Advancing eastwards, we have before us the wall separating the outer and inner ward, and the gatehouse (D) affording communication between the two. On passing through the gateway, the outer court of the inner ward was entered, with the western *façade* of the monastic church in front. Immediately on the right of entrance was the abbot's house (G), in close proximity to the guest-house (F). On the other side of the court were the stables, for the accommodation of the horses of the guests and their attendants (H). The church occupied a central position. To the south were the great cloister (A), surrounded by the chief monastic buildings, and further to the east the smaller cloister, opening out of which were the infirmary, novices' lodgings, and quarters for the aged monks. Still further to the east, divided from the monastic buildings by a wall, were the vegetable gardens and orchards, and tank for fish. The large fish-ponds, an indispensable adjunct to any ecclesiastical foundation, on the formation of which the monks lavished extreme care and pains, and which often remain as almost the only visible traces of these vast establishments, were placed outside the abbey walls.

The Plan No. 2 furnishes the ichnography of the distinctly monastic buildings on a larger scale. The usually unvarying arrangement of the Cistercian houses allows us to accept this as a type of the monasteries of this order. The church (A) is the chief feature. It consists of a vast nave of eleven bays, entered by a narthex, with a transept and short apsidal choir. (It may be remarked that the eastern limb in all unaltered Cistercian churches is remarkably short, and usually square.) To the east of each limb of



Clairvaux, No. 2 (Cistercian), Monastic Buildings.

A. Church.	K. Infirmary.	S. Cellars and Store-houses.
B. Cloister.	L. Lodgings of Novices.	T. Water-course.
C. Chapter-House.	M. Old Guest-House.	U. Saw-mill and Oil-mill.
D. Monks' Parlour	N. Old Abbot's Lodgings.	V. Currier's Workshops.
E. Calefactory.	O. Cloister of Supernumerary Monks.	X. Sacristy.
F. Kitchen and Court.	P. Abbot's Hall.	Y. Little Library
G. Refectory.	Q. Cell of St Bernard.	Z. Undercroft of Dormitory.
H. Cemetery.	R. Stables.	
I. Little Cloister.		

the transept are two square chapels, divided according to Cistercian rule by solid walls. Nine radiating chapels, similarly divided, surround the apse. The stalls of the monks, forming the ritual choir, occupy the four eastern bays of the nave. There was a second range of stalls in the extreme western bays of the nave for the *fratres conversi*, or lay brothers. To the south of the church, so as to secure as much sun as possible, the cloister was invariably placed, except when local reasons forbade it. Round the cloister (B) were ranged the buildings connected with the monks' daily life. The chapter-house (C) always opened out of the east walk of the cloister in a line with the

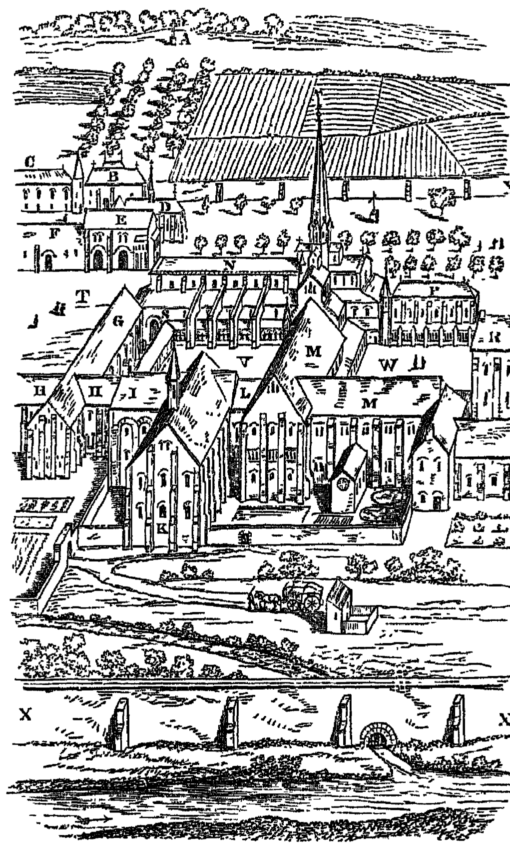
Clairvaux. south transept. In Cistercian houses this was quadrangular, and was divided by pillars and arches into two or three aisles. Between it and the transept we find the sacristy (X), and a small book room (Y), *armariolum*, where the brothers deposited the volumes borrowed from the library. On the other side of the chapter-house, to the south, is a passage (D) communicating with the courts and buildings beyond. This was sometimes known as the *parlour*, *colloquii locus*, the monks having the privilege of conversation here. Here also, when discipline became relaxed, traders, who had the liberty of admission, were allowed to display their goods. Beyond this we often find the *calefactorium* or *day-room*—an apartment warmed by flues beneath the pavement, where the brethren, half-frozen during the night offices, betook themselves after the conclusion of lauds, to gain a little warmth, grease their sandals, and get themselves ready for the work of the day. In the plan before us this apartment (E) opens from the south cloister walk, adjoining the refectory. The place usually assigned to it is occupied by the vaulted substructure of the *dormitory* (Z). The *dormitory*, as a rule, was placed on the east side of the cloister, running over the *calefactory* and *chapter-house*, and joined the south transept, where a flight of steps admitted the brethren into the church for nocturnal services. Opening out of the dormitory was always the *necessarium*, planned with the greatest regard to health and cleanliness, a water-course invariably running from end to end. The refectory opens out of the south cloister at (G). The position of the refectory is usually a marked point of difference between Benedictine and Cistercian abbeys. In the former, as at Canterbury, the refectory ran east and west parallel to the nave of the church, on the side of the cloister furthest removed from it. In the Cistercian monasteries, to keep the noise and sound of dinner still further away from the sacred building, the refectory was built north and south, at right angles to the axis of the church. It was often divided, sometimes into two, sometimes, as here, into three aisles. Outside the refectory door, in the cloister, was the *lavatory*, where the monks washed their hands at dinner time. The buildings belonging to the material life of the monks lay near the refectory, as far as possible from the church, to the S.W. With a distinct entrance from the outer court was the kitchen court (F), with its buttery, scullery, and larder, and the important adjunct of a stream of running water. Further to the west, projecting beyond the line of the west front of the church, were vast vaulted apartments (SS), serving as cellars and storehouses, above which was the dormitory of the *conversi*. Detached from these, and separated entirely from the monastic buildings, were various workshops, which convenience required to be banished to the outer precincts, a saw-mill and oil-mill (UU) turned by water, and a currier's shop (V), where the sandals and leathern girdles of the monks were made and repaired.

Returning to the cloister, a vaulted passage admitted to the small cloister (I), opening from the north side of which were eight small cells, assigned to the scribes employed in copying works for the library, which was placed in the upper story, accessible by a turret staircase. To the south of the small cloister a long hall will be noticed. This was a *lecture-hall*, or rather a hall for the religious disputations customary among the Cistercians. From this cloister opened the *infirmary* (K), with its hall, chapel, cells, blood-letting house, and other dependencies. At the eastern verge of the vast group of buildings we find the *novices' lodgings* (L), with a third cloister near the novices' quarters and the original guest-house (M). Detached from the great mass of the monastic edifices was the original abbot's house (N), with its dining-hall (P). Closely adjoining to this, so that the eye of the father of the whole establishment should be constantly over those who stood the most in need of his watchful care,—those who were training for the monastic life, and those who had worn themselves out in its duties,—was a fourth cloister (O), with annexed buildings, devoted to the aged and infirm members of the establishment. The cemetery, the last resting-place of the brethren, lay to the north side of the nave of the church (H).

It will be seen that the arrangement of a Cistercian monastery was in accordance with a clearly-defined system, and admirably adapted to its purpose.

The base court nearest to the outer wall contained the buildings belonging to the functions of the body as agriculturalists and employers of labour. Advancing into the inner court, the buildings devoted to hospitality are found close to the entrance; while those connected with the supply of the material wants of the brethren,—the kitchen, cellars, &c.,—form a court of themselves outside the cloister, and quite detached from the church. The church refectory, dormitory, and other buildings belonging to the professional life of the brethren, surround the great cloister. The small cloister beyond, with its scribes' cells, library, hall for disputations, &c., is the centre of the literary life of the community. The requirements of sickness and old age are carefully provided for in the infirmary cloister, and that for the aged and infirm members of the establishment. The same group contains the quarters of the novices.

This stereotyped arrangement is further illustrated by Citeaux. the accompanying bird's eye view of the mother establishment of Citeaux. A cross (A), planted on the high road



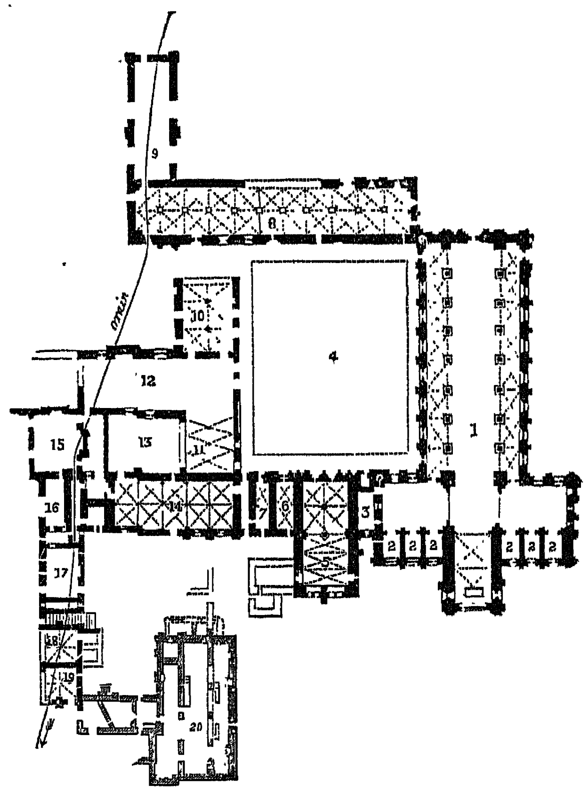
Bird's eye View of Citeaux.

A. Cross.
B. Gate-House.
C. Almonry.
D. Chapel.
E. Inner Gate-House.
F. Stable.
G. Dormitory of Lay Brethren.
H. Abbot's House.
I. Kitchen.
K. Refectory.
L. Staircase to Dormitory.
M. Dormitory.
N. Church.
P. Library.
R. Infirmary.
S. Door to the Church for the Lay Brothers
T. Base Court.
V. Great Cloister.
W. Small Cloister.
X. Boundary Wall.

Citeaux. directs travellers to the gate of the monastery, reached by an avenue of trees. On one side of the gate-house (B) is a long building (C), probably the almonry, with a dormitory above for the lower class of guests. On the other side is a chapel (D). As soon as the porter heard a stranger knock at the gate, he rose, saying, *Deo gratias*, the opportunity for the exercise of hospitality being regarded as a cause for thankfulness. On opening the door he welcomed the new arrival with a blessing—*Benedicite.* He fell on his knees before him, and then went to inform the abbot. However important the abbot's occupations might be, he at once hastened to receive him whom heaven had sent. He also threw himself at his guest's feet, and conducted him to the chapel (D) purposely built close to the gate. After a short prayer, the abbot committed the guest to the care of the brother hospitaller, whose duty it was to provide for his wants, and conduct the beast on which he might be riding to the stable (F), built adjacent to the inner gate-house (E). This inner gate conducted into the base court (T), round which were placed the barns, stables, cow-sheds, &c. On the eastern side stood the dormitory of the lay brothers, *fratres conversi* (G), detached from the cloister, with cellars and storehouses below. At (H), also outside the monastic buildings proper, was the abbot's house, and annexed to it the guest-house. For these buildings there was a separate door of entrance into the church (S). The large cloister, with its surrounding arcades, is seen at V. On the south end projects the refectory (K), with its kitchen at (I), accessible from the base court. The long gabled building on the east side of the cloister contained on the ground floor the chapter-house and calefactory, with the monks' dormitory above (M), communicating with the south transept of the church. At (L) was the staircase to the dormitory. The small cloister is at (W), where were the *carols* or cells of the scribes, with the library (P) over, reached by a turret staircase. At (R) we see a portion of the infirmary. The whole precinct is surrounded by a strong buttressed wall (XXX), pierced with arches, through which streams of water are introduced. It will be noticed that the choir of the church is short, and has a square end instead of the usual apse. The tower, in accordance with the Cistercian rule, is very low. The windows throughout accord with the studied simplicity of the order.

England. The English Cistercian houses, of which there are such extensive and beautiful remains at Fountains, Rievaulx, Kirkstall, Tintern, Netley, &c., were mainly arranged after the same plan, with slight local variations. As an example, we give the ground-plan of Kirkstall Abbey, which is one of the best preserved and least altered. The church here

Kirkstall. is of the Cistercian type, with a short chancel of two squares, and transepts with three eastward chapels to each, divided by solid walls (2 2 2). The whole is of the most studied plainness. The windows are unornamented, and the nave has no triforium. The cloister to the south (4) occupies the whole length of the nave. On the east side stands the two-aisled chapter house (5), between which and the south transept is a small sacristy (3), and on the other side two small apartments, one of which was probably the parlour (6). Beyond this stretches southward the calefactory or day-room of the monks (14). Above this whole range of building runs the monks' dormitory, opening by stairs into the south transept of the church. At the other end were the necessaries. On the south side of the cloister we have the remains of the old refectory (11), running, as in Benedictine houses, from east to west, and the new refectory (12), which, with the increase of the inmates of the house, superseded it, stretching, as is usual in Cistercian houses, from north to south. Adjacent to this apartment are the remains of the kitchen, pantry, and buttery. The arches of the lavatory are to be seen near the refectory entrance. The western side of the cloister is, as usual, occupied by vaulted cellars, supporting on the upper story the dormitory of the lay brothers (8). Extending from the south-east angle of the main group of buildings are the walls and foundations of a secondary group of considerable extent. These have been identified either with the hospitium or with the abbot's house, but they occupy the position in which the infirmary is more usually found. The hall was a very spacious apartment, measuring 83 feet in length by 48 feet 9 inches in breadth



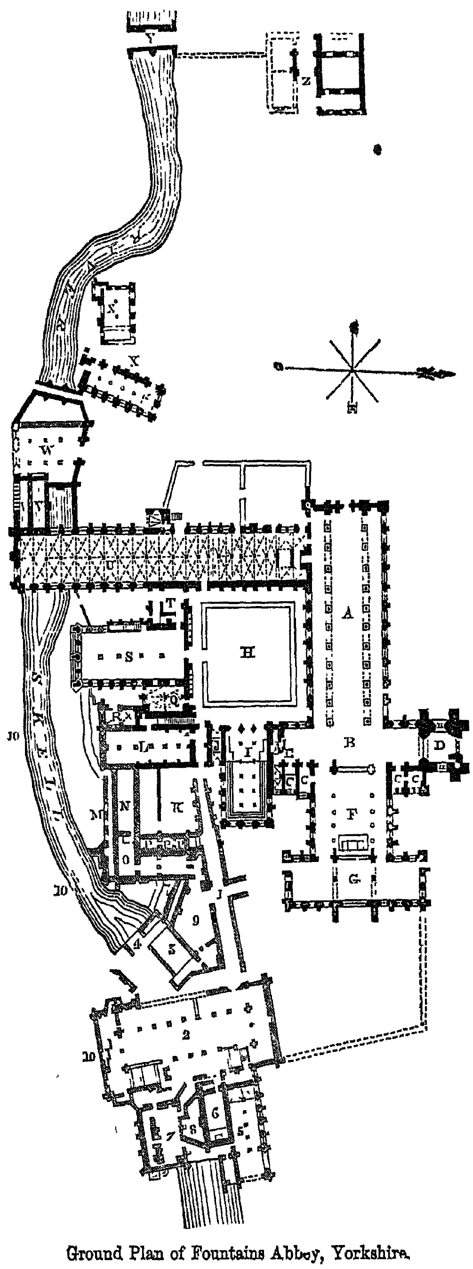
Kirkstall Abbey, Yorkshire (Cistercian).

1. Church.
2. Chapels.
3. Sacristy.
4. Cloister.
5. Chapter-House.
6. Parlour.
7. Punishment Cell (?)
8. Cellars, with Dormitories for conversi over.
9. Guest-House.
10. Common Room.
11. Old Refectory.
12. New Refectory.
13. Kitchen Court.
14. Calefactory or Day-Room.
15. Kitchen and Offices.
16–19. Uncertain; perhaps Offices connected with the Infirmary.
20. Infirmary or Abbot's House.

and was divided by two rows of columns. The fish-ponds lay between the monastery and the river to the south. The abbey mill was situated about 80 yards to the north-west. The mill-pool may be distinctly traced, together with the gowt or mill stream.

Fountains. Fountains Abbey, first founded A.D. 1132, deserves special notice, as one of the largest and best preserved Cistercian houses in England. But the earlier buildings received considerable additions and alterations in the later period of the order, causing deviations from the strict Cistercian type. The church stands a short distance to the north of the river Skell, the buildings of the abbey stretching down to and even across the stream. We have the cloister (H) to the south, with the three-aisled chapter-house (I) and calefactory (L) opening from its eastern walk, and the refectory (S), with the kitchen (Q) and buttery (T) attached, at right angles to its southern walk. Parallel with the western walk is an immense vaulted substructure (U), incorrectly styled the cloisters, serving as cellars and store-rooms, and supporting the dormitory of the *conversi* above. This building extended across the river At its

S.W. corner were the necessaries (V), also built, as usual, above the swiftly flowing stream. The monks' dormitory was in its usual position above the chapter-house, to the south of the transept. As peculiarities of arrangement may be noticed the position of the kitchen (Q), between the refectory and calefactory, and of the infirmary (W) (unless there is some error in its designation) above the river to



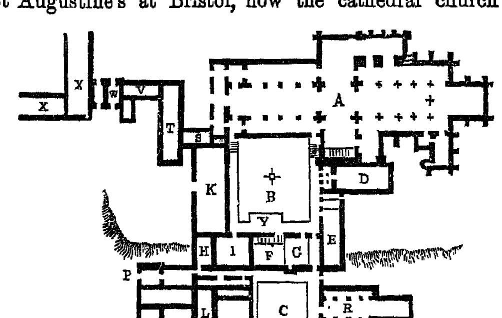
Ground Plan of Fountains Abbey, Yorkshire.

A. Nave of the Church.	N. Cellar.	Z. Gate-House.
B. Transept.	O. Brew House.	ABBOT'S HOUSE.
C. Chapels.	P. Prisons.	1. Passage.
D. Tower.	Q. Kitchen.	2. Great Hall.
E. Sacristy.	R. Offices.	3. Refectory.
F. Choir.	S. Refectory.	4. Buttery.
G. Chapel of Nine Altars.	T Buttery	5. Storehouse.
H. Cloister.	U. Cellars and Storehouses.	6. Chapel.
I. Chapter-House.	V. Necessary.	7. Kitchen.
K Base Court.	W. Infirmary (?)	8. Ashpit.
L. Calefactory.	X. Guest-Houses.	9. Yard.
M. Water Course.	Y. Mill Bridge.	10. Kitchen Tank.

the west, adjoining the guest-houses (XX). We may also call attention to the greatly lengthened choir, commenced by Abbot John of York, 1203–1211, and carried on by his successor, terminating, like Durham Cathedral, in an eastern transept, the work of Abbot John of Kent, 1220–1247, and to the tower (D), added not long before the dissolution by Abbot Huby, 1494–1526, in a very unusual position at the northern end of the north transept. The abbot's house, the largest and most remarkable example of this class of buildings in the kingdom, stands south to the east of the church and cloister, from which it is divided by the kitchen court (K), surrounded by the ordinary domestic offices. A considerable portion of this house was erected on arches over the Skell. The size and character of this house, probably, at the time of its erection, the most spacious house of a subject in the kingdom, not a castle, bespeaks the wide departure of the Cistercian order from the stern simplicity of the original foundation. The hall (2) was one of the most spacious and magnificent apartments in mediæval times, measuring 170 feet by 70 feet. Like the hall in the castle at Winchester, and Westminster Hall, as originally built, it was divided by 18 pillars and arches, with 3 aisles. Among other apartments, for the designation of which we must refer to the ground-plan, was a domestic oratory or chapel, $46\frac{1}{2}$ feet by 23 feet, and a kitchen (7), 50 feet by 38 feet. The whole arrangements and character of the building bespeak the rich and powerful feudal lord, not the humble father of a body of hard-working brethren, bound by vows to a life of poverty and self-denying toil. In the words of Dean Milman, "the superior, once a man bowed to the earth with humility, care-worn, pale, emaciated, with a coarse habit bound with a cord, with naked feet, had become an abbot on his curvetting palfrey, in rich attire, with his silver cross before him, travelling to take his place amid the lordliest of the realm."—(*Lat. Christ.*, vol. iii. p. 330.)

Black or Austin Canons.

The buildings of the *Austin Canons* or *Black Canons* (so called from the colour of their habit) present few distinctive peculiarities. This order had its first seat in England at Colchester, where a house for Austin Canons was founded about A.D. 1105, and it very soon spread widely. As an order of regular clergy, holding a middle position between monks and secular canons, almost resembling a community of parish priests living under rule, they adopted naves of great length to accommodate large congregations. The choir is usually long, and is sometimes, as at Llanthony and Christ Church (Twynham), shut off from the aisles, or, as at Bolton, Kirkham, &c., is destitute of aisles altogether. The nave in the northern houses, not unfrequently, had only a north aisle, as at Bolton, Brinkburn, and Lanercost. The arrangement of the monastic buildings followed the ordinary type. The prior's lodge was almost invariably attached to the S.W. angle of the nave. The annexed plan of the Abbey of St Augustine's at Bristol, now the cathedral church of Bristol.



St Augustine's Abbey, Bristol (Bristol Cathedral).

A. Church.	H. Kitchen.	S. Friars' Lodging.
B. Great Cloister.	I. Kitchen Court.	T. King's Hall
C. Little Cloister.	K. Cellars.	V. Guest-House.
D. Chapter-House.	L. Abbot's Hall.	W. Abbey Gateway.
E. Calefactory.	P. Abbot's Gateway.	X. Barns, Stables, &c.
F. Refectory.	R. Infirmary.	Y. Lavatory.
G. Parlour.		

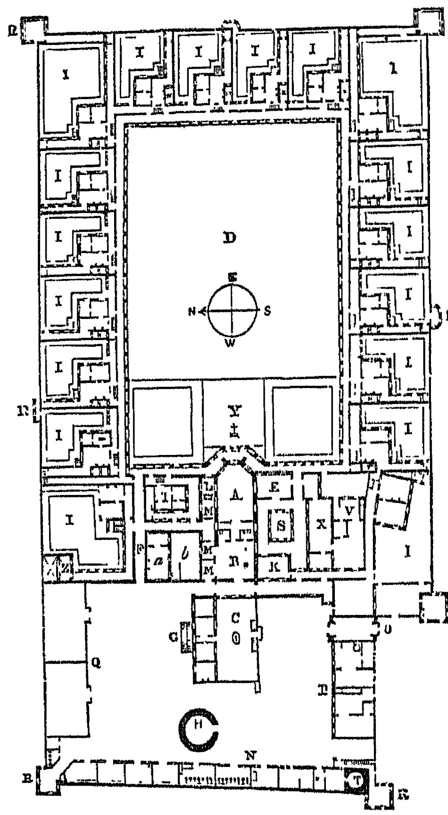
that city, shows the arrangement of the buildings, which departs very little from the ordinary Benedictine type. The Austin Canons' house at Thornton, in Lincolnshire, is remarkable for the size and magnificence of its gate-house, the upper floors of which formed the guest-house of the establishment, and for possessing an octagonal chapter-house of Decorated date.

Premonstratensian. The *Premonstratensian* regular canons, or White Canons, had as many as 35 houses in England, of which the most perfect remaining are those of Easby, Yorkshire, and Bayham, Sussex. The head house of the order in England was Welbeck. This order was a reformed branch of the Austin canons, founded, A.D. 1119, by Norbert (born at Xanten, on the Lower Rhine, c. 1080) at Prémontré, a secluded marshy valley in the forest of Coucy, in the diocese of Laon. The order spread widely. Even in the founder's lifetime it possessed houses in Syria and Palestine. It long maintained its rigid austerity, till in the course of years wealth impaired its discipline, and its members sank into indolence and luxury. The Premonstratensians were brought to England shortly after A.D. 1140, and were first settled at Newhouse, in Lincolnshire, near the Humber. The ground-plan of Easby Abbey, owing to its situation on the edge of the steeply-sloping banks of a river, is singularly irregular. The cloister is duly placed on the south side of the church, and the chief buildings occupy their usual positions round it. But the cloister garth, as at Chichester, is not rectangular, and all the surrounding buildings are thus made to sprawl in a very awkward fashion. The church follows the plan adopted by the Austin canons in their northern abbeys, and has only one aisle to the nave—that to the north; while the choir is long, narrow, and aisleless. Each transept has an aisle to the east, forming three chapels.

The church at Bayham was destitute of aisle either to nave or choir. The latter terminated in a three-sided apse. This church is remarkable for its exceeding narrowness in proportion to its length. Extending in longitudinal dimensions 257 feet, it is not more than 25 feet broad. To adopt the words of Mr Beresford Hope—"Stern Premonstratensian canons wanted no congregations, and cared for no processions; therefore they built their church like a long room."

Carthusian. The *Carthusian* order, on its establishment by St Bruno, about A.D. 1084, developed a greatly modified form and arrangement of a monastic institution. The principle of this order, which combined the cœnobitic with the solitary life, demanded the erection of buildings on a novel plan. This plan, which was first adopted by St Bruno and his twelve companions at the original institution at Chartreux, near Grenoble, was maintained in all the Carthusian establishments throughout Europe, even after the ascetic severity of the order had been to some extent relaxed, and the primitive simplicity of their buildings had been exchanged for the magnificence of decoration which characterises such foundations as the *Certosas* of Pavia and Florence. According to the rule of St Bruno, all the members of a Carthusian brotherhood lived in the most absolute solitude and silence. Each occupied a small detached cottage, standing by itself in a small garden surrounded by high walls and connected by a common corridor or cloister. In these cottages or cells a Carthusian monk passed his time in the strictest asceticism, only leaving his solitary dwelling to attend the services of the Church, except on certain days when the brotherhood assembled in the refectory.

The peculiarity of the arrangements of a Carthusian monastery, or *charter-house*, as it was called in England, from a corruption of the French *chartreux*, is exhibited in the plan of that of Clermont, from Viollet le Duc. Clermont. The whole establishment is surrounded with a wall, furnished at intervals with watch towers (R). The enclosure is divided into two courts, of which the eastern court, surrounded by a cloister, from which the cottages of the monks (I) open, is much the larger. The two courts are

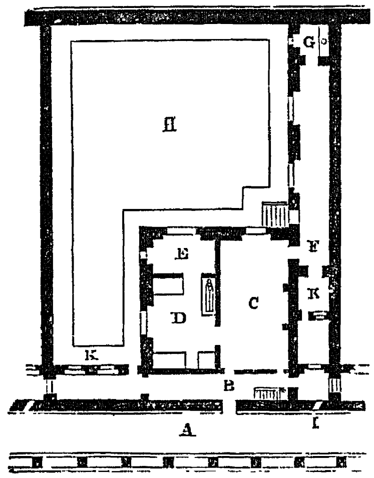


A. Church.
B. Monks Choir.
C. Prior's Garden.
D. Great Cloister.
E. Chapter-House.
F. Passage.
G. Prior's Lodgings.
H. Dovecot.
I. Cells.
K. Chapel of Pontgibaud.
L. Sacristy.
M. Chapel.
N. Stables.
O. Gateway.
P. Guest-Chambers.
Q. Barns and Granaries.
R. Watch Towers
S. Little Cloister
T. Bakehouse.
V. Kitchen.
X. Refectory.
Y. Cemetery.
Z. Prison.
a. Cell of Sub-prior
b. Garden of do.

Carthusian Monastery of Clermont.

divided by the main buildings of the monastery, including the church, the sanctuary (A), divided from (B), the monks' choir, by a screen with two altars, the smaller cloister to the south (S) surrounded by the chapter-house (E), the refectory (X)—these buildings occupying their normal position—and the chapel of Pontgibaud (K). The kitchen with its offices (V) lies behind the refectory, accessible from the outer court without entering the cloister. To the north of the church, beyond the sacristy (L), and the side chapels (M), we find the cell of the sub-prior (*a*), with its garden. The lodgings of the prior (G) occupy the centre of the outer court, immediately in front of the west door of the church, and face the gateway of the convent (O). A small raised court with a fountain (C) is before it. This outer court also contains the guest-chambers (P), the stables, and lodgings of the lay brothers (N), the barns and granaries (Q), the dovecot (H), and the bakehouse (T). At (Z) is the prison. (In this outer court, in all the earlier foundations, as at Witham, there was a smaller church in addition to the larger church of the monks.) The outer and inner court are connected by a long passage (F), wide enough to admit a cart laden with wood to supply the cells of the brethren with fuel. The number of cells surrounding the great cloister is 18. They are all arranged on a uniform plan. Each little dwelling contains three rooms: a sitting-room (C), warmed with a stove in winter; a sleeping-room (D), furnished with a bed, a table, a bench, and a bookcase; and a closet (E). Between the cell and the cloister gallery (A) is a passage or corridor (B), cutting off the inmate of the cell from all sound or movement which might interrupt his meditations. The superior had

Clermont. free access to this corridor, and through open niches was able to inspect the garden without being seen. At (I) is the hatch or turn-table, in which the daily allowance of food was deposited by a brother appointed for that purpose, affording no view either inwards or outwards. (H) is the garden,



Carthusian Cell, Clermont.

cultivated by the occupant of the cell. At (K) is the wood-house. (F) is a covered walk, with the necessary at the end. These arrangements are found with scarcely any variation in all the charter-houses of Western Europe. The Yorkshire Charter-house of Mount Grace, founded by Thomas Holland the young Duke of Surrey, nephew of Richard II., and Marshal of England, during the revival of the popularity of the order, about A.D. 1397, is the most perfect and best preserved English example. It is characterised by all the simplicity of the order. The church is a modest building, long, narrow, and aisleless. Within the wall of enclosure are two courts. The smaller of the two, the south, presents the usual arrangement of church, refectory, &c., opening out of a cloister. The buildings are plain and solid. The northern court contains the cells, 14 in number. It is surrounded by a double stone wall, the two walls being about 30 feet or 40 feet apart. Between these, each in its own garden, stand the cells; low-built two-storied cottages, of two or three rooms on the ground-floor, lighted with a larger and a smaller window to the side, and provided with a doorway to the court, and one at the back, opposite to one in the outer wall, through which the monk may have conveyed the sweepings of his cell and the refuse of his garden to the "eremus" beyond. By the side of the door to the court is a little hatch, through which the daily pittance of food was supplied, so contrived by turning at an angle in the wall that no one could either look in or look out. A very perfect example of this hatch —an arrangement belonging to all Carthusian houses— exists at Miraflores, near Burgos, which remains nearly as it was completed in 1480.

Witham. There were only nine Carthusian houses in England. The earliest was that at Witham in Somersetshire, founded by Henry II., by whom the order was first brought into England. The wealthiest and most magnificent was that of Shene or Richmond in Surrey, founded by Henry V. about A.D. 1414. The dimensions of the buildings at Shene are stated to have been remarkably large. The great court measured 300 feet by 250 feet; the cloisters were a square of 500 feet; the hall was 110 feet in length by 60 feet in breadth. The most celebrated historically is the Charter-house of London, founded by Sir Walter Manny A.D. 1371, the name of which is preserved by the famous public school established on the site by Thomas Sutton A.D. 1611.

Mendicant Friars. An article on monastic arrangements would be incomplete without some account of the convents of the Mendicant or Preaching Friars, including the Black Friars or Dominicans, the Grey or Franciscans, the White or Carmelites, the Eremite or Austin Friars. These orders arose at the beginning of the 13th century, when the Benedictines, together with their various reformed branches, had terminated their active mission, and Christian Europe was ready for a new religious revival. Planting themselves, as a rule, in large towns, and by preference in the poorest and most densely populated districts, the Preaching Friars were obliged to adapt their buildings to the requirements of the site. Regularity of arrangement, therefore, was not possible, even if they had studied it. Their churches, built for the reception of large congregations of hearers rather than worshippers, form a class by themselves, totally unlike those of the elder orders in ground-plan and character. They were usually long parallelograms unbroken by transepts. The nave very usually consisted of two equal bodies, one containing the stalls of the brotherhood, the other left entirely free for the congregation. The constructional choir is often wanting, the whole church forming one uninterrupted structure, with a continuous range of windows. The east end was usually square, but the Friars Church at Winchelsea had a polygonal apse. We not unfrequently find a single transept, sometimes of great size, rivalling or exceeding the nave. This arrangement is frequent in Ireland, where the numerous small friaries afford admirable exemplifications of these peculiarities of ground-plan. The friars' churches were at first destitute of towers; but in the 14th and 15th centuries, tall, slender towers were commonly inserted between the nave and the choir. The Grey Friars at Lynn, where the tower is hexagonal, is a good example. The arrangement of the monastic buildings is equally peculiar and characteristic. We miss entirely the regularity of the buildings of the earlier orders. At the Jacobins at Paris, a cloister lay to the north of the long narrow church of two parallel aisles, while the refectory— a room of immense length, quite detached from the cloister —stretched across the area before the west front of the church. At Toulouse the nave also has two parallel aisles, but the choir is apsidal, with radiating chapels. The refectory stretches northwards at right angles to the cloister, which lies to the north of the church, having the chapter-hous and sacristy on the east. As examples of English friaries, the Dominican house at Norwich, and those of the Dominicans and Franciscans at Gloucester, may be mentioned. The church of the Black Friars of Norwich departs from the original type in the nave (now St Andrew's Hall), in having regular aisles. In this it resembles the earlier examples of the Grey Friars at Reading. The choir is long and aisleless; an hexagonal tower between the two, like that existing at Lynn, has perished. The cloister and monastic buildings remain tolerably perfect to the north. The Dominican convent at Gloucester still exhibits the cloister-court, on the north side of which is the desecrated church. The refectory is on the west side, and on the south the dormitory of the 13th century. This is a remarkably good example. There were 18 cells or cubicles on each side, divided by partitions, the bases of which remain. On the east side was the prior's house, a building of later date. At the Grey or Franciscan Friars, the church followed the ordinary type in having two equal bodies, each gabled, with a continuous range of windows. There was a slender tower between the nave and choir. Of the convents of the Carmelite or White Friars we have a good example in the Abbey of Hulne, near Alnwick, the first of the order in England, founded A.D. 1240. The church is a narrow

Norwich. Gloucester. Hulne.

Mendicant Friars.

oblong, destitute of aisles, 123 feet long by only 26 feet wide. The cloisters are to the south, with the chapter-house, &c., to the east, with the dormitory over. The prior's lodge is placed to the west of the cloister. The guest-houses adjoin the entrance gateway, to which a chapel was annexed on the south side of the conventual area. The nave of the church of the Austin Friars or Eremites in London is still standing. It is of Decorated date, and has wide centre and side aisles, divided by a very light and graceful arcade. Some fragments of the south walk of the cloister of the Grey Friars exist among the buildings of Christ's Hospital or the Blue-Coat School. Of the Black Friars all has perished but the name. Taken as a whole, the remains of the establishments of the friars afford little warrant for the bitter invective of the Benedictine of St Alban's, Matthew Paris:—"The friars who have been founded hardly 40 years have built residences as the palaces of kings. These are they who, enlarging day by day their sumptuous edifices, encircling them with lofty walls, lay up in them their incalculable treasures, imprudently transgressing the bounds of poverty, and violating the very fundamental rules of their profession." Allowance must here be made for jealousy of a rival order just rising in popularity.

Cells.

Every large monastery had depending upon it one or more smaller establishments known as *cells.* These cells were monastic colonies, sent forth by the parent house, and planted on some outlying estate. As an example, we may refer to the small religious house of St Mary Magdalene's, a cell of the great Benedictine house of St Mary's, York, in the valley of the Witham, to the south-east of the city of Lincoln. This consists of one long narrow range of building, of which the eastern part formed the chapel, and the western contained the apartments of the handful of monks of which it was the home. To the east may be traced the site of the abbey mill, with its dam and mill-lead. These cells, when belonging to a Cluniac house, were called *Obedientiæ.*

The plan given by Viollet le Duc of the Priory of *St Jean des Bons Hommes*, a Cluniac cell, situated between the town of Avallon and the village of Savigny, shows that these diminutive establishments comprised every essential feature of a monastery,—chapel, cloister, chapter-room, refectory, dormitory, all grouped according to the recognised arrangement.

These Cluniac *obedientiæ* differed from the ordinary Benedictine cells in being also places of punishment, to which monks who had been guilty of any grave infringement of the rules were relegated as to a kind of penitentiary. Here they were placed under the authority of a prior, and were condemned to severe manual labour, fulfilling the duties usually executed by the lay brothers, who acted as farm-servants.

The outlying farming establishments belonging to the monastic foundations were known as *villæ* or *granges.* They gave employment to a body of *conversi* and labourers under the management of a monk, who bore the title of *Brother Hospitaller*—the granges, like their parent institutions, affording shelter and hospitality to belated travellers.

Authorities:—Dugdale, *Monasticon;* Fosbrooke, *British Monachism;* Helyot, *Dictionnaire des Ordres Religieux;* Lenoir, *Architecture Monastique;* Viollet le Duc, *Dictionnaire Raisonnée de l'Architecture Francaise;* Walcott, *Conventual Arrangement;* Willis, *Abbey of St Gall;* Archæological Journal, vol. v., *Conventual Buildings of Canterbury;* Curzon, *Monasteries of the Levant.* (E. V.)

ABBIATE GRASSO, a town in the north of Italy, near the Ticino, 14 miles W.S.W. of Milan. It has silk manufactures, and contains about 5000 inhabitants.

ABBON OF FLEURY, or ABBO FLORIACENSIS, a learned Frenchman, born near Orleans in 945. He distinguished himself in the schools of Paris and Rheims, and was a proficient in science, as known in his time. After spending two years in England, assisting Archbishop Oswald of York in restoring the monastic system, he returned to France, and was made Abbot of Fleury (970). He was twice sent to Rome by Robert the Wise (986, 996), and on each occasion succeeded in warding off a threatened papal interdict. He was killed in 1004, in endeavouring to quell a monkish revolt. He wrote an epitome of the *Lives of the Roman Pontiffs*, besides controversial treatises, letters, &c.

ABBOT, the head and chief governor of a community of monks, called also in the East *Archimandrita*, from *mandra*, "a fold," or *Hegumenos.* The name *abbot* is derived from the Hebrew אָב, *Ab*, or *father*, through the Syriac *Abba.* It had its origin in the monasteries of Syria, whence it spread through the East, and soon became accepted generally in all languages as the designation of the head of a monastery. At first it was employed as a respectful title for any monk, as we learn from St Jerome (in Epist. ad Gal. iv. 6, in Matt. xxiii. 9), but it was soon restricted to the Superior.

The name abbot, though general in the West, was not universal. Among the Dominicians, Carmelites, Augustines, &c., the superior was called *Præpositus*, "Provost," and *Prior;* among the Franciscans, *Custos*, "Guardian;" and by the monks of Camaldoli, *Major.*

Monks, as a rule, were laymen, nor at the outset was the abbot any exception. All orders of clergy, therefore, even the "doorkeeper," took precedence of him. For the reception of the sacraments, and for other religious offices, the abbot and his monks were commanded to attend the nearest church.—(*Novellæ*, 133, c. ii.) This rule naturally proved inconvenient when a monastery was situated in a desert, or at a distance from a city, and necessity compelled the ordination of abbots. This innovation was not introduced without a struggle, ecclesiastical dignity being regarded as inconsistent with the higher spiritual life, but, before the close of the 5th century, at least in the East, abbots seem almost universally to have become deacons, if not presbyters. The change spread more slowly in the West, where the office of abbot was commonly filled by laymen till the end of the 7th century, and partially so up to the 11th. Ecclesiastical Councils were, however, attended by abbots. Thus, at that held at Constantinople, A.D. 448, for the condemnation of Eutyches, 23 archimandrites or abbots sign, with 30 bishops, and, *cir.* A.D. 690, Archbishop Theodore promulgated a canon, inhibiting bishops from compelling abbots to attend councils. Examples are not uncommon in Spain and in England in Saxon times. Abbots were permitted by the Second Council of Nicæa, A.D. 787, to ordain their monks to the inferior orders. This rule was adopted in the West, and the strong prejudice against clerical monks having gradually broken down, eventually monks, almost without exception, belonged to some grade of the ministry.

Originally no abbot was permitted to rule over more than one monastic community, though, in some exceptional cases, Gregory the Great allowed the rule to be broken. As time went on, violations of the rule became increasingly frequent, as is proved by repeated enactments against it. The cases of Wilfrid of York, *cir.* A.D. 675, who held the abbacy of the monasteries he had founded at Hexham and Ripon, and of Aldhelm, who, at the same date, stood in the same double relation to those of Malmesbury, Frome, and Bradford, are only apparent transgressions of the rule. We find more decided instances of plurality in Hugh of the royal Carlovingian house, *cir.* 720, who was at the same

time Bishop of Rouen, Paris, Bayeux, and Abbot of Fontenelle and Jumièges; and Sidonius, Bishop of Constance, who, being already Abbot of Reichenau, took the abbacy of St Gall also. Hatto of Mentz, *cir.* 912, annexed to his see no less than 12 abbacies.

In Egypt, the first home of monasticism, we find *abbots in chief* or *archimandrites* exercising jurisdiction over a large number of communities, each of which had its own abbot. Thus, Cassian speaks of an abbot in the Thebaid who had 500 monks under him, a number exceeded in other cases. In later times also, general jurisdiction was exercised over the houses of their order by the abbots of Monte Cassino, St Dalmatius, Clugny, &c. The abbot of Cassino was styled *Abbas Abbatum.* The chiefs of other orders had the titles of *Abbas Generalis*, or *Magister*, or *Minister Generalis.*

Abbots were originally subject to episcopal jurisdiction, and continued generally so, in fact, in the West till the 11th century. The *Codex of Justinian* (lib. i. tit. iii. de Ep. leg. xl.), expressly subordinates the abbot to episcopal oversight. The first case recorded of the partial exemption of an abbot from episcopal control is that of Faustus, Abbot of Lerins, at the Council of Arles, A.D. 456; but the oppressive conduct, and exorbitant claims and exactions of bishops, to which this repugnance to episcopal control is to be traced, far more than to the arrogance of abbots, rendered it increasingly frequent, and, in the 6th century, the practice of exempting religious houses partly or altogether from episcopal control, and making them responsible to the Pope alone, received an impulse from Gregory the Great. These exceptions, though introduced with a good object, had grown into a wide-spread and crying evil by the 12th century, virtually creating an *imperium in imperio*, and entirely depriving the bishop of all authority over the chief centres of power and influence in his diocese. In the 12th century the abbots of Fulda claimed precedence of the Archbishop of Cologne. Abbots more and more aped episcopal state, and in defiance of the express prohibition of early councils, and the protests of St Bernard and others, adopted the episcopal insignia of mitre, ring, gloves, and sandals. A mitre is said to have been granted to the Abbot of Bobbio by Pope Theodorus I., A.D. 643, and to the Abbot of St Savianus by Sylvester II., A.D. 1000. Ducange asserts that pontifical insignia were first assigned to abbots by John XVIII., A.D. 1004–1009; but the first undoubted grant is said to be that to the Abbot of St Maximinian at Treves, by Gregory VII. (Hildebrand), A.D. 1073–1085. The mitred abbots in England were those of Abingdon, St Alban's, Bardney, Battle, Bury St Edmund's, St Augustine's Canterbury, Colchester, Croyland, Evesham, Glastonbury, Gloucester, St Benet's Hulme, Hyde, Malmesbury, Peterborough, Ramsey, Reading, Selby, Shrewsbury, Tavistock, Thorney, Westminster, Winchcombe, St Mary's York. Of these the precedence was originally yielded to the Abbot of Glastonbury, until in A.D. 1154 Adrian IV. (Nicholas Breakspear) granted it to the Abbot of St Alban's, in which monastery he had been brought up. Next after the Abbot of St Alban's ranked the Abbot of Westminster.

To distinguish abbots from bishops, it was ordained that their mitre should be made of less costly materials, and should not be ornamented with gold, a rule which was soon entirely disregarded, and that the crook of their pastoral staff should turn inwards instead of outwards, indicating that their jurisdiction was limited to their own house. The adoption of episcopal insignia by abbots was followed by an encroachment on episcopal functions, which had to be specially but ineffectually guarded against by the Lateran Council, A.D. 1123. In the East, abbots, if in priests' orders, with the consent of the bishop, were, as we have seen, permitted by the Second Nicene Council, A.D. 787, to confer the tonsure and admit to the order of reader; but they gradually advanced higher claims, until we find them authorised by Bellarmine to be associated with a single bishop in episcopal consecrations, and permitted by Innocent IV., A.D. 1489, to confer both the subdiaconate and diaconate. Of course, they always and everywhere had the power of admitting their own monks, and vesting them with the religious habit. In the first instance, when a vacancy occurred, the bishop of the diocese chose the abbot out of the monks of the convent, but the right of election was transferred by jurisdiction to the monks themselves, reserving to the bishop the confirmation of the election and the benediction of the new abbot. In abbeys exempt from episcopal jurisdiction, the confirmation and benediction had to be conferred by the Pope in person, the house being taxed with the expenses of the new abbot's journey to Rome. By the rule of St Benedict, the consent of the laity was in some undefined way required; but this seems never to have been practically enforced. It was necessary that an abbot should be at least 25 years of age, of legitimate birth, a monk of the house, unless it furnished no suitable candidate, when a liberty was allowed of electing from another convent, well instructed himself, and able to instruct others, one also who had learned how to command by having practised obedience. In some exceptional cases an abbot was allowed to name his own successor. Cassian speaks of an abbot in Egypt doing this; and in later times we have another example in the case of St Bruno. Popes and sovereigns gradually encroached on the rights of the monks, until in Italy the Pope had usurped the nomination of all abbots, and the king in France, with the exception of Clugny, Prémontré, and other houses, chiefs of their order. The election was for life, unless the abbot was canonically deprived by the chiefs of his order, or, when he was directly subject to them, by the Pope or the bishop.

The ceremony of the formal admission of a Benedictine abbot in mediæval times is thus prescribed by the consuetudinary of Abingdon. The newly elected abbot was to put off his shoes at the door of the church, and proceed barefoot to meet the members of the house advancing in a procession. After proceeding up the nave, he was to kneel and pray at the topmost step of the entrance of the choir, into which he was to be introduced by the bishop or his commissary, and placed in his stall. The monks, then kneeling, gave him the kiss of peace on the hand, and rising, on the mouth, the abbot holding his staff of office. He then put on his shoes in the vestry, and a chapter was held, and the bishop or his commissary preached a suitable sermon.

The power of the abbot was paternal but absolute, limited, however, by the canons of the church, and, until the general establishment of exemptions, by episcopal control. As a rule, however, implicit obedience was enforced; to act without his orders was culpable; while it was a sacred duty to execute his orders, however unreasonable, until they were withdrawn. Examples among the Egyptian monks of this blind submission to the commands of the superiors, exalted into a virtue by those who regarded the entire crushing of the individual will as the highest excellence, are detailed by Cassian and others,—*e.g.*, a monk watering a dry stick, day after day, for months, or endeavouring to remove a huge rock immensely exceeding his powers. St Jerome, indeed, lays down, as the principle of the compact between the abbot and his monks, that they should obey their superiors in all things, and perform whatever they commanded.—(Ep. 2, ad Eustoch. de custod,

virgin.) So despotic did the tyranny become in the West, that in the time of Charlemagne it was necessary to restrain abbots by legal enactments from mutilating their monks, and putting out their eyes; while the rule of St Columba ordained 100 lashes as the punishment for very slight offences. An abbot also had the power of excommunicating refractory nuns, which he might use if desired by their abbess.

The abbot was treated with the utmost submission and reverence by the brethren of his house. When he appeared either in church or chapter all present rose and bowed. His letters were received kneeling, like those of the Pope and the king. If he gave a command, the monk receiving it was also to kneel. No monk might sit in his presence, or leave it without his permission. The highest place was naturally assigned to him, both in church and at table. In the East he was commanded to eat with the other monks. In the West the rule of St Benedict appointed him a separate table, at which he might entertain guests and strangers. This permission opening the door to luxurious living, the Council of Aix, A.D. 817, decreed that the abbot should dine in the refectory, and be content with the ordinary fare of the monks, unless he had to entertain a guest. These ordinances proved, however, generally ineffectual to secure strictness of diet, and contemporaneous literature abounds with satirical remarks and complaints concerning the inordinate extravagance of the tables of the abbots. When the abbot condescended to dine in the refectory, his chaplains waited upon him with the dishes, a servant, if necessary, assisting them. At St Alban's the abbot took the lord's seat, in the centre of the high table, and was served on silver plate, and sumptuously entertained noblemen, ambassadors, and strangers of quality. When abbots dined in their own private hall, the rule of St Benedict charged them to invite their monks to their table, provided there was room, on which occasions the guests were to abstain from quarrels, slanderous talk, and idle gossipping. The complaint, however, was sometimes made (as by Matt. Paris of Wulsig, the third abbot of St Alban's), that they invited ladies of rank to dine with them instead of their monks. The ordinary attire of the abbot was according to rule to be the same as that of the monks. But by the 10th century the rule was commonly set aside, and we find frequent complaints of abbots dressing in silk, and adopting great sumptuousness of attire. Nay, they sometimes laid aside the monastic habit altogether, and assumed a secular dress.[1] This was a necessary consequence of their following the chase, which was quite usual, and indeed at that time only natural. With the increase of wealth and power, abbots had lost much of their special religious character, and become great lords, chiefly distinguished from lay lords by celibacy. Thus we hear of abbots going out to sport, with their men carrying bows and arrows; keeping horses, dogs, and huntsmen; and special mention is made of an abbot of Leicester, *cir.* 1360, who was the most skilled of all the nobility in hare-hunting. In magnificence of equipage and retinue the abbots vied with the first nobles of the realm. They rode on mules with gilded bridles, rich saddles and housings, carrying hawks on their wrist, attended by an immense train of attendants. The bells of the churches were rung as they passed. They associated on equal terms with laymen of the highest distinction, and shared all their pleasures and pursuits. This rank and power was, however, often used most beneficially. For instance, we read of Whiting, the last Abbot of Glastonbury, judicially murdered by Henry VIII., that his house was a kind of well-ordered court, where as many as 300 sons of noblemen and gentlemen, who had been sent to him for virtuous education, had been brought up, besides others of a meaner rank, whom he fitted for the universities. His table, attendance, and officers were an honour to the nation. He would entertain as many as 500 persons of rank at one time, besides relieving the poor of the vicinity twice a-week. He had his country houses and fisheries, and when he travelled to attend Parliament his retinue amounted to upwards of 100 persons. The abbots of Clugny and Vendome were, by virtue of their office, cardinals of the Romish Church.

In process of time the title abbot was improperly transferred to clerics who had no connection with the monastic system, as to the principal of a body of parochial clergy; and under the Carlovingians to the chief chaplain of the king, *Abbas Curiæ*, or military chaplain of the emperor, *Abbas Castrensis*. It even came to be adopted by purely secular officials. Thus the chief magistrate of the republic at Genoa was called *Abbas Populi*. Ducange, in his Glossary, also gives us *Abbas Campanilis*, *Clocherii*, *Palatii*, *Scholaris*, &c.

Lay abbots, so called, had their origin in the system of *commendation*, in the 8th century. By this, to meet any great necessity of the state, such as an inroad of the Saracens, the revenues of monasteries were temporarily commended, *i.e.*, handed over to some layman, a noble, or even the king himself, who for the time became titular abbot. Enough was reserved to maintain the monastic brotherhood, and when the occasion passed away the revenues were to be restored to their rightful owners. The estates, however, had a habit of lingering in lay hands, so that in the 9th and 10th centuries most of the sovereigns and nobles among the Franks and Burgundians were titular abbots of some great monastery, the revenues of which they applied to their own purposes. These lay-abbots were styled *Abbacomites* or *Abbates Milites*. Hugh Capet, before his elevation to the throne, as an *Abbacomes* held the abbeys of St Denis and St Germain *in commendam*. Bishop Hatto, of Mentz, A.D. 891–912, is said to have held 12 abbeys *in commendam* at once. In England, as we see from the Acts of the Council of Cloveshoo, in the 8th century, monasteries were often invaded and occupied by laymen. This occurred sometimes from the monastery having voluntarily placed itself under the protection of a powerful layman, who, from its protector, became its oppressor. Sometimes there were two lines of abbots, one of laymen enjoying the lion's share of the revenues, another of clerics fulfilling the proper duties of an abbot on a small fraction of the income. The gross abuse of lay commendation which had sprung up during the corruption of the monastic system passed away with its reformation in the 10th century, either voluntarily or by compulsion. The like abuse prevailed in the East at a later period. John, Patriarch of Antioch, at the beginning of the 12th century, informs us that in his time most monasteries had been handed over to laymen, *beneficiarii*, for life, or for part of their lives, by the emperors.

In conventual cathedrals, where the bishop occupied the place of the abbot, the functions usually devolving on the superior of the monastery were performed by a *prior*. In other convents the prior was the second officer next to the abbot, representing him in his absence, and fulfilling his duties. The superiors of the cells, or small monastic establishments dependent on the larger monasteries, were also called priors. They were appointed by the abbots, and held office at their pleasure.

Authorities:—Bingham, *Origines*; Ducange, *Glossary*; Herzog, *Realwörterbuch*; Robertson, *Ch. Hist.*; Martene, *De Antiq. Monast. Ritibus*, Montalembert, *Monks of the West*.

(E. V.)

[1] Walworth, the fourth abbot of St Alban's, *circa* 930, is charged by Matthew Paris with adopting the attire of a sportsman.

ABBOT, CHARLES, speaker of the House of Commons from 1802 to 1817, afterwards created Lord Colchester. See COLCHESTER.

ABBOT, GEORGE, Archbishop of Canterbury, was born October 19, 1562, at Guildford in Surrey, where his father was a cloth-worker. He studied at Balliol College, Oxford, and was chosen Master of University College in 1597. He was three times appointed to the office of Vice-Chancellor of the University. When in 1604 the version of the Bible now in use was ordered to be prepared, Dr Abbot's name stood second on the list of the eight Oxford divines to whom was intrusted the translation of the New Testament, excepting the Epistles. In 1608 he went to Scotland with the Earl of Dunbar to arrange for a union between the Churches of England and Scotland, and his conduct in that negotiation laid the foundation of his preferment, by attracting to him the notice and favour of the king. Without having held any parochial charge, he was appointed Bishop of Lichfield and Coventry in 1609, was translated to the see of London a month afterwards, and in less than a year was made Archbishop of Canterbury. This rapid preferment was due as much perhaps to his flattering his royal master as to his legitimate merits. After his elevation he showed on several occasions firmness and courage in resisting the king. In the scandalous divorce suit of the Lady Frances Howard against the Earl of Essex, the archbishop persistently opposed the dissolution of the marriage, though the influence of the king and court was strongly and successfully exerted in the opposite direction. In 1618, when a declaration was published by the king, and ordered to be read in all the churches, permitting sports and pastimes on the Sabbath, Abbot had the courage to forbid its being read at Croydon, where he happened to be at the time. As may be inferred from the incident just mentioned, Abbot was of the Protestant or Puritan party in the Church. He was naturally, therefore, a promoter of the match between the Elector Palatine and the Princess Elizabeth, and a firm opponent of the projected marriage of the Prince of Wales with the Infanta of Spain. This policy brought upon him the hatred of Laud and the court. The king, indeed, never forsook him; but Buckingham was his avowed enemy, and he was regarded with dislike by the Prince of Wales, afterwards Charles I. In 1622 a sad misfortune befell the archbishop while hunting in Lord Zouch's park at Bramzill. A bolt from his cross-brow aimed at a deer happened to strike one of the keepers, who died within an hour, and Abbot was so greatly distressed by the event that he fell into a state of settled melancholy. His enemies maintained that the fatal issue of this accident disqualified him for his office, and argued that, though the homicide was involuntary, the sport of hunting which had led to it was one in which no clerical person could lawfully indulge. The king had to refer the matter to a commission of ten, though he said that "an angel might have miscarried after this sort." A decision was given in the archbishop's favour; but to prevent disputes, it was recommended that the king should formally absolve him, and confer his office upon him anew. After this the archbishop seldom appeared at the council, chiefly on account of his infirmities. He attended the king constantly, however, in his last illness, and performed the ceremony of the coronation of Charles I. A pretext was soon found by his enemies for depriving him of all his functions as primate, which were put in commission by the king. This high-handed procedure was the result of Abbot's refusal to license a sermon preached by Dr Sibthorp, in which the king's prerogative was stretched beyond constitutional limits. The archbishop had his powers restored to him shortly afterwards, however, when the king found it absolutely necessary to summon a Parliament. His presence being unwelcome at court, he lived from that time in retirement, leaving Laud and his party in undisputed ascendency. He died at Croydon on the 5th August 1633, and was buried at Guildford, his native place, where he had endowed an hospital with lands to the value of £300 a year. Abbot wrote a large number of works; but, with the exception of his *Exposition on the Prophet Jonah* (1600), which was reprinted in 1845, they are now little known. His *Geography, or a Brief Description of the Whole World*, passed through numerous editions.

ABBOT, GEORGE, known as "The Puritan," has been oddly and persistently mistaken for others. He has been described as a clergyman, which he never was, and as son of Sir Morris Abbot, and his writings accordingly entered in the bibliographical authorities as by the nephew of the Archbishop of Canterbury. One of the sons of Sir Morris Abbot was, indeed, named George, and he was a man of mark, but the more famous George Abbot was of a different family altogether. He was son or grandson (it is not clear which) of Sir Thomas Abbot, knight of Easington, East Yorkshire, having been born there in 1603–4, his mother (or grandmother) being of the ancient house of Pickering. He married a daughter of Colonel Purefoy of Caldecote, Warwickshire, and as his monument, which may still be seen in the church there, tells, he bravely held it against Prince Rupert and Maurice during the civil war. He was a member of the Long Parliament for Tamworth. As a layman, and nevertheless a theologian and scholar of rare ripeness and critical ability, he holds an almost unique place in the literature of the period. His *Whole Booke of Job Paraphrased, or made easy for any to understand* (1640, 4to), is in striking contrast, in its concinnity and terseness, with the prolixity of too many of the Puritan expositors and commentators. His *Vindiciæ Sabbathi* (1641, 8vo) had a profound and lasting influence in the long Sabbatic controversy. His *Brief Notes upon the Whole Book of Psalms* (1651, 4to), as its date shows, was posthumous. He died February 2, 1648. (MS. collections at Abbeyville for history of all of the name of Abbot, by J. T. Abbot, Esq., F.S.A., Darlington; Dugdale's *Antiquities of Warwickshire*, 1656, p. 791; Wood's *Athenæ* (Bliss), s. v.; Cox's *Literature of the Sabbath;* Dr James Gilfillan on *The Sabbath; Lowndes, Bodleian, B. Museum Catal.* s. v.) (A. B. G.)

ABBOT, ROBERT. Noted as this Puritan divine was in his own time, and representative in various ways, he has hitherto been confounded with others, as Robert Abbot, Bishop of Salisbury, and his personality distributed over a Robert Abbot of Cranbrook; another of Southwick, Hants; a third of St Austin's, London; while these successive places were only the successive livings of the one Robert Abbot. He is also described as of the Archbishop's or Guildford Abbots, whereas he was in no way related, albeit he acknowledges very gratefully, in the first of his epistles-dedicatory of *A Hand of Fellowship to Helpe Keepe ovt Sinne and Antichrist* (1623, 4to), that it was from the archbishop he had "received all" his "worldly maintenance," as well as "best earthly countenance" and "fatherly incouragements." The worldly maintenance was the presentation to the vicarage of Cranbrook in Kent, of which the archbishop was patron. This was in 1616. He had received his education at Cambridge, where he proceeded M.A., and was afterwards incorporated at Oxford. In 1639, in the epistle to the reader of his most noticeable book historically, his *Triall of our Church-Forsakers*, he tells us, "I have lived now, by God's gratious dispensation, above fifty years, and in the place of my allotment two and twenty full." The former date carries us back to 1588–89, or perhaps 1587–88—the

"Armada" year—as his birth-time; the latter to 1616-17 (*ut supra*). In his *Bee Thankfull London and her Sisters* (1626), he describes himself as formerly "assistant to a reverend divine . . . . now with God," and the name on the margin is "Master Haiward of Wool Church." This was doubtless previous to his going to Cranbrook. Very remarkable and effective was Abbot's ministry at Cranbrook, where the father of Phineas and Giles Fletcher was the first "Reformation" pastor, and which, relatively small as it is, is transfigured by being the birth-place of the poet of the "Locustæ" and "The Purple Island." His parishioners were as his own "sons and daughters" to him, and by day and night he thought and felt, wept and prayed, for them and with them. He is a noble specimen of the rural clergyman of his age. Puritan though he was in his deepest convictions, he was a thorough Churchman as toward Nonconformists, *e.g.*, the Brownists, with whom he waged stern warfare. He remained until 1643 at Cranbrook, and then chose the very inferior living of Southwick, Hants, as between the one and the other, the Parliament deciding against pluralities of ecclesiastical offices. Succeeding the "extruded" Udall of St Austine's, Abbot continued there until a good old age. In 1657, in the *Warning-piece*, he is described as still "pastor of Austine's in London." He disappears silently between 1657-8 and 1662. Robert Abbot's books are distinguished from many of the Puritans by their terseness and variety. (Brook's *Puritans*, iii. 182, 3; Walker's *Sufferings;* Wood's *Athenæ* (Bliss); *Catalogus Impressorum Librorum in Bibliotheca Bodleiana*, s.v.; Palmer's *Nonconf. Mem.*, ii. 218.) (A. B. G.)

ABBOTSFORD, the celebrated residence of Sir Walter Scott, situated on the south bank of the river Tweed, about three miles above Melrose. The nucleus of the property was a small farm of 100 acres, with the "inharmonious designation" of Clarty Hole, acquired by Scott on the lapse of his lease (1811) of the neighbouring house of Ashestiel. It was gradually increased by various acquisitions, the last and principal being that of Toftfield (afterwards named Huntlyburn), purchased in 1817. The present new house was then commenced, and was completed in 1824. The general ground-plan is a parallelogram, with irregular outlines—one side overlooking the Tweed, and the other facing a courtyard; and the general style of the building is the Scottish baronial. Scott had only enjoyed his new residence one year when (1825) he met with that reverse of fortune (connected with the failure of Ballantyne and Constable); which involved the estate in debt. In 1830, the library[1] and museum were presented as a free gift by the creditors; and after Scott's death, which took place at Abbotsford in September 1832, a committee of friends subscribed a further sum of about £8000 towards the same object. The property was wholly disencumbered in 1847, by Mr Cadell, the publisher, accepting the remaining claims of the family over Sir Walter Scott's writings in requital of his obligation to obliterate the heritable bond on the property. The result of this transaction was, that not only was the estate redeemed by the fruit of Scott's brain, but a handsome residue fell to the publisher. Scott's only son Walter (Lieutenant-Colonel 15th Hussars) did not live to enjoy the property, having died on his way from India in 1847. Its subsequent possessors have been Scott's son-in-law, J. G. Lockhart, and the latter's son-in-law, J. R. Hope Scott, Q.C., whose daughter (Scott's great-granddaughter) is the present proprietor. Mr Lockhart died at Abbotsford in 1854.—See *Life of Scott*, by J. G. Lockhart; *Abbotsford and Newstead Abbey*, by Washington Irving; *Abbotsford Notanda* in *Gentleman's Mag.*, April and May 1869; *The Lands of Scott*, by James F. Hunnewell, cr. 8vo, 1871; *Scott Loan Exhibition Catalogue*, 4to, 1871.

ABBOTSFORD CLUB, one of the principal printing clubs, was founded in 1834 by Mr W. B. D. D. Turnbull, and named in honour of Sir Walter Scott. Taking a wider range than its predecessors, the Bannatyne and Maitland Clubs, it did not confine its printing (as remarked by Mr Lockhart) to works connected with Scotland, but admitted all materials that threw light on the ancient history of literature of any country, anywhere described or discussed by the Author of Waverley. The club, now dissolved, consisted of fifty members; and the publications extend to 34 vols. quarto, issued during the years 1835-1864.

ABBREVIATION, a letter or group of letters, taken from a word or words, and employed to represent them for the sake of brevity. Abbreviations, both of single words and of phrases, having a meaning more or less fixed and recognised, are common in ancient writings and inscriptions, and very many are in use at the present time. A distinction is to be observed between abbreviations and the contractions that are frequently to be met with in old manuscripts, and even in early printed books, whereby letters are dropped out here and there, or particular collocations of letters represented by somewhat arbitrary symbols. The commonest form of abbreviation is the substitution for a word of its initial letter; but, with a view to prevent ambiguity, one or more of the other letters are frequently added. Letters are often doubled to indicate a plural or a superlative.

I. Classical Abbreviations.—The following list contains a selection from the abbreviations that occur in the writings and inscriptions of the Romans:—

A.

A. Absolvo, Ædilis, Æs, Ager, Ago, Aio, Amicus, Annus, Antiquo, Auctor, Auditor, Augustus, Aulus, Aurum, Aut.
A.A. Æs alienum, Ante audita, Apud agrum, Aurum argentum.
AA. Augusti. AAA. Augusti tres.
A.A.A.F.F. Auro argento ære flando feriundo.[1]
A.A.V. Alter ambove.
A.C. Acta causa, Alius civis.
A.D. Ante diem; *e.g.*, A.D.V. Ante diem quintum.
A.D.A. Ad dandos agros.
ÆD. Ædes, Ædilis, Ædilitas.
ÆM. *and* AIM. Æmilius, Æmilia.
ÆR. Ærarium. ÆR.P. Ære publico.
A.F. Actum fide, Auli filius.
AG. Ager, Ago, Agrippa.
A. G. Animo grato, Aulus Gellius.
A.L.Æ. *and* A.L.E. Arbitrium litis æstimandæ.
A.M. *and* A.MILL. Ad milliarium.
AN. Aniensis, Annus, Ante.
ANN. Annales, Anni, Annona.
ANT. Ante, Antonius.
A.O. Alii omnes, Amico optimo.
AP. Appius, Apud.
A.P. Ad pedes, Ædilitia potestate.
A.P.F. Auro (*or* argento) publico feriundo.
A.P.M. Amico posuit monumentum, Annorum plus minus.
A.P.R.C. Anno post Romam conditam.
ARG. Argentum.
AR.V.V.D.D. Aram votam volens dedicavit, Arma votiva dono dedit.
A T. A tergo. *Also* A TE. *and* A TER.
A.T.M.D.O. Aio te mihi dare opertere.
AV. Augur, Augustus, Aurelius.
A.V. Annos vixit.
A.V.C. Ab urbe condita.
AVG. Augur, Augustus.
AVGG. Augusti (*generally of two*). AVGGG. Augusti tres.
AVT.PR.R. Auctoritas provinciæ Romanorum.

B.

B. Balbius, Balbus, Beatus, Bene, Beneficiarius, Beneficium, Bonus, Brutus, Bustum.
B. *for* V. Berna, Bivus, Bixit.
B.A. Bixit annos, Bonis auguriis, Bonus amabilis.

[1] The Catalogue of the Library at Abbotsford forms vol. lxi. of the Bannatyne Club publications.

[1] Describing the function of the *triumviri monetales*.

BB. *or* B.B. Bene bene, *i.e.*, optime, Optimus.
B.D. Bonæ deæ, Bonum datum.
B.DD. Bonis deabus.
B.D.S.M. Bene de se merenti.
B.F. Bona femina, Bona fides, Bona fortuna, Bonum factum.
ꓭ.ꟻ. Bona femina, Bona filia.
B.H. Bona hereditaria, Bonorum heres.
B.I. Bonum judicium. B.I.I. Boni judicis judicium.
B.M. Beatæ memoriæ, Bene merenti.
B.N. Bona nostra, Bonum nomen.
BN.H.I. Bona hic invenies.
B.P. Bona paterna, Bonorum potestas, Bonum publicum.
B.Q. Bene quiescat, Bona quæsita.
B.RP.N. Bono reipublicæ natus.
BRT. Britannicus.
B.T. Bonorum tutor, Brevi tempore.
B.V. Bene vale, Bene vixit, Bonus vir.
B.V.V. Balnea vina Venus.
BX. Bixit, *for* vixit.

C.

C. Cæsar, Caius, Caput, Causa, Censor, Civis, Cohors, Colonia, Comitialis (dies), Condemno, Consul, Cum, Curo, Custos.
Ɔ. Caia, Centuria, Cum, *the prefix* Con.
C.B. Civis bonus, Commune bonum, Conjugi benemerenti, Cui bono.
C.C. Calumniæ causa, Causa cognita, Conjugi carissimæ, Consilium cepit, Curiæ consulto.
C.C.C. Calumniæ cavendæ causâ.
C.C.F. Cæsar (*or* Caius) curavit faciendum, Caius Caii filius.
CC.VV. Clarissimi viri.
C.D. Cæsaris decreto, Caius Decius, Comitialibus diebus.
CES. Censor, Censores. CESS. Censores
C.F. Causa fiduciæ, Conjugi fecit, Curavit faciendum.
C.H. Custos heredum, Custos hortorum.
C.I. Caius Julius, Consul jussit, Curavit judex.
CL. Clarissimus, Claudius, Clodius, Colonia.
CL.V. Clarissimus vir, Clypeum vovit.
C. M. Caius Marius, Causa mortis.
CN. Cnæus.
COH. Coheres, Cohors.
COL. Collega, Collegium, Colonia, Columna.
COLL. Collega, Coloni, Coloniæ.
COM. Comes, Comitium, Comparatum.
CON. Conjux, Consensus, Consiliarius, Consul, Consularis.
COR. Cornelia (tribus), Cornelius, Corona, Corpus.
COS. Consiliarius, Consul, Consulares. COSS. Consules.
C.P. Carissimus *or* Clarissimus puer, Civis publicus, Curavit ponendum.
C.R. Caius Rufus, Civis Romanus, Curavit reficiendum.
CS. Cæsar, Communis, Consul.
C.V. Clarissimus *or* consularis vir.
CVR. Cura, Curator, Curavit, Curia.

D.

D. Dat, Dedit, &c., De, Decimus, Decius, Decretum, Decurio, Deus, Dicit, &c., Dies, Divus, Dominus, Domus, Donum.
D.C. Decurio coloniæ, Diebus comitialibus, Divus Cæsar.
D.D. Dea Dia, Decurionum decreto, Dedicavit, Deo dedit, Dono dedit.
D.D.D. Datum decreto decurionum, Dono dedit dedicavit.
D.E.R. De ea re.
DES. Designatus.
D.I. Dedit imperator, Diis immortalibus, Diis inferis.
D.I.M. Deo invicto Mithræ, Diis inferis Manibus.
D.M. Deo Magno, Dignus memoria, Diis Manibus, Dolo malo.
D.O.M. Deo Optimo Maximo.
D.P.S. Dedit proprio sumptu, Deo perpetuo sacrum, De pecunia sua.

E.

E. Ejus, Eques, Erexit, Ergo, Est, Et, Etiam, Ex.
EG. Æger, Egit, Egregius.
E. M. Egregiæ memoriæ, Ejusmodi, Erexit monumentum.
EQ.M. Equitum magister.
E.R.A. Ea res agitur.

F.

F. Fabius, Facere, Fecit, &c., Familia, Fastus (dies), Felix, Femina, Fides, Filius, Flamen, Fortuna, Frater, Fuit, Functus.
F.C. Faciendum curavit, Fidei commissum, Fiduciæ causa.
F.D. Fidem dedit, Flamen Dialis, Fraude donavit.
F.F.F. Ferro flamma fame, Fortior fortuna fato.
FL. Filius, Flamen, Flaminius, Flavius.
F.L. Favete linguis, Fecit libens, Felix liber.
FR. Forum, Fronte, Frumentarius.
F.R. Forum Romanum.

G.

G. Gaius (= Caius), Gallia, Gaudium, Gellius, Gemina, Gens Gesta, Gratia.
G.F. Gemina fidelis (*applied to a legion*). *So* G.P.F. Gemina pia fidelis.
GL. Gloria.
GN. Genius, Gens, Genus, Gnæus (= Cnæus).
G.P.R. Genio populi Romani.

H.

H. Habet, Heres, Hic, Homo, Honor, Hora.
HER. Heres, Herennius. HER. *and* HERC. Hercules.
H.L. Hac lege, Hoc loco, Honesto loco.
H.M. Hoc monumentum, Honesta mulier, Hora mala.
H.S.E. Hic sepultus est, Hic situs est.
H.V. Hæc urbs, Hic vivit, Honeste vixit, Honestus vir.

I.

I. Immortalis, Imperator, In, Infra, Inter, Invictus, Ipse, Isis, Judex, Julius, Junius, Jupiter, Justus.
IA. Jam, Intra.
I.C. Julius Cæsar, Juris Consultum, Jus civile.
ID. Idem, Idus, Interdum.
I.D. Inferis diis, Jovi dedicatum, Jus dicendum, Jussu Dei.
I.D.M. Jovi deo magno.
I.F. In foro, In fronte.
I. H. Jacet hic, In honestatem, Justus homo.
IM. Imago, Immortalis, Immunis, Impensa.
IMP. Imperator, Imperium.
I.O.M. Jovi optimo maximo.
I.P. In publico, Intra provinciam, Justa persona.
I.S.V.P. Impensa sua vivus posuit.

K.

K. Kæso, Caia, Calumnia, Caput, Carus, Castra.
K., KAL., *and* KL. Kalendæ.

L.

L. Lælius, Legio, Lex, Libens, Liber, Libra, Locus, Lollius, Lucius, Ludus.
LB. Libens, Liberi, Libertus.
L.D.D.D. Locus datus decreto decurionum.
LEG. Legatus, Legio.
LIB. Liber, Liberalitas, Libertas, Libertus, Librarius.
LL. Leges, Libentissime, Liberti.
L.M. Libens merito, Locus monumenti.
L.S. Laribus sacrum, Libens solvit, Locus sacer.
LVD. Ludus.
LV.P.F. Ludos publicos fecit.

M.

M. Magister, Magistratus, Magnus, Manes, Marcus, Marius, Marti, Mater, Memoria, Mensis, Miles, Monumentum, Mortuus, Mucius, Mulier.
M'. Manius.
M.D. Magno Deo, Manibus diis, Matri deum, Merenti dedit.
MES. Mensis. MESS. Menses.
M.F. Mala fides, Marci filius, Monumentum fecit.
M.I. Matri Idaeæ, Matri Isidi, Maximo Jovi.
MNT. *and* MON. Moneta.
M.P. Male positus, Monumentum posuit.
M.S. Manibus sacrum, Memoriæ sacrum, Manu scriptum.
MVN. Municeps, *or* municipium; *so also* MN., MV., *and* MVNIC.
M.V.S. Marti ultori sacrum, Merito votum solvit.

N.

N. Natio, Natus, Nefastus (dies), Nepos, Neptunus, Nero, Nomen, Non, Nonæ, Noster, Novus, Numen, Numerius, Numerus, Nummus.
NEP. Nepos, Neptunus.
N.F.C. Nostræ fidei commissum.
N.L. Non licet, Non liquet, Non longe.
N.M.V. Nobilis memoriæ vir.
NN. Nostri. NN., NNO., *and* NNR. Nostrorum.
NOB. Nobilis. NOB., NOBR., *and* NOV. Novembris.
N.P. Nefastus primo (*i.e.*, priore parte diei), Non potest.

O.

O. Ob, Officium, Omnis, Oportet, Optimus, Opus, Ossa.
OB. Obiit, Obiter, Orbis.
O.C.S. Ob cives servatos.
O.H.F. Omnibus honoribus functus.
O.H.S.S. Ossa hic sita sunt.
OR. Hora, Ordo, Ornamentum.
O.T.B.Q. Ossa tua bene quiescant.

P.

P. Pars, Passus, Pater, Patronus, Pax, Perpetuus, Pes, Pius, Plebs, Pondo, Populus, Post, Posuit, Præses, Prætor, Primus, Pro, Provincia, Publicus, Publius, Puer.
P.C. Pactum conventum, Patres conscripti, Pecunia constituta, Ponendum curavit, Post consulatum, Potestate censoria.

P.F. Pia fidelis, Pius felix, Promissa fides, Publii filius.
P.M. Piæ memoriæ, Plus minus, Pontifex maximus.
P.P. Pater patratus, Pater patriæ, Pecunia publica, Præpositus, Primipilus, Proprætor.
PR. Præses, Prætor, Pridie, Princeps.
P.R. Permissu reipublicæ, Populus Romanus.
P.R.C. Post Romam conditam.
PR.PR. Præfectus prætorii, Proprætor.
P. S. Pecunia sua, Plebiscitum, Proprio sumptu, Publicæ saluti.
P.V. Pia victrix, Præfectus urbi, Præstantissimus vir.

Q.

Q. Quæstor, Quando, Quantus, Que, Qui, Quinquennalis, Quintus, Quirites.
Q.D.R. Qua de re.
Q.I.S.S. Quæ infra scripta sunt; *so* Q. S. S. S. Quæ supra, &c.
QQ. Quæcunque, Quinquennalis, Quoque.
Q.R. Quæstor reipublicæ.

R.

R. Recte, Res, Respublica, Retro, Rex, Ripa, Roma, Romanus, Rufus, Rursus.
R.C. Romana civitas, Romanus civis.
RESP. *and* RP. Respublica.
RET. P. *and* RP. Retro pedes.

S.

S. Sacrum, Scriptus, Semis, Senatus, Sepultus, Servius, Servus, Sextus, Sibi, Sine, Situs, Solus, Solvit, Sub, Suus.
SAC. Sacerdos, Sacrificium, Sacrum.
S.C. Senatus consultum.
S.D. Sacrum diis, Salutem dicit, Senatus decreto, Sententiam dedit.
S.D.M. Sacrum diis Manibus, Sine dolo malo.
SER. Servius, Servus.
S.E.T.L. Sit ei terra levis.
SN. Senatus, Sententia, Sine.
S.P. Sacerdos perpetua, Sine pecunia, Sua pecunia.
S.P.Q.R. Senatus populusque Romanus.
S.S. Sanctissimus senatus, Supra scriptum.
S.V.B.E.E.Q.V. Si vales bene est, ego quidem valeo.

T.

T. Terminus, Testamentum, Titus, Tribunus, Tu, Turma, Tutor.
TB., TI., *and* TIB. Tiberius.
TB., TR., *and* TRB. Tribunus.
T.F. Testamentum fecit, Titi filius, Titulum fecit, Titus Flavius.
TM. Terminus, Testamentum, Thermæ.
T.P. Terminum posuit, Tribunicia potestate, Tribunus plebis.
TVL. Tullius, Tullus.

V.

V. Urbs, Usus, Uxor, Vale, Verba, Vestalis, Vester, Vir, Vivus, Vixit, Volo, Votum.
V.A. Veterano assignatus, Vixit annos.
V.C. Vale conjux, Vir clarissimus, Vir consularis.
V.E. Verum etiam, Vir egregius, Visum est.
V.F. Usus fructus, Verba fecit, Vivus fecit.
V.P. Urbis præfectus, Vir perfectissimus, Vivus posuit.
V.R. Urbs Roma, Uti rogas, Votum reddidit.

II. Mediæval Abbreviations.—Of the different kinds of abbreviations in use in the middle ages, the following are examples:—

A.M. Ave Maria.
B.P. Beatus Paulus, Beatus Petrus.
CC. Carissimus (*also plur.* Carissimi), Clarissimus, Circum.
D. Deus, Dominicus, Dux.
D.N.PP. Dominus noster Papa.
FF. Felicissimus, Fratres, Pandectæ (*prob. for Gr.* Π).
I.C. *or* I.X. Jesus Christus.
I.D.N. In Dei nomine.
KK. Karissimus (*or* -mi).
MM. Magistri, Martyres, Matrimonium, Meritissimus.
O.S.B. Ordinis Sancti Benedicti.
PP. Papa, Patres, Piissimus.
R.F. Rex Francorum.
R.P.D. Reverendissimus Pater Dominus.
S.C.M. Sacra Cæsarea Majestas.
S.M.E. Sancta Mater Ecclesia.
S.M.M. Sancta Mater Maria.
S.R.I. Sanctum Romanum Imperium.
S.V. Sanctitas Vestra, Sancta Virgo.
V. Venerabilis, Venerandus.
V.R.P. Vestra Reverendissima Paternitas.

III. Abbreviations now in use.—The import of these will often be readily understood from the connection in which they occur. There is no occasion to explain here the common abbreviations used for Christian names, books of Scripture, months of the year, points of the compass, grammatical and mathematical terms, or familiar titles, like "Mr," &c.

The ordinary abbreviations, now or recently in use, may be conveniently classified under the following headings:—

1. Abbreviated Titles and Designations.

A.A. Associate of Arts.
A.B. Able-bodied seaman.
A.M. (*Artium Magister*), Master of Arts.
A.R.A. Associate of the Royal Academy.
A.R.S.A. Associate of the Royal Scottish Academy.
B.A. Bachelor of Arts.
B.C.L. Bachelor of Civil Law.
B.D. Bachelor of Divinity.
B.LL. Bachelor of Laws.
B.Sc. Bachelor of Science.
C. Chairman.
C.A. Chartered Accountant.
C.B. Companion of the Bath.
C.E. Civil Engineer.
C.M. (*Chirurgiæ Magister*), Master in Surgery.
C.M.G. Companion of St Michael and St George.
C.S.I. Companion of the Star of India.
D.C.L. Doctor of Civil Law.
D.D. Doctor of Divinity.
D.Lit. Doctor of Literature.
D.M. Doctor of Medicine [Oxford].
D.Sc. Doctor of Science.
Ebor. (*Eboracensis*), of York.[1]
F.C.S. Fellow of the Chemical Society.
F.D. (*Fidei Defensor*), Defender of the Faith.
F.F.P.S. Fellow of the Faculty of Physicians & Surgeons [Glasgow.]
F.G.S. Fellow of the Geological Society.
F.K.Q.C.P.I. Fellow of King and Queen's College of Physicians in Ireland.
F.L.S. Fellow of the Linnæan Society.
F.M. Field Marshal.
F.P.S. Fellow of the Philological Society.
F.R.A.S. Fellow of the Royal Astronomical Society.
F.R.C.P. Fellow of the Royal College of Physicians.
F.R.C.P.E. Fellow of the Royal College of Physicians of Edinburgh.
F.R.C.S. Fellow of the Royal College of Surgeons.
F.R.G.S. Fellow of the Royal Geographical Society.
F.R.S. Fellow of the Royal Society.
F.R.S.E. Fellow of the Royal Society of Edinburgh.
F.R.S.L. Fellow of the Royal Society of Literature.
F.S.A. Fellow of the Society of Antiquaries.
F.S.S. Fellow of the Statistical Society.
F.Z.S. Fellow of the Zoological Society.
G.C.B. Knight Grand Cross of the Bath.
G.C.H. Knight Grand Cross of Hanover.
G.C.M.G. Knight Grand Cross of St Michael and St George.
G.C.S.I. Knight Grand Commander of the Star of India.
H.R.H. His (*or* Her) Royal Highness.
J.P. Justice of the Peace.
J.U.D. (*Juris utriusque Doctor*), Doctor of Civil and Canon Law.
K.C.S.I. Knight Commander of the Star of India.
K.C.B. Knight Commander of the Bath.
K.G. Knight of the Garter.
K.P. Knight of St Patrick.
K.T. Knight of the Thistle.
L.A.H. Licentiate of the Apothecaries' Hall.
L.C.J. Lord Chief Justice.
LL.B. (*Legum Baccalaureus*), Bachelor of Laws.
LL.D. (*Legum Doctor*), Doctor of Laws.
LL.M. (*Legum Magister*), Master of Laws.
L.R.C.P. Licentiate of the Royal College of Physicians.
L.R.C.S. Licentiate of the Royal College of Surgeons.
L.S.A. Licentiate of the Apothecaries' Society.
M.A. Master of Arts.
M.B. (*Medicinæ Baccalaureus*), Bachelor of Medicine.
M.C. Member of Congress.
M.D. (*Medicinæ Doctor*), Doctor of Medicine.
M.P. Member of Parliament.
M.R.C.P. Member of the Royal College of Physicians.
M.R.I.A. Member of the Royal Irish Academy.
Mus. B. Bachelor of Music.

[1] An archbishop or bishop, in writing his signature, substitutes for his surname the name of his see; thus the prelates of Canterbury, York, Oxford, London, &c., subscribe themselves A. C. Cantuar., W. Ebor., J. F. Oxon., J. London, &c.

Mus. D. Doctor of Music.
N.P. Notary Public.
P.C. Privy Councillor.
Ph.D. (*Philosophiæ Doctor*), Doctor of Philosophy
P.P. Parish Priest.
P.R.A. President of the Royal Academy.
Q.C. Queen's Counsel.
R. (*Rex, Regina*), King, Queen.
R.A. Royal Academician. Royal Artillery
R.A.M. Royal Academy of Music.
R.E. Royal Engineers.
Reg. Prof. Regius Professor.
R.M. Royal Marines.
R.N. Royal Navy.
S. *or* St. Saint.
S.S.C. Solicitor before the Supreme Courts [of Scotland].
S.T.P. (*Sacrosanctæ Theologiæ Professor*), Professor of Sacred Theology.
V.C. Vice-Chancellor. Victoria Cross.
V.G. Vicar-General.
V.S. Veterinary Surgeon.
W.S. Writer to the Signet [in Scotland]. *Equivalent to Attorney.*

2. Abbreviations denoting Monies, Weights, and Measures :—[1]

ac. acre.
bar. barrel.
bus. bushel.
c. cent.
c. (*or* cub.) ft. &c. cubic foot, &c.
cwt. hundredweight.
d. (*denarius*), penny.
deg. degree.
dr. drachm *or* dram
dwt. pennyweight.
f. franc.
fl. florin.
ft. foot.
fur. furlong.
gal. gallon.
gr. grain.
h. *or* hr. hour.
hhd. hogshead.
in. inch.
kilo. kilometre.
L.,[2] £,[2] or *l.* (*libra*), pound (money).
lb. *or* ℔. (*libra*), pound (weight).
m. *or* mi. mile; minute.
♏. minim.
mo. month.
na. nail.
oz. ounce.
pk. peck.
po. pole.
pt. pint.
q. (*quadrans*), farthing.
qr. quarter.
qt. quart.
ro. rood.
Rs.[2] rupees.
s. *or* / (*solidus*), shilling.
s. *or* sec. second.
sc. *or* scr. scruple.
sq. ft. &c. square foot, &c.
st. stone.
yd. yard.

3. Miscellaneous Abbreviations.

A. Accepted.
A.C. (*Ante Christum*), Before Christ.
acc., a/c., *or* acct. Account.
A.D. (*Anno Domini*), In the year of our Lord.
A.E.I.O.U. Austriæ est imperare orbi universo,[3] *or* Alles Erdreich Ist Oesterreich Unterthan.
Æt. *or* Ætat. (*Ætatis* [*anno*]), In the year of his age.
A.H. (*Anno Hegiræ*), In the year of the Hegira (the Mohammedan era).
A.M. (*Anno Mundi*), In the year of the world.
A.M. (*Ante meridiem*), Forenoon.
Anon. Anonymous.
A.U.C. (*Anno urbis conditæ*), In the year from the building of the city (*i.e.*, Rome.)
B.C. Before Christ.
C. *or* Cap. (*Caput*), Chapter.
C. Centigrade (*or* Celsius's) Thermometer.
cent.[4] (*Centum*), A hundred, *frequently* £100.
Cf. (*Confer*), Compare.
Ch. *or* Chap. Chapter.
Co. Company. County.
Cr. Creditor.
curt. Current, the present month.
D.G. (*Dei gratia*), By the grace of God.
Do. Ditto, the same.
D.O.M. (*Deo Optimo Maximo*), To God the Best and Greatest.
Dr. Debtor.
D.V. (*Deo volente*), God willing.

[1] Characters, not properly abbreviations, are used in the same way; *e.g.*, ° ′ ″ for "degrees, minutes, seconds," (circular measure); ℥, ʒ, ℈ for "ounces, drachms, scruples." ℥ is probably to be traced to the written form of the *z* in "*oz.*"

[2] These forms (as well as $, the symbol for the American dollar) are placed before their amounts.

[3] *It is given to Austria to rule the whole earth.* The device of Austria, first adopted by Frederick III.

[4] "Per cent." is often signified by %, a form traceable to "100."

e.g. (*Exempli gratia*), For example.
ect. *or* &c. (*Et cætera*), And the rest; and so forth.
Ex. Example.
F. *or* Fahr. Fahrenheit's Thermometer.
Fec. (*Fecit*), He made (*or* did) it.
fl. Flourished.
Fo. *or* Fol. Folio.
f.o.b. Free on board.
G.P.O. General Post Office.
H.M.S. Her Majesty's Ship.
Ib. *or* Ibid. (*Ibidem*), In the same place,
Id. (*Idem*), The same.
i.e. (*Id est*), That is.
I.H.S. (*Jesus Hominum Salvator*), Jesus the Saviour of men.
Inf. (*Infra*), Below.
inst. Instant, the present month.
I.O.U. I owe you.
i.q. (*Idem quod*), The same as.
κ.τ.λ. (καὶ τὰ λοιπά), *Et cætera*, and the rest,
L. *or* Lib. (*Liber*), Book.
Lat. Latitude.
l.c. (*Loco citato*), In the place cited.
Lon. *or* Long. Longitude.
L.S. (*Locus sigilli*), The place of the seal.
Mem. (*Memento*), Remember, Memorandum.
MS. Manuscript. MSS. Manuscripts.
N.B. (*Nota bene*), Mark well; take notice.
N.B. North Britain (*i.e.*, Scotland).
N.D. No date.
nem. con. (*Nemine contradicente*), No one contradicting.
No. (*Numero*), Number.
N.S. New Style.
N.T. New Testament.
ob. (*Obiit*), Died.
Obs. Obsolete.
O.H.M.S. On Her Majesty's Service.
O.S. Old Style.
O.T. Old Testament.
P. Page. Pp. Pages.
℘. (*Per*), For; *e.g.*, ℘ lb., For one pound.
Pinx. (*Pinxit*), He painted it.
P.M. (*Post meridiem*), Afternoon.
P.O. Post Office. P.O.O. Post Office Order.
P.P.C. (*Pour prendre congé*), To take leave.
P.R. Prize-ring.
prox. (*Proximo* [*mense*]), Next month.
P.S. Postscript.
Pt. Part.
p.t. *or* pro. tem. (*Pro tempore*), For the time.
P.T.O. Please turn over.
Q., Qu., *or* Qy. Query; Question.
q.d. (*Quasi dicat*), As if he should say; as much as to say.
Q.E.D. (*Quod erat demonstrandum*), which was to be demonstrated.
Q.E.F. (*Quod erat faciendum*), which was to be done.
q.s. *or* quant. suff. (*Quantum sufficit*), As much as is sufficient.
q.v. (*Quod vide*), Which see.
R. *or* ℞. (*Recipe*), Take.
√ (= *r.* for *radix*), the sign of the square root.
R.I.P. (*Requiescat in pace!*), May he rest in peace!
sc. (*Scilicet*), Namely; that is to say.
Sc. *or* Sculp. (*Sculpsit*), He engraved it.
S.D.U.K. Society for the Diffusion of Useful Knowledge.
seq. *or* sq., seqq. *or* sqq. (*Sequens, sequentia*), The following.
s.p. (*Sine prole*), Without offspring.
S.P.G. Society for the Propagation of the Gospel.
Sup. (*Supra*), Above.
s.v. (*Sub voce*), Under the word (*or* heading).
T.C.D. Trinity College, Dublin.
ult. (*Ultimo* [*mense*]), Last month.
U.S. United States.
v. (*Versus*), Against.
v. *or* vid. (*Vide*), See.
viz. (*Videlicet*), Namely.
V. R. (*Victoria Regina*), Victoria the Queen.
Xmas. Christmas [*This X is a Greek letter, corresponding to* Ch.].

(See Grævius's *Thesaurus Antiquitatum*, 1694, *sqq.*; Nicolai's *Tractatus de Siglis Veterum*; Mommsen's *Corpus Inscriptionum Latinarum*, 1863, *sqq.*; Natalis de Wailly's *Paléographie*, Paris, 1838; Alph. Chassant's *Paléographie*, 1854, and *Dictionnaire des Abréviations*, 3d ed., 1866. A manual of the abbreviations in current use is a desideratum.)

ABBREVIATORS, a body of writers in the Papal Chancery, whose business is to sketch out and prepare in due form the Pope's bulls, briefs, and consistorial decrees.

They are first mentioned in a bull of Benedict XII., early in the 14th century. Their number is fixed at seventy-two, of whom twelve, distinguished as *de parco majori*, hold prelatic rank; twenty-two, *de parco minori*, are clergymen of lower rank; and the remainder, *examinatores*, may be laymen.

ABDALLATIF, or ABD-UL-LATIF, a celebrated physician and traveller, and one of the most voluminous writers of the East, was born at Baghdad in 1162. An interesting memoir of Abdallatif, written by himself, has been preserved with additions by Ibn-Abu-Osaiba, a contemporary. From that work we learn that the higher education of the youth of Baghdad consisted principally in a minute and careful study of the rules and principles of grammar, and in their committing to memory the whole of the Koran, a treatise or two on philology and jurisprudence, and the choicest Arabian poetry. After attaining to great proficiency in that kind of learning, Abdallatif applied himself to natural philosophy and medicine. To enjoy the society of the learned, he went first to Mosul (1189), and afterwards to Damascus, the great resort of the eminent men of that age. The chemical fooleries that engrossed the attention of some of these had no attraction for him, but he entered with eagerness into speculative discussions. With letters of recommendation from Saladin's vizier, he visited Egypt, where the wish he had long cherished to converse with Maimonides, "the Eagle of the Doctors," was gratified. He afterwards formed one of the circle of learned men whom Saladin gathered around him at Jerusalem, and shared in the great sultan's favours. He taught medicine and philosophy at Cairo and at Damascus for a number of years, and afterwards, for a shorter period, at Aleppo. His love of travel led him in his old age to visit different parts of Armenia and Asia Minor, and he was setting out on a pilgrimage to Mecca when he died at Baghdad in 1231. Abdallatif was undoubtedly a man of great knowledge and of an inquisitive and penetrating mind, but is said to have been somewhat vain of his attainments. Of the numerous works—most of them on medicine—which Osaiba ascribes to him, one only, the *Account of Egypt*, appears to be known in Europe. The manuscript of this work, which was discovered by Pococke the Orientalist, is preserved in the Bodleian Library. It was translated into Latin by Professor White of Oxford in 1800, and into French, with very valuable notes, by De Sacy in 1810. It consists of two parts: the first gives a general view of Egypt; the second treats of the Nile, and contains a vivid description of a famine caused, during the author's residence in Egypt, by the river failing to overflow its banks. The work gives an authentic detailed account of the state of Egypt during the middle ages.

ABD-EL-KADER, celebrated for his brave resistance to the advance of the French in Algeria, was born near Mascara, in the early part of the year 1807. His father was a man of great influence among his countrymen from his high rank and learning, and Abd-el-Kader himself at an early age acquired a wide reputation for wisdom and piety, as well as for skill in horsemanship and other manly exercises. In 1831 he was chosen Emir of Mascara, and leader of the combined tribes in their attempt to check the growing power of the French in Africa. His efforts were at first successful, and in 1834 he concluded a treaty with the French general, which was very favourable to his cause. This treaty was broken in the succeeding year; but as the war that followed was mainly in favour of the Arabs, peace was renewed in 1837. War again broke out in 1839, and for more than a year was carried on in a very desultory manner. In 1841, however, Marshal Bugeaud assumed the chief command of the French force, which numbered nearly 100,000 men. The war was now carried on with great vigour, and Abd-el-Kader, after a most determined resistance, surrendered himself to the Duc d'Aumale, on the 22d December 1847. The promise, that he would be allowed to retire to Alexandria or St Jean d'Acre, upon the faith of which Abd-el-Kader had given himself up, was broken by the French government. He was taken to France, and was imprisoned first in the castle of Pau, and afterwards in that of Amboise. In 1852 Louis Napoleon gave him his liberty on condition of his not returning to Algeria. Since then he resided successively at Broussa, Constantinople, and Damascus. He is reported to have died at Mecca in October 1873. See ALGERIA.

ABDERA (1.), in *Ancient Geography*, a maritime town of Thrace, eastward from the mouth of the river Nestus. Mythology assigns the founding of the town to Hercules; but Herodotus states that it was first colonised by Timesias of Clazomenæ, whom the Thracians in a short time expelled. Rather more than a century later (B.C. 541), the people of Seos recolonised Abdera. The town soon became one of considerable importance, and in B.C. 408, when it was reduced by Thrasybulus the Athenian, it is described as in a very flourishing condition. Its prosperity was greatly impaired by its disastrous war with the Triballi (*circa* B.C. 376), and very little is heard of it thereafter. The Abderitæ, or Abderitani, were proverbial for their want of wit and judgment; yet their city gave birth to several eminent persons, as Protagoras, Democritus, and Anaxarchus the philosophers, Hecatæus the historian, Nicænetus the poet, and others.

ABDERA (2.), a town in *Hispania Bætica*, founded by the Carthaginians, on the south coast, between *Malaca* and *Prom. Charidemi*. It is probably represented by the modern Adra.

ABDICATION, the act whereby a person in office renounces and gives up the same before the expiry of the time for which it is held. The word is seldom used except in the sense of surrendering the supreme power in a state. Despotic sovereigns are at liberty to divest themselves of their powers at any time, but it is otherwise with a limited monarchy. The throne of Great Britain cannot be lawfully abdicated unless with the consent of the two Houses of Parliament. When James II., after throwing the Great Seal into the Thames, fled to France in 1688, he did not formally resign the crown, and the question was discussed in Parliament whether he had forfeited the throne or had abdicated. The latter designation was agreed on, for in a full assembly of the Lords and Commons, met in convention, it was resolved, in spite of James's protest, "that King James II. having endeavoured to subvert the constitution of the kingdom, by breaking the original contract between king and people, and, by the advice of Jesuits and other wicked persons, having violated the fundamental laws, and having withdrawn himself out of this kingdom, has abdicated the government, and that the throne is thereby vacant." The Scotch Parliament pronounced a decree of forfeiture and deposition. Among the most memorable abdications of antiquity may be mentioned that of Sulla the dictator, B.C. 79, and that of the Emperor Diocletian, A.D. 305. The following is a list of the more important abdications of later times:—

	A.D.
Benedict IX., Pope,	1048
Stephen II. of Hungary,	1131
Albert (the Bear) of Brandenburg,	1169
Ladislaus III., Duke of Poland,	1207
John Balliol of Scotland,	1296
John Cantacuzene, Emperor of the East.	1355
John XXIII., Pope,	1415
Eric VII. of Denmark and XIII. of Sweden,	1439
Amurath II., Ottoman Emperor,	1444 and 1445
Charles V., Emperor,	1556
Christina of Sweden,	1654
John Casimir of Poland,	1668
James II. of England,	1688
Frederick Augustus of Poland	1706

		A.D.
Philip V. of Spain,		1724
Victor Amadeus II. of Sardinia,		1730
Achmet III., Ottoman Emperor,		1730
Charles of Naples (on accession to throne of Spain),		1759
Stanislaus II. of Poland,		1795
Charles Emanuel IV. of Sardinia,	June 4,	1802
Charles IV. of Spain,	Mar. 19,	1808
Joseph Bonaparte of Naples,	June 6,	1808
Gustavus IV. of Sweden,	Mar. 29,	1809
Louis Bonaparte of Holland,	July 2,	1810
Napoleon of France,	April 4, 1814, and June 22,	1815
Victor Emanuel of Sardinia,	Mar. 13,	1821
Charles X. of France,	Aug. 2,	1830
Pedro of Brazil,[1]	April 7,	1831
Don Miguel of Portugal,	May 26,	1834
William I. of Holland,	Oct. 7,	1840
Louis Philippe of France,	Feb. 24,	1848
Louis Charles of Bavaria,	Mar. 21,	1848
Ferdinand of Austria,	Dec. 2,	1848
Charles Albert of Sardinia,	Mar. 23,	1849
Leopold II. of Tuscany,	July 21,	1859
Isabella II. of Spain,	June 25,	1870
Amadeus I. of Spain,	Feb. 11,	1873

ABDOMEN, in *Anatomy*, the lower part of the trunk of the body, situated between the thorax and the pelvis. See ANATOMY.

ABDOMINALES, or ABDOMINAL FISHES, a sub-division of the Malacopterygious Order, whose ventral fins are placed behind the pectorals, under the abdomen. The typical abdominals are carp, salmon, herring, silures, and pike.

ABDUCTION, a law term denoting the forcible or fraudulent removal of a person, limited by custom to the case where a woman is the victim. In the case of men or children, it has been usual to substitute the term KIDNAPPING (*q.v.*) The old severe laws against abduction, generally contemplating its object as the possession of an heiress and her fortune, have been repealed by 24 and 25 Vict. c. 100, s. 53, which makes it felony for any one from motives of lucre to take away or detain against her will, with intent to marry or carnally know her, &c., any woman of any age who has any interest in any real or personal estate, or is an heiress presumptive, or co-heiress, or presumptive next of kin to any one having such an interest; or for any one to cause such a woman to be married or carnally known by any other person; or for any one with such intent to allure, take away, or detain any such woman under the age of twenty-one, out of the possession and against the will of her parents or guardians. By s. 54, forcible taking away or detention against her will of any woman of any age with like intent is felony. Even without such intent, abduction of any unmarried girl under the age of sixteen is a misdemeanour. In Scotland, where there is no statutory adjustment, abduction is similarly dealt with by practice.

ABDUL MEDJID, Sultan of Turkey, the thirty-first sovereign of the house of Othman, was born April 23, 1823, and succeeded his father Mahmoud II. on the 2d of July 1839. Mahmoud appears to have been unable to effect the reforms he desired in the mode of educating his children, so that his son received no better education than that given, according to use and wont, to Turkish princes in the harem. When Abdul Medjid succeeded to the throne, the affairs of Turkey were in an extremely critical state. At the very time his father died, the news was on its way to Constantinople that the Turkish army had been signally defeated at Nisib by that of the rebel Egyptian viceroy, Mehemet Ali; and the Turkish fleet was at the same time on its way to Egypt, to be surrendered perfidiously by its commander to the same enemy. But through the intervention of the great European powers, Mehemet Ali was obliged to come to terms, and the Ottoman empire was saved. In compliance with his father's express instructions, Abdul Medjid set at once about carrying out the extensive reforms to which Mahmoud had so energetically devoted himself. In November 1839 was proclaimed an edict, known as the Hatti-sherif of Gulhané, consolidating and enforcing these reforms, which was supplemented, at the close of the Crimean war, by a similar statute, issued in February 1856. By these enactments it was provided that all classes of the sultan's subjects should have security for their lives and property; that taxes should be fairly imposed and justice impartially administered; and that all should have full religious liberty and equal civil rights. The scheme was regarded as so revolutionary by the aristocracy and the educated classes (the Ulema) that it met with keen opposition, and was in consequence but partially put in force, especially in the remoter parts of the empire; and more than one conspiracy was formed against the sultan's life on account of it. Of the other measures of reform promoted by Abdul Medjid the more important were—the reorganisation of the army (1843–4), the institution of a council of public instruction (1846), the abolition of an odious and unfairly imposed capitation tax, the repression of slave trading, and various provisions for the better administration of the public service and for the advancement of commerce. The public history of his times—the disturbances and insurrections in different parts of his dominions throughout his reign, and the great war successfully carried on against Russia by Turkey, and by England, France, and Sardinia, in the interest of Turkey (1853–56)—can be merely alluded to in this personal notice. When Kossuth and others sought refuge in Turkey, after the failure of the Hungarian rising in 1849, the sultan was called on by Austria and Russia to surrender them, but boldly and determinedly refused. It is to his credit, too, that he would not allow the conspirators against his own life to be put to death. He bore the character of being a kind and honourable man. Against this, however, must be set down his excessive extravagance, especially towards the end of his life. He died on the 25th of June 1861, and was succeeded, not by one of his sons, but by his brother, Abdul Aziz, the present sultan, as the oldest survivor of the family of Othman.

A BECKET, THOMAS, Archbishop of Canterbury and Chancellor of England in the 12th century, was born in London on the 21st of December 1118. His father, Gilbert Becket, and his mother Roesa or Matilda, were both, there can be little doubt, of Norman extraction, if indeed they themselves were not immigrants from Normandy to England. Gilbert Becket, a merchant, and at one time Sheriff of London, a man of generous impulses and somewhat lavish hospitality, provided for his only child Thomas all the attainable advantages of influential society and a good education. At ten years of age Thomas was placed under the tuition of the canons regular of Merton on the Wandle in Surrey. From Merton he proceeded to study in the London schools, then in high repute. At Pevensey Castle, the seat of his father's friend Richer de l'Aigle, one of the great barons of England, he subsequently became a proficient in all the feats and graces of chivalry. From Pevensey he betook himself to the study of theology in the University of Paris. He never became a scholar, much less a theologian, like Wolsey, or even like some of the learned ecclesiastics of his own day; but his intellect was vigorous and original, and his manners captivating to his associates and popular with the multitude. His father's failure in business recalled him to London, and for three years he acted as a clerk in a lawyer's office. But a man so variously accomplished could not fail to stumble on preferment sooner or later. Accordingly, about 1142, Archdeacon Baldwin, a learned civilian, a friend of the elder Becket, introduced him to Theobald, Archbishop of

[1] Pedro had succeeded to the throne of Portugal in 1826, but abdicated it at once in favour of his daughter.

Canterbury, who at once appointed him to an office in the Archiepiscopal Court. His talents speedily raised him to the archdeaconry of the see. À Becket's tact in assisting to thwart an attempt to interest the Pope in favour of the coronation of Stephen's son Eustace, paved the way to the archdeacon's elevation to the Chancellorship of England under Henry II., a dignity to which he was raised in 1155. As he had served Theobald the archbishop, so he served Henry the king faithfully and well. It was his nature to be loyal. Enthusiastic partisanship is, in fact, the key to much that is otherwise inexplicable in his subsequent conduct towards Henry. When at a later period À Becket was raised to the primacy of England, a dignity not of his own seeking, he must needs quarrel with Henry in the interest of the Pope and "for the honour of God." As Chancellor of England he appeared in the war of Toulouse at the head of the chivalry of England, and "who can recount," says his attendant and panegyrist Grim, "the carnage, the desolation he made at the head of a strong body of soldiers? He attacked castles, and razed towns and cities to the ground; he burned down houses and farms, and never showed the slightest touch of pity to any one who rose in insurrection against his master." In single combat he vanquished and made prisoner the valiant Knight Engelram de Trie. Nor did À Becket the chancellor seek to quell Henry's secular foes alone. He was the able mouthpiece of the Crown in its contention with the Bishop of Chichester, who had alleged that the permission of the Pope was necessary to the conferring or taking away of ecclesiastical benefices; and he rigorously exacted *scutage*, a military tax in lieu of personal service in the field, from the clergy, who accused him of "plunging a sword into the bosom of his mother the church." His pomp and munificence as chancellor were beyond precedent. In 1159 he undertook, at Henry's request, an embassy to the French Court for the purpose of affiancing the king's eldest son to the daughter of the king of France. His progress through the country was like a triumphal procession. "How wonderful must be the king of England himself whose chancellor travels in such state!" was on every one's lips. In 1162 he was elected Archbishop of Canterbury, Gilbert Foliot, Bishop of Herford, alone dissenting, and remarking sarcastically, at the termination of the ceremony, that "the king had worked a miracle in having that day turned a layman into an archbishop and a soldier into a saint." Hitherto À Becket had only been in deacon's orders, and had made no profession of sanctity of life. At the same time, there is nothing to show that his character was stained by the gross licentiousness of the times. Now, however, he devoted himself body and soul to the service of the church. The fastidious courtier was at once transformed into the squalid penitent, who wore hair-cloth next his skin, fed on roots, drank nauseous water, and daily washed the feet of thirteen beggars. Henry, who had expected to see the archbishop completely sunk in the chancellor, was amazed to receive the following laconic message from À Becket:—"I desire that you will provide yourself with another chancellor, as I find myself hardly sufficient for the duties of one office, much less of two." From that moment there was strife between À Becket and Henry, À Becket straining every nerve to extend the authority of the Pope, and Henry doing his utmost to subject the church to his own will. Throughout the bitter struggle for supremacy which ensued between À Becket and the king, À Becket was backed by the sympathy of the Saxon populace, Henry by the support of the Norman barons and by the greater dignitaries of the church. At the outset À Becket was worsted. He was constrained to take an oath, "with good faith and without fraud or reserve, to observe the Constitutions of Clarendon," which subjected clerks guilty of crime to the ordinary civil tribunals, put ecclesiastical dignities at the royal disposal, prevented all appeals to Rome, and made Henry the virtual "head of the church." For his guilty compliance with these anti-papal constitutions he received the special pardon and absolution of his holiness, and proceeded to anathematise them with the energy of a genuine remorse. The king resolved on his ruin. He was summoned before a great council at Northampton, and in defiance of justice was called on to account for the sum of 44,000 marks declared to have been misappropriated by him during his chancellorship. "For what happened before my consecration," said À Becket, "I ought not to answer, nor will I. Know, moreover, that ye are my children in God; neither law nor reason allows you to judge your father. I refer my quarrel to the decision of the Pope. To him I appeal, and shall now, under the protection of the Catholic Church and the Apostolic See, depart." He effected his escape to France, and took refuge in the Cistercian monastery of Pontigny, whence he repeatedly anathematised his enemies in England, and hesitated not to speak of Henry as a "malicious tyrant." Pope Alexander III., though at heart a warm supporter of Becket, was guarded in his conduct towards Henry, who had shown a disposition to support the anti-pope Pascal III., and it was not till the Archbishop of York, in defiance of a papal bull, had usurped the functions of the exiled primate by officiating at the coronation of Henry's son, that Alexander became really formidable. À Becket was now resolute for martyrdom or victory. Henry began to tremble, and an interview between him and Becket was arranged to take place at Fereitville in 1170. It was agreed that À Becket should return to his see, and that the king should discharge his debts and defray the expenses of his journey. À Becket proceeded to the coast, but the king, who had promised to meet him, broke his engagement in every particular. À Becket, in retaliation, excommunicated the Archbishop of York and the Bishops of London and Salisbury for officiating at the coronation of the king's son. The terrified prelates took refuge in Normandy with Henry, who, on hearing their tale, accompanied by an account of À Becket's splendid reception at Canterbury, exclaimed in ungovernable fury, "Of the cowards who eat my bread, is there not one who will free me from this turbulent priest?" Four knights, Fitzurse, Tracy, Morville, and Brito, resolved to avenge their sovereign, who it appears was ignorant of their intention. They arrived in Canterbury, and finding the archbishop, threatened him with death if he would not absolve the excommunicated bishops. "In vain," replied À Becket, "you threaten me. If all the swords in England were brandishing over my head, your terrors could not move me. Foot to foot you will find me fighting the battle of the Lord." He was barbarously murdered in the great cathedral, at the foot of the altar of St Benedict, on the 29th December 1170. Two years thereafter he was canonised by the Pope; and down to the Reformation innumerable pilgrimages were made to the shrine of St Thomas of Canterbury by devotees from every corner of Christendom. So numerous were the miracles wrought at his tomb, that Gervase of Canterbury tells us two large volumes kept in the cathedral were filled with accounts of them. Every fiftieth year a jubilee was celebrated in his honour, which lasted fifteen days; plenary indulgences were then granted to all who visited his tomb; and as many as 100,000 pilgrims were registered at a time in Canterbury. The worship of St Thomas superseded the adoration of God, and even that of the Virgin. In one year there was offered at God's altar nothing; at that of the Virgin £4, 1s. 8d.; while St Thomas received for his share £954, 6s. 3d.—an enormous sum, if the purchasing power of money in those times be considered. Henry VIII., with a just if somewhat ludicrous appreciation of the issue which À Becket had raised

with his royal predecessor Henry II., not only pillaged the rich shrine dedicated to St Thomas, but caused the saint himself to be cited to appear in court, and to be tried and condemned as a traitor, at the same time ordering his name to be struck out of the calendar, and his bones to be burned and the ashes thrown in the air. À Becket's character and aims have been the subject of the keenest ecclesiastical and historic controversy down to the present time, but it is impossible to doubt the fundamental sincerity of the one or the disinterestedness of the other, however inconsistent his actions may sometimes appear. If the fruit of the Spirit be "love, joy, peace, long-suffering, gentleness, goodness, faith, meekness, and temperance," À Becket was assuredly not a saint, for he indulged to the last in the bitterest invectives against his foes; but that he fought with admirable courage and devotion the "battle of the Lord," according to the warlike ideas of an age with which he was in intense sympathy, is beyond dispute. He was the leading Ultramontane of his day, hesitating not to reprove the Pope himself for lukewarmness in the cause of the "church's liberty." He was the last of the great ecclesiastics of the type of Lanfranc and Anselm, who struggled for supremacy with the civil power in England on almost equal terms. In his day the secular stream was running very strong, and he might as chancellor have floated down the current pleasantly enough, governing England in Henry's name. He nevertheless perished in a chivalrous effort to stem the torrent. The tendency of his principles was to supersede a civil by a spiritual despotism; "but, in point of fact," says Hook, in his valuable Life, "he was a high-principled, high-spirited demagogue, who taught the people to struggle for their liberties," a struggle soon to commence, and of which he was by no means an impotent if an unconscious precursor.—See Dr Giles's *Vita et Epistolæ S. Thomæ Cantuariensis;* Canon Morris's *Life of St Thomas Becket;* Canon Robertson's *Life of Becket;* Canon Stanley's *Historical Memorials of Canterbury;* J. G. Nichol's *Pilgrimages of Walsingham and Canterbury;* Hook's *Lives of the Archbishops of Canterbury;* and Lord Campbell's *Lives of the Chancellors of England.*

A'BECKETT, Gilbert Abbott, a successful cultivator of light literature, was born in London in 1811, and educated at Westminster School. He wrote burlesque dramas with success from his boyhood, took an active share in the establishment of different comic periodicals, particularly *Figaro in London* and *Punch,* and was a constant contributor to the columns of the latter from its commencement till the time of his death. His principal publications, all overflowing with kindly humour, and rich in quaint fancies, are his parodies of living dramatists (himself included), reprinted from *Punch* (1844); *The Small Debts Act, with Annotations and Explanations* (1845); *The Quizziology of the British Drama* and *The Comic Blackstone* (1846); *A Comic History of England* (1847); and *A Comic History of Rome* (1852). He contributed occasionally, too, to the *Times* and other metropolitan papers. A'Beckett was called to the bar in 1841, and from 1849 discharged with great efficiency the duties of a metropolitan police magistrate. He died at Boulogne on the 30th of August 1856.

ABEL (הֶבֶל, *breath, vanity, transitoriness*), the second son of Adam, slain by Cain his elder brother (Gen. iv 1–16). The narrative in Genesis, which tells us that "the Lord had respect unto Abel and to his offering, but unto Cain and to his offering he had not respect," is supplemented by the statement of the New Testament, that "by faith Abel offered unto God a more excellent sacrifice than Cain," (Heb. xi. 4), and that Cain slew Abel "because his own works were evil and his brother's righteous" (1 John iii. 12). In patristic theology the striking contrast between the brothers was mystically explained and typically applied in various ways. Augustine, for example, regards Abel as the representative of the regenerate or spiritual man, and Cain as the representative of the natural or corrupt man. Augustine in his treatise *De Hæresibus,* c. 86, mentions a sect of *Abelitae* or Abelians, who seem to have lived in North Africa, and chiefly in the neighbourhood of Hippo-Regius. According to their tradition, Abel, though married, lived in continence, and they followed his practice in this respect, so as to avoid the guilt of bringing sinful creatures into the world.

ABEL, Karl Friedrich (1726–1787), a celebrated German musician. His adagio compositions have been highly praised, but he attained greater distinction as a performer than as a composer, his instrument being the *Viola di gamba,* which from his time has given place to the violoncello. He studied under Sebastian Bach, played for ten years (1748–58) in the band formed at Dresden by the Elector of Saxony, under Hasse, and then, proceeding to England, became (1759) chamber-musician to the queen of George III. His life was shortened by habits of intemperance.

ABEL, Niels Henrik, one of the ablest and acutest mathematicians of modern times, was born at Findöe in Norway in 1802, and died near Arendal in 1829. Considering the shortness of his life, the extent and thoroughness of his mathematical investigations and analyses are marvellous. His great powers of generalisation were displayed in a remarkable degree in his development of the theory of elliptic functions. Legendre's eulogy of Abel, "Quelle tête celle du jeune Norvegien!" is the more forcible, that the French mathematician had occupied himself with those functions for most of his lifetime. Abel's works, edited by M. Holmboe, the professor under whom he studied at Christiania, were published by the Swedish government in 1839.

ABEL, Thomas, a Roman Catholic divine during the reign of Henry VIII., was an Englishman, but when or where born does not appear. He was educated at Oxford, where he passed B.A. on 4th July 1513, M.A. on 27th June 1516, and proceeded D.D. On 23d June 1530 he was presented by Queen Catherine to the rectory of Bradwell in Essex, on the sea-coast. He had been introduced to the court through the report of his learning in classical and living languages, and accomplishments in music; and he was appointed domestic chaplain to Queen Catherine. It speaks well both for the chaplain and his royal mistress, that to the last he defended the outraged queen against "bluff King Hal." The *Defence, "Invicta Veritas,"* was printed at Luneberge in 1532. This pungent little book was replied to, but never answered, and remains *the* defence on Queen Catherine's part. Abel was ensnared, as greater men were, in the prophetic delusions and ravings of Elizabeth Barton, called the "Holy Maid of Kent." As belonging to the Church of Rome, he inevitably opposed Henry VIII.'s assumption of supremacy in the church. Ultimately he was tried and condemned for "misprision of treason," and perished in the usual cruel and ignoble way. The execution, as described, took place at Smithfield on July 30, 1540. If we may not concede the venerable and holy name of martyr to Abel—and John Foxe is passionate in his refusal of it—yet we must hold that he at least fell a victim to his unsparing defence of his queen and friend, the "misprision of treason" having been a foregone conclusion. In stat. 25, Henry VIII., c. 12, he is described as having "caused to be printed and set forth in this realme diverse books against the divorce and separation." Neither the *Tractatus* nor the "diverse books" are known.—Dodd, *Church History,* Brussels, 1737, folio, vol. i. p. 208; Bourchier, *Hist. Eccl.*

de Martyr. Fratr. minor. (Ingolst. 1583); Pitts, *De illustr. Angl. Scrip.;* Tanner's *Bibliotheca Hibernico-Britannica*, p. i.; Zurich, *Original Letters relative to the English Reformation* (Parker Society, pt. ii. pp. 209–211, 1846); Foxe's *Acts and Monuments* (Cattley's, vol. v. pp. 438–440); Burnet, *Soames, Biog. Brit.;* Wood's *Athenæ* (Bliss), s. v.; Stow, *Chron.* p. 581. (A. B. G.)

ABELARD, PETER, born at Pallet (Palais), not far from Nantes, in 1079, was the eldest son of a noble Breton house. The name *Abœlardus* (also written *Abailardus*, *Abaielardus*, and in many other ways) is said to be a corruption of *Habelardus*, substituted by himself for a nickname *Bajolardus* given to him when a student. As a boy, he showed an extraordinary quickness of apprehension, and, choosing a learned life instead of the active career natural to a youth of his birth, early became an adept in the art of dialectic, under which name philosophy, meaning at that time chiefly the logic of Aristotle transmitted through Latin channels, was the great subject of liberal study in the episcopal schools. Roscellin, the famous canon of Compiègne, is mentioned by himself as his teacher; but whether he heard this champion of extreme Nominalism in early youth, when he wandered about from school to school for instruction and exercise, or some years later, after he had already begun to teach for himself, remains uncertain. His wanderings finally brought him to Paris, still under the age of twenty. There, in the great cathedral school of Notre-Dame, he sat for a while under the teaching of William of Champeaux, the disciple of St Anselm and most advanced of Realists, but, presently stepping forward, he overcame the master in discussion, and thus began a long duel that issued in the downfall of the philosophic theory of Realism, till then dominant in the early Middle Age. First, in the teeth of opposition from the metropolitan teacher, he proceeded to set up a school of his own at Melun, whence, for more direct competition, he removed to Corbeil, nearer Paris. The success of his teaching was signal, though for a time he had to quit the field, the strain proving too great for his physical strength. On his return, after 1108, he found William lecturing no longer at Notre-Dame, but in a monastic retreat outside the city, and there battle was again joined between them. Forcing upon the Realist a material change of doctrine, he was once more victorious, and thenceforth he stood supreme. His discomfited rival still had power to keep him from lecturing in Paris, but soon failed in this last effort also. From Melun, where he had resumed teaching, Abelard passed to the capital, and set up his school on the heights of St Geneviève, looking over Notre-Dame. When he had increased his distinction still further by winning reputation in the theological school of Anselm of Laon, no other conquest remained for him. He stepped into the chair at Notre-Dame, being also nominated canon, about the year 1115.

Few teachers ever held such sway as Abelard now did for a time. Distinguished in figure and manners, he was seen surrounded by crowds—it is said thousands—of students, drawn from all countries by the fame of his teaching, in which acuteness of thought was relieved by simplicity and grace of exposition. Enriched by the offerings of his pupils, and feasted with universal admiration, he came, as he says, to think himself the only philosopher standing in the world. But a change in his fortunes was at hand. In his devotion to science, he had hitherto lived a very regular life, varied only by the excitement of conflict: now, at the height of his fame, other passions began to stir within him. There lived at that time, within the precincts of Notre-Dame, under the care of her uncle, the canon Fulbert, a young girl named Heloise, of noble extraction and born about 1101. Fair, but still more remarkable for her knowledge, which extended beyond Latin, it is said, to Greek and Hebrew, she awoke a feeling of love in the breast of Abelard; and with intent to win her, he sought and gained a footing in Fulbert's house as a regular inmate. Becoming also tutor to the maiden, he used the unlimited power which he thus obtained over her for the purpose of seduction, though not without cherishing a real affection which she returned in unparalleled devotion. Their relation interfering with his public work, and being, moreover, ostentatiously sung by himself, soon became known to all the world except the too-confiding Fulbert; and, when at last it could not escape even his vision, they were separated only to meet in secret. Thereupon Heloise found herself pregnant, and was carried off by her lover to Brittany, where she gave birth to a son. To appease her furious uncle, Abelard now proposed a marriage, under the condition that it should be kept secret, in order not to mar his prospects of advancement in the church; but of marriage, whether public or secret, Heloise would hear nothing. She appealed to him not to sacrifice for her the independence of his life, nor did she finally yield to the arrangement without the darkest forebodings, only too soon to be realised. The secret of the marriage was not kept by Fulbert; and when Heloise, true to her singular purpose, boldly then denied it, life was made so unsupportable to her that she sought refuge in the convent of Argenteuil. Immediately Fulbert, believing that her husband, who aided in the flight, designed to be rid of her, conceived a dire revenge. He and some others broke into Abelard's chamber by night, and, taking him defenceless, perpetrated on him the most brutal mutilation. Thus cast down from his pinnacle of greatness into an abyss of shame and misery, there was left to the brilliant master only the life of a monk. Heloise, not yet twenty, consummated her work of self-sacrifice at the call of his jealous love, and took the veil.

It was in the Abbey of St Denis that Abelard, now aged forty, sought to bury himself with his woes out of sight. Finding, however, in the cloister neither calm nor solitude, and having gradually turned again to study, he yielded after a year to urgent entreaties from without and within, and went forth to reopen his school at the Priory of Maisoncelle (1120). His lectures, now framed in a devotional spirit, were heard again by crowds of students, and all his old influence seemed to have returned; but old enmities were revived also, against which he was no longer able as before to make head. No sooner had he put in writing his theological lectures (apparently the *Introductio ad Theologiam* that has come down to us), than his adversaries fell foul of his rationalistic interpretation of the Trinitarian dogma. Charging him with the heresy of Sabellius in a provincial synod held at Soissons in 1121, they procured by irregular practices a condemnation of his teaching, whereby he was made to throw his book into the flames, and then was shut up in the convent of St Médard. After the other, it was the bitterest possible experience that could befall him, nor, in the state of mental desolation into which it plunged him, could he find any comfort from being soon again set free. The life in his own monastery proving no more congenial than formerly, he fled from it in secret, and only waited for permission to live away from St Denis before he chose the one lot that suited his present mood. In a desert place near Nogent-sur-Seine, he built himself a cabin of stubble and reeds, and turned hermit. But there fortune came back to him with a new surprise. His retreat becoming known, students flocked from Paris, and covered the wilderness around him with their tents and huts. When he began to teach again, he found consolation, and in gratitude he consecrated the new oratory they built for him by the name of the Paraclete.

Upon the return of new dangers, or at least of fears, Abelard left the Paraclete to make trial of another refuge, accepting an invitation to preside over the Abbey of St Gildas-de-Rhuys, on the far-off shore of Lower Brittany. It proved a wretched exchange. The region was inhospitable, the domain a prey to lawless exaction, the house itself savage and disorderly. Yet for nearly ten years he continued to struggle with fate before he fled from his charge, yielding in the end only under peril of violent death. The misery of those years was not, however, unrelieved; for he had been able, on the breaking-up of Heloise's convent at Argenteuil, to establish her as head of a new religious house at the deserted Paraclete, and in the capacity of spiritual director he often was called to revisit the spot thus made doubly dear to him. All this time Heloise had lived amid universal esteem for her knowledge and character, uttering no word under the doom that had fallen upon her youth; but now, at last, the occasion came for expressing all the pent-up emotions of her soul. Living on for some time in Brittany after his flight from St Gildas, Abelard wrote, among other things, his famous *Historia Calamitatum*, and thus moved her to pen her first *Letter*, which remains an unsurpassed utterance of human passion and womanly devotion; the first being followed by the two other *Letters*, in which she finally accepted the part of resignation which, now as a brother to a sister, Abelard commended to her. He not long after was seen once more upon the field of his early triumphs, lecturing on Mount St Geneviève in 1136 (when he was heard by John of Salisbury), but it was only for a brief space: no new triumph, but a last great trial, awaited him in the few years to come of his chequered life. As far back as the Paraclete days, he had counted as chief among his foes Bernard of Clairvaux, in whom was incarnated the principle of fervent and unhesitating faith, from which rational inquiry like his was sheer revolt, and now this uncompromising spirit was moving, at the instance of others, to crush the growing evil in the person of the boldest offender. After preliminary negotiations, in which Bernard was roused by Abelard's steadfastness to put forth all his strength, a council met at Sens, before which Abelard, formally arraigned upon a number of heretical charges, was prepared to plead his cause. When, however, Bernard, not without foregone terror in the prospect of meeting the redoubtable dialectician, had opened the case, suddenly Abelard appealed to Rome. The stroke availed him nothing; for Bernard, who had power, notwithstanding, to get a condemnation passed at the council, did not rest a moment till a second condemnation was procured at Rome in the following year. Meanwhile, on his way thither to urge his plea in person, Abelard had broken down at the Abbey of Cluni, and there, an utterly fallen man, with spirit of the humblest, and only not bereft of his intellectual force, he lingered but a few months before the approach of death. Removed by friendly hands, for the relief of his sufferings, to the Priory of St Marcel, he died on the 21st of April 1142. First buried at St Marcel, his remains soon after were carried off in secrecy to the Paraclete, and given over to the loving care of Heloise, who in time came herself to rest beside them. The bones of the pair were shifted more than once afterwards, but they were marvellously preserved even through the vicissitudes of the French Revolution, and now they lie united in the well-known tomb at Père-Lachaise.

Great as was the influence exerted by Abelard on the minds of his contemporaries and the course of mediæval thought, he has been little known in modern times but for his connection with Heloise. Indeed, it was not till the present century, when Cousin in 1836 issued the collection entitled *Ouvrages inédits d'Abélard*, that his philosophical performance could be judged at first hand; of his strictly philosophical works only one, the ethical treatise *Scito te ipsum*, having been published earlier, namely, in 1721. Cousin's collection, besides giving extracts from the theological work *Sic et Non* (an assemblage of opposite opinions on doctrinal points, culled from the Fathers as a basis for discussion), includes the *Dialectica*, commentaries on logical works of Aristotle, Porphyry, and Boëthius, and a fragment, *De Generibus et Speciebus*. The last-named work, and also the psychological treatise *De Intellectibus*, published apart by Cousin (in *Fragmens Philosophiques*, vol. ii.), are now considered upon internal evidence not to be by Abelard himself, but only to have sprung out of his school. A genuine work, the *Glossulæ super Porphyrium*, from which M. de Rémusat, in his classical monograph *Abélard* (1845), has given extracts, remains in manuscript.

The general importance of Abelard lies in his having fixed more decisively than any one before him the scholastic manner of philosophising, with its object of giving a formally rational expression to the received ecclesiastical doctrine. However his own particular interpretations may have been condemned, they were conceived in essentially the same spirit as the general scheme of thought afterwards elaborated in the 13th century with approval from the heads of the church. Through him was prepared in the Middle Age the ascendency of the philosophical authority of Aristotle, which became firmly established in the half-century after his death, when first the completed *Organon*, and gradually all the other works of the Greek thinker, came to be known in the schools: before his time it was rather upon the authority of Plato that the prevailing Realism sought to lean. As regards the central question of Universals, without having sufficient knowledge of Aristotle's views, Abelard yet, in taking middle ground between the extravagant Realism of his master, William of Champeaux, or of St Anselm, and the not less extravagant Nominalism (as we have it reported) of his other master, Roscellin, touched at more than one point the Aristotelian position. Along with Aristotle, also with Nominalists generally, he ascribed full reality only to the particular concretes; while, in opposition to the "*insana sententia*" of Roscellin, he declared the Universal to be no mere word (*vox*), but to consist, or (perhaps we may say) emerge, in the fact of predication (*sermo*). Lying in the middle between Realism and (extreme) Nominalism, this doctrine has often been spoken of as Conceptualism, but ignorantly so. Abelard, pre-eminently a logician, did not concern himself with the psychological question which the Conceptualist aims at deciding as to the mental subsistence of the Universal. Outside of his dialectic, it was in ethics that Abelard showed greatest activity of philosophical thought; laying very particular stress upon the subjective intention as determining, if not the moral character, at least the moral value, of human action. His thought in this direction, wherein he anticipated something of modern speculation, is the more remarkable because his scholastic successors accomplished least in the field of morals, hardly venturing to bring the principles and rules of conduct under pure philosophical discussion, even after the great ethical inquries of Aristotle became fully known to them. (G. C. R.)

ABENCERRAGES, a family or faction that is said to have held a prominent position in the Moorish kingdom of Granada in the 15th century. The name appears to have been derived from the Yussuf ben-Serragh, the head of the tribe in the time of Mahommed VII., who did that sovereign good service in his struggles to retain the crown of which he was three times deprived. Nothing is known of the family with certainty; but the name is

familiar from the interesting romance of Gines Perez de Hita, *Guerras civiles de Granada*, which celebrates the feuds of the Abencerrages and the rival family of the Zegris, and the cruel treatment to which the former were subjected. Florian's *Gonsalvo of Cordova*, and Chateaubriand's *Last of the Abencerrages*, are imitations of Perez de Hita's work. The hall of the Abencerrages in the Alhambra takes its name from being the reputed scene of the massacre of the family.

ABENEZRA, or IBN EZRA, is the name ordinarily given to ABRAHAM BEN MEIR BEN EZRA (called also *Abenare* or *Evenare*), one of the most eminent of the Jewish literati of the Middle Ages. He was born at Toledo about 1090; left Spain for Rome about 1140; resided afterwards at Mantua (1145), at Lucca (1154), at Rhodes (1155 and 1166), and in England (1159); and died probably in 1168. He was distinguished as a philosopher, astronomer, physician, and poet, but especially as a grammarian and commentator. The works by which he is best known form a series of *Commentaries* on the books of the Old Testament, which have nearly all been printed in the great Rabbinic Bibles of Bomberg (1525–6), Buxtorf (1618–9), and Frankfurter (1724–7). Abenezra's commentaries are acknowledged to be of very great value; he was the first who raised biblical exegesis to the rank of a science, interpreting the text according to its literal sense, and illustrating it from cognate languages. His style is elegant, but is so concise as to be sometimes obscure; and he occasionally indulges in epigram. In addition to the commentaries, he wrote several treatises on astronomy or astrology, and a number of grammatical works.

ABENSBERG, a small town of Bavaria, 18 miles S.W. of Regensburg, containing 1300 inhabitants. Here Napoleon gained an important victory over the Austrians on the 20th of April 1809. The town is the *Abusina* of the Romans, and ancient ruins exist in its neighbourhood.

ABERAVON, a parliamentary and municipal borough of Wales, in the county of Glamorgan, beautifully situated on the Avon, near its mouth, 8 miles east of Swansea. The town and adjacent villages have increased rapidly in recent years, from the extension of the mines of coal and iron in the vicinity, and the establishment of extensive works for the smelting of tin, copper, and zinc. The harbour, Port Talbot, has been much improved, and has good docks; and there is regular steam communication with Bristol. Ores for the smelting furnaces are imported from Cornwall, and copper, tin, and coal are exported. Aberavon unites with Swansea, Kenfigg, Loughor, and Neath, in returning a member to Parliament. In 1871 the population of the parish was 3396, of the parliamentary borough, 11,906.

ABERCONWAY. See CONWAY.

ABERCROMBIE, JOHN, an eminent physician of Edinburgh, was the son of the Rev. George Abercrombie of Aberdeen, in which city he was born in 1781. After attending the Grammar School and Marischal College, Aberdeen, he commenced his medical studies at Edinburgh in 1800, and obtained his degree of M.D. there in 1803. Soon afterwards he went to London, and for about a year gave diligent attention to the medical practice and lectures in St George's Hospital. In 1804 he returned to Edinburgh, became a Fellow of the College of Surgeons, and commenced as general practitioner in that city; where, in dispensary and private practice, he laid the foundation of that character for sagacity as an observer of disease, and judgment in its treatment, that eventually elevated him to the head of his profession. In 1823, he became a Licentiate of the College of Physicians; in 1824, a Fellow of that body; and from the death of Dr Gregory in 1822, he was considered the first physician in Scotland. Abercrombie early began the laudable practice of preserving accurate notes of the cases that fell under his care; and at a period when pathological anatomy was far too little regarded by practitioners in this country, he had the merit of sedulously pursuing it, and collecting a mass of most important information regarding the changes produced by disease on different organs; so that, before the year 1824, he had more extended experience, and more correct views in this interesting field, than most of his contemporaries engaged in extensive practice. From 1816 he occasionally enriched the pages of the *Edinburgh Medical and Surgical Journal* with essays, that display originality and industry, particularly those "on the diseases of the spinal cord and brain," and "on diseases of the intestinal canal, of the pancreas, and spleen." The first of these formed the basis of his great and very original work, *Pathological and Practical Researches on Diseases of the Brain and Spinal Cord*, which appeared at Edinburgh in 1828. In the same year he published also another very valuable work, his *Researches on the Diseases of the Intestinal Canal, Liver, and other Viscera of the Abdomen.* Though his professional practice was very extensive and lucrative, he found time for other speculations and occupations. In 1830 he published his *Inquiries concerning the Intellectual Powers of Man and the Investigation of Truth*, a work which, though less original and profound than his medical speculations, contains a popular view of an interesting subject, expressed in simple language. It was followed in 1833 by a sequel, *The Philosophy of the Moral Feelings*, the object of which, as stated in the preface, was "to divest the subject of all improbable speculations," and to show "the important relation which subsists between the science of mind and the doctrines of revealed religion." Both works have been very extensively read, reaching the 18th and 14th editions respectively in 1869. Soon after the publication of *Moral Feelings*, the University of Oxford conferred on the author the honorary degree of Doctor of Medicine, and in 1835 he was elected Lord Rector of Marischal College, Aberdeen. Dr Abercrombie was much beloved by his numerous friends for the suavity and kindness of his manners, and was universally esteemed for his benevolence and unaffected piety. He died on the 14th of November 1844 of a very uncommon disease, the bursting (from softening of the muscular substance) of the coronary vessels of the heart.

ABERCROMBY, DAVID, M.D. This Scottish physician was sufficiently noteworthy half a century after his (probable) decease to have his *Nova Medicinæ Praxis* reprinted at Paris in 1740; while during his lifetime his *Tuta ac efficax luis venereæ sæpe absque mercurio ac semper absque salivatione mercuriali curando methodus* (1684, 8vo) was translated into German and published at Dresden in 1702 (8vo). In 1685 were published *De Pulsus Variatione* (London; Paris, 1688, 12mo), and *Ars explorandi medicas facultates plantarum ex solo sap.* (London). His *Opuscula* were collected in 1687. These professional writings gave him a place and memorial in Haller's *Bibliotheca Medicinæ Pract.* (4 vols. 8vo, 1779, tom. iii. p. 619); but he claims passing remembrance rather as a metaphysician by his remarkable controversial books in theology and philosophy. Formerly a Roman Catholic and Jesuit, he abjured Popery, and published *Protestancy proved Safer than Popery* (London, 1686). But by far the most noticeable of his productions is *A Discourse of Wit* (London, 1685). This treatise somehow has fallen out of sight—much as old coined gold gets hidden away—so that bibliographers do not seem to have met with it, and assign it at hap-hazard to Patrick Abercromby, M.D. Notwithstanding, the most cursory examination of it proves that in this *Discourse of Wit* are contained

some of the most characteristic and most definitely-put metaphysical opinions of the Scottish philosophy of common sense. Of this early metaphysician nothing biographically has come down save that he was a Scotchman ("Scotus")—born at Seaton. He was living early in the 18th century. (Haller, as *supra;* Lawrence Charteris's M.S., *s. v.*) So recently as 1833 was printed *A Short Account of Scots Divines* by him, edited by James Maidment, Edinburgh. (A. B. G.)

ABERCROMBY, JAMES, LORD DUNFERMLINE, third son of the celebrated Sir Ralph Abercromby, was born on the 7th Nov. 1776. Educated for the profession of the law, he was called to the bar at Lincoln's Inn in 1801, but he was prevented from engaging to any considerable extent in general practice by accepting appointments, first as commissioner in bankruptcy, and subsequently, as steward of the estates of the Duke of Devonshire. He commenced his political career in 1807, when he was elected member of Parliament for the borough of Midhurst. His sympathies with the small and struggling Opposition had already been declared, and he at once attached himself to the Whig party, with which he consistently acted throughout life. In 1812 he was returned for Calne, which he continued to represent until his elevation to the Scotch bench in 1830. During this lengthened period he rendered conspicuous and valuable services to his party and the country. In Scotch affairs he took, as was natural, a deep interest; and, by introducing, on two separate occasions, a motion for the redress of a special glaring abuse, he undoubtedly gave a strong impulse to the growing desire for a general reform. In 1824, and again in 1826, he presented a petition from the inhabitants of Edinburgh, and followed it up by a motion "for leave to bring in a Bill for the more effectual representation of the city of Edinburgh in the Commons House of Parliament." The motion was twice rejected, but by such narrow majorities as showed that the monopoly of the self-elected Council of thirty-three was doomed. In 1827, on the accession of the Whigs to power under Mr Canning, Abercromby received the appointment of Judge-Advocate-General and Privy Counsellor. In 1830 he was raised to the judicial bench as Chief Baron of the Exchequer in Scotland. The office was abolished in 1832; and almost contemporaneously, Edinburgh, newly enfranchised, was called to return two members to the first reformed Parliament. As the election marked the commencement of a new political era, the honour to be conferred possessed a peculiar value, and the choice of the citizens fell most appropriately on Francis Jeffrey and James Abercromby, two of the foremost of those to whom they were indebted for their hard-won privileges. In 1834 Mr Abercromby obtained a seat in the cabinet of Lord Grey as Master of the Mint. On the assembling of the new Parliament in 1835, the election of a speaker gave occasion for the first trial of strength between the Reform party and the followers of Sir Robert Peel. After a memorable division, in which more members voted than had ever before been known, Abercromby was elected by 316 votes, to 310 recorded for Manners-Sutton. The choice was amply justified, not only by the urbanity, impartiality, and firmness with which Abercromby discharged the public duties of the chair, but also by the important reforms he introduced in regard to the conduct of private business. In 1839 he resigned the office, and received the customary honour of a peerage, with the title of Lord Dunfermline. The evening of his life was passed in retirement at Colinton, near Edinburgh, where he died on the 17th April 1858. The courage and sagacity which marked his entire conduct as a Liberal were never more conspicuous than when, towards the close of his life, he availed himself of an opportunity of practically asserting his cherished doctrine of absolute religious equality. The important part he took in originating and supporting the United Industrial School in Edinburgh for ragged children, irrespective of their religious belief, deserves to be gratefully acknowledged and remembered, even by those who took the opposite side in the controversy which arose with regard to it.

ABERCROMBY, PATRICK, M.D., was the third son of Alexander Abercromby of Fetterneir in Aberdeenshire, and brother of Francis Abercromby, who was created by James II. Lord Glasford. He was born at Forfar in 1656. As throughout Scotland, he could have had there the benefits of a good parish school; but it would seem from after events that his family was Roman Catholic, and hence, in all probability, his education was private. This, and not the unproved charge of perversion from Protestantism in subserviency to James II., explains his Roman Catholicism and adhesion to the fortunes of that king. But, intending to become a doctor of medicine, he entered the University of St Andrews, where he took his degree of M.D. in 1685. From a statement in one of his preface-epistles to his *magnum opus*, the *Martial Achievements of the Scots Nation,* he must have spent most of his youthful years abroad. It has been stated that he attended the University of Paris. The *Discourse of Wit* (1685), assigned to him, belongs to Dr David Abercromby, a contemporary. On his return to Scotland, he is found practising as a physician in Edinburgh, where, besides his professional duties, he gave himself with characteristic zeal to the study of antiquities, a study to which he owes it that his name still lives, for he finds no place in either Haller or Hutchison's *Medical Biographies.* He was out-and-out a Scot of the old patriotic type, and, living as he did during the agitations for the union of England and Scotland, he took part in the war of pamphlets inaugurated and sustained by prominent men on both sides of the Border. He crossed swords with no less redoubtable a foe than Daniel Defoe in his *Advantages of the Act of Security, compared with those of the intended Union* (Edinburgh, 1707), and *A Vindication of the Same against Mr De Foe* (*ibid.*) The logic and reason were with Defoe, but there was a *sentiment* in the advocates of independence which was not sufficiently allowed for in the clamour of debate; and, besides, the disadvantages of union were near, hard, and actual, the advantages remote, and contingent on many things and persons. Union wore the look to men like Abercromby and Lord Belhaven of absorption, if not extinction. Abercromby was appointed physician to James II., but the Revolution deprived him of the post. Crawford (in his *Peerage,* 1716) ascribes the title of Lord Glasford to an intended recognition of ancestral loyalty; its bestowment in 1685 corresponding with the younger brother's graduation as M.D., may perhaps explain his appointment. A minor literary work of Abercromby's was a translation of M. Beague's partizan History (so called) of the War carried on by the Popish Government of Cardinal Beaton, aided by the French, against the English under the Protector Somerset, which appeared in 1707. The work with which Abercromby's name is permanently associated is his already noticed *Martial Achievements of the Scots Nation,* issued in two noble folios, vol. i. 1711, vol. ii. 1716. In the title-page and preface to vol. i. he disclaims the ambition of being an historian, but in vol. ii., in title-page and preface alike, he is no longer a simple biographer, but an historian. That Dr Abercromby did not use the word "*genuine* history" in his title-page without warrant is clear on every page of his large work. Granted that, read in the light of after researches, much of the first volume must necessarily be relegated to the region of the mythical, none the less was the historian a laborious and accomplished reader and investigator of all available authorities, as well manuscript as

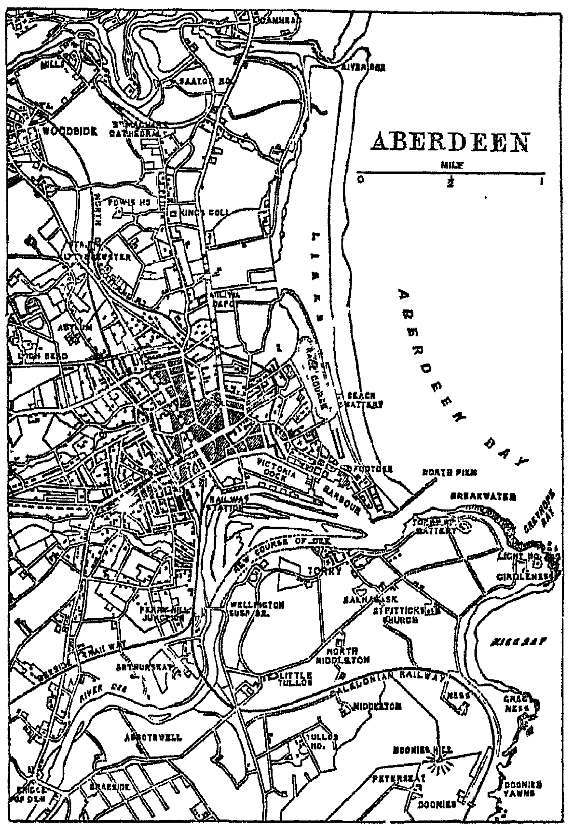
printed; while the roll of names of those who aided him includes every man of note in Scotland at the time, from Sir Thomas Craig and Sir George Mackenzie to Mr Alexander Nisbet and Mr Thomas Ruddiman. The *Martial Achievements* has not been reprinted, though practically the first example of Scottish typography in any way noticeable, vol. ii. having been printed under the scholarly supervision of Thomas Ruddiman. The date of his death is uncertain. It has been variously assigned to 1715, 1716, 1720, and 1726, and it is usually added that he left a widow in great poverty. That he was living in 1716 is certain, as Crawford speaks of him (in his *Peerage*, 1716) as "my worthy friend." Probably he died about 1716. *Memoirs of the Abercrombys*, commonly given to him, does not appear to have been published. (Chambers's *Eminent Scotsmen, s. v.*; Anderson's *Scottish Nation, s. v.*; Chalmers's *Biog. Dict., s. v.*; Chalmers's *Life of Ruddiman;* Haller's *Bibliotheca Medicinæ Pract.*, 4 vols. 4to, 1779; Hutchinson's *Biog. Medical*, 2 vols. 8vo, 1799; Lee's *Defoe*, 3 vols. 8vo.) (A. B. G.)

ABERCROMBY, Sir Ralph, K.B., Lieutenant-General in the British army, was the eldest son of George Abercromby of Tullibody, Clackmannanshire, and was born in October 1734. After passing some time at an excellent school at Alloa, he went to Rugby, and in 1752–53 he attended classes in Edinburgh University. In 1754 he was sent to Leipsic to study civil law, with a view to his proceding to the Scotch bar, of which it is worthy of notice that both his grandfather and his father lived to be the oldest members. On returning from the Continent he expressed a strong preference for the military profession, and a cornet's commission was accordingly obtained for him (March 1756) in the 3d Dragoon Guards. He rose through the intermediate gradations to the rank of lieutenant-colonel of the regiment (1773), and in 1781 he became colonel of the 103d infantry. When that regiment was disbanded in 1783 he retired upon half-pay. That up to this time he had scarcely been engaged in active service, was owing mainly to his disapproval of the policy of the Government, and especially to his sympathies with the American colonists in their struggles for independence; and his retirement is no doubt to be ascribed to similar feelings. But on France declaring war against England in 1793, he hastened to resume his professional duties; and, being esteemed one of the ablest and most intrepid officers in the whole British forces, he was appointed to the command of a brigade under the Duke of York, for service in Holland. He commanded the advanced guard in the action on the heights of Cateau, and was wounded at Nimeguen. The duty fell to him of protecting the British army in its disastrous retreat out of Holland, in the winter of 1794–5. In 1795 he received the honour of knighthood, the Order of the Bath being conferred on him in acknowledgment of his services. The same year he was appointed to succeed Sir Charles Grey, as commander-in-chief of the British forces in the West Indies. In 1796, Grenada was suddenly attacked and taken by a detachment of the army under his orders. He afterwards obtained possession of the settlements of Demerara and Essequibo, in South America, and of the islands of St Lucia, St Vincent, and Trinidad. He returned in 1797 to Europe, and, in reward for his important services, was appointed to the command of the regiment of Scots Greys, intrusted with the governments of the Isle of Wight, Fort George, and Fort Augustus, and raised to the rank of lieutenant-general. He held, in 1797–8, the chief command of the forces in Ireland. There he laboured to maintain the discipline of the army, to suppress the rising rebellion, and to protect the people from military oppression, with a care worthy alike of a great general and an enlightened and beneficent statesman. When he was appointed to the command in Ireland, an invasion of that country by the French was confidently anticipated by the English Government. He used his utmost efforts to restore the discipline of an army that was utterly disorganised; and, as a first step, he anxiously endeavoured to protect the people, by re-establishing the supremacy of the civil power, and not allowing the military to be called out, except when it was indispensably necessary for the enforcement of the law and the maintenance of order. Finding that he received no adequate support from the head of the Irish Government, and that all his efforts were opposed and thwarted by those who presided in the councils of Ireland, he resigned the command. His departure from Ireland was deeply lamented by the reflecting portion of the people, and was speedily followed by those disastrous results which he had anticipated, and which he so ardently desired and had so wisely endeavoured to prevent. After holding for a short period the office of Commander-in-Chief in Scotland, Sir Ralph, when the enterprise against Holland was resolved upon in 1799, was again called to command under the Duke of York. The difficulties of the ground, the inclemency of the season, unavoidable delays, the disorderly movements of the Russians, and the timid duplicity of the Dutch, defeated the objects of that expedition. But it was confessed by the Dutch, the French, and the British alike, that even victory the most decisive could not have more conspicuously proved the talents of this distinguished officer. His country applauded the choice, when, in 1801, he was sent with an army to dispossess the French of Egypt. His experience in Holland and the West Indies particularly fitted him for this new command, as was proved by his carrying his army in health, in spirits, and with the requisite supplies, in spite of very great difficulties, to the destined scene of action. The debarkation of the troops at Aboukir, in the face of an opposing force, is justly ranked among the most daring and brilliant exploits of the English army. A battle in the neighbourhood of Alexandria (March 21, 1801) was the sequel of this successful landing, and it was Sir R. Abercromby's fate to fall in the moment of victory. He was struck by a spent ball, which could not be extracted, and died seven days after the battle. The Duke of York paid a just tribute to the great soldier's memory in the general order issued on the occasion of his death:—"His steady observance of discipline, his ever-watchful attention to the health and wants of his troops, the persevering and unconquerable spirit which marked his military career, the splendour of his actions in the field, and the heroism of his death, are worthy the imitation of all who desire, like him, a life of heroism and a death of glory." By a vote of the House of Commons, a monument was erected in honour of Sir Ralph Abercromby in St Paul's Cathedral. His widow was created a peeress, and a pension of £2000 a year was settled on her and her two successors in the title. It may be mentioned that Abercromby was returned, after a keen contest, as member of Parliament for his native county of Clackmannanshire in 1773; but a parliamentary life had no attractions for him, and he did not seek re-election. A memoir of the later years of his life (1793–1801), by his son, Lord Dunfermline, was published in 1861.

ABERDARE, a town of Wales, in the county of Glamorgan, on the right bank of the river Cynon, four miles S.W. of Merthyr-Tydvil. The district around is rich in valuable mineral products, and coal and iron mining are very extensively carried on in the neighbourhood. Important tin-works, too, have been recently opened. Part of the coal is used at the iron-works, and large quantities are sent to Cardiff for exportation. Aber-

dare is connected with the coast by canal and railway. Owing to the great development of the coal and iron trade, it has rapidly increased from a mere village to a large and flourishing town. Handsome churches, banks, and hotels have been erected, a good supply of water has been introduced, and a public park has been opened. Two markets are held weekly. The whole parish falls within the parliamentary borough of Merthyr-Tydvil. The rapid growth of its population is seen by the following figures: in 1841 the number of inhabitants was 6471; in 1851, 14,999; in 1861, 32,299; and in 1871, 37,774.

ABERDEEN, a royal burgh and city, the chief part of a parliamentary burgh, the capital of the county of Aberdeen, the chief seaport in the north of Scotland, and the fourth Scottish town in population, industry, and wealth. It lies in lat. 57° 9′ N. and long. 2° 6′ W., on the German Ocean, near the mouth of the river Dee, and is 542 miles north of London, and 111 miles north of Edinburgh, by the shortest railway routes.



History. Aberdeen, probably the Devana on the Diva of Ptolemy, was an important place in the 12th century. William the Lion had a residence in the city, to which he gave a charter in 1179, confirming the corporate rights granted by David I. The city received many subsequent royal charters. It was burned by Edward III. in 1336, but it was soon rebuilt and extended, and called New Aberdeen. The houses were of timber and thatched, and many such existed till 1741. The burgh records are the oldest of any Scottish burgh. They begin in 1398, and are complete to the present time, with only a short break. Extracts from them, extending from 1398 to 1570, have been published by the Spalding Club. For many centuries the city was subject to attacks by the barons of the surrounding districts, and its avenues and six ports had to be guarded. The ports had all been removed by 1770. Several monasteries existed in Aberdeen before the Reformation. Most of the Scottish sovereigns visited the city and received gifts from the authorities. In 1497 a blockhouse was built at the harbour mouth as a protection against the English. During the religious struggle in the 17th century between the Royalists and Covenanters the city was plundered by both parties. In 1715 Earl Marischal proclaimed the Pretender at Aberdeen. In 1745 the Duke of Cumberland resided a short time in the city. In the middle of the 18th century boys were kidnapped in Aberdeen, and sent as slaves to America. In 1817 the city became insolvent, with a debt of £225,710, contracted by public improvements, but the debt was soon paid off. The motto on the city arms is Bon-Accord. It formed the watchword of the Aberdonians while aiding King Robert the Bruce in his battles with the English.

Of eminent men connected with Aberdeen, New and Old, may be mentioned—John Barbour, Hector Boece or Boethius, Bishop Elphinstone, the Earls Marischal; George Jamesone, the famous portrait painter; Edward Raban, the first printer in Aberdeen, 1622; Rev. Andrew Cant, the Covenanter; David Anderson (Davie do a' thing), a mechanic; James Gregory, inventor of the reflecting telescope; Dr Thomas Reid, the metaphysician; Dr George Campbell, Principal of Marischal College, author of several important works, and best known by his *Philosophy of Rhetoric;* Dr James Beattie; Lord Byron; Sir James Mackintosh; Robert Hall; Dr R. Hamilton, who wrote on the National Debt.

Till 1800 the city stood on a few eminences, and had steep, narrow, and crooked streets, but, since the Improvement Act of that year, the whole aspect of the place has been altered by the formation of two new spacious and nearly level streets (Union Street and King Street, meeting in Castle Street), and by the subsequent laying out of many others, besides squares, terraces, &c., on nearly flat ground. The city is above eight miles in circuit, and is built on sand, gravel, and boulder clay. The highest parts are from 90 to 170 feet above the sea. The chief thoroughfare is Union Street, nearly a mile long and 70 feet broad. It runs W.S.W. from Castle Street, and crosses the Denburn, now the railway valley, by a noble granite arch 132 feet in span and 50 feet high, which cost, with a hidden arch on each side, £13,000.

Public Buildings. Aberdeen is now a capacious, elegant, and well-built town, and from the material employed, consisting chiefly of light grey native granite, is called the "granite city." It contains many fine public buildings. The principal of these is Marischal College or University Buildings, which stands on the site of a pre-Reformation Franciscan Convent, and was rebuilt, 1836–1841, at a cost of about £30,000. It forms three sides of a court, which is 117 by 105 feet, and has a back wing, and a tower 100 feet high. The accommodation consists of twenty-five large class-rooms and laboratories, a hall, library, museums, &c.

The University of Aberdeen was formed by the union and incorporation, in 1860, by Act of Parliament, of the University and King's College of Aberdeen, founded in Old Aberdeen, in 1494, by William Elphinstone, Bishop of Aberdeen, under the authority of a Papal bull obtained by James IV., and of the Marischal College and University of Aberdeen, founded in New Aberdeen, in 1593, by George Keith, Earl Marischal, by a charter ratified by Act of Parliament. The officials consist of a chancellor, with rector and principal; there are 21 professors and 8 assistants. Arts and divinity are taught in King's College, and medicine, natural history, and law in Marischal College. The arts session lasts from the end of October to the beginning of April. The arts curriculum of four years, with graduation, costs £36, 11s. There are 214 arts bursaries, 29 divinity, and 1 medical, of the aggregate annual value of £3646, £650. and £26, respectively. About 60 arts

bursaries, mostly from £10 to £35 in value, are given yearly by competition, or by presentation and examination. Two-thirds of the arts students are bursars. Seventeen annual scholarships and prizes of the yearly value of £758 are given at the end of the arts curriculum. The average yearly number of arts students, in the thirteen years since the union of the arts classes of the two colleges in 1860, has been 342, while in the separate colleges together for the nine years before the union, it was 431. In winter session 1872–73 there were 623 matriculated students in all the faculties. In 1872, 32 graduated in arts, 68 in medicine, 5 in divinity, and 1 in law. The library has above 80,000 volumes. The General Council in 1873 had 2075 registered members, who, with those of Glasgow University, return one member to Parliament.

The Free Church Divinity College was built in 1850, at the cost of £2025, in the Tudor-Gothic style. It has a large hall, a library of 12,000 volumes, and 15 bursaries of the yearly value of from £10 to £25.

At the east end of Union Street, and partly in Castle Street, on the north side, are the new County and Municipal buildings, an imposing Franco-Scottish Gothic pile, 225 feet long, 109 feet broad, and 64 feet high, of four stories, built 1867–1873 at the cost of £80,000, including £25,000 for the site. Its chief feature is a tower 200 feet high. It contains a great hall, 74 feet long, 35 feet broad, and 50 feet high, with an open timber ceiling: a Justiciary Court-House, 50 feet long, 37 feet broad, and 31 feet high; a Town Hall, 41 feet long, 25 feet broad, and 15 feet high, and a main entrance corridor 60 feet long, 16 feet broad, and 24 feet high. A little to the west is the Town and County Bank, a highly ornamented building inside and outside, in the Italian style, costing about £24,000.

A very complete closed public market of two floors was built in 1842, at a cost of £28,000, by a company incorporated by Act of Parliament. The upper floor or great hall is 315 feet long, 106 feet broad, and 45 feet high, with galleries all round. The lower floor is not so high. The floors contain numerous small shops for the sale of meat, fowls, fish, &c., besides stalls and seats for the sale of vegetables, butter, eggs, &c. The galleries contain small shops for the sale of drapery, hardware, fancy goods, and books. On the upper floor is a fountain of polished Peterhead granite, costing £200, with a basin 7¼ feet diameter, cut out of one block of stone. Connected with this undertaking was the laying out of Market Street from Union Street to the quay. At the foot of this street is being built in the Italian style the new post and telegraph office, at a cost of £16,000, including £4000, the cost of the site. It is to form a block of about 100 feet square and 40 feet high.

Churches and Schools.

Aberdeen has about 60 places of worship, with nearly 48,000 sittings. There are 10 Established churches; 20 Free, 6 Episcopalian, 6 United Presbyterian, 5 Congregational, 2 Baptist, 2 Methodist, 2 Evangelical Union, 1 Unitarian, 1 of Roman Catholic, 1 of Friends, and 1 of Original Seceders. There are also several mission chapels. In 1843 all the Established ministers seceded, with 10,000 lay members. The Established and Free Church denominations have each about 11,000 members in communion. The Established West and East churches, in the centre of the city, within St Nicholas churchyard, form a continuous building 220 feet long, including an intervening aisle, over which is a tower and spire 140 feet high. The West was built in 1775 in the Italian style, and the East in 1834 in the Gothic, each costing about £5000. They occupy the site of the original cruciform church of St Nicholas, erected in the 13th, 14th, and 15th centuries. One of the nine bells in the tower bears the date of 1352, and is 4 feet diameter at the mouth, 3½ feet high, and very thick. The Union Street front of the churchyard is occupied by a very elegant granite façade, built in 1830, at the cost of £1460. It is 147½ feet long, with a central arched gateway and entablature 32½ feet high, with two attached Ionic columns on each side. Each of the two wings has six Ionic columns (of single granite blocks, 15 feet 2 inches long), with basement and entablature, the whole being 23½ feet high. The following are the style, cost, and date of erection of the other principal Aberdeen churches—St Andrew's, Episcopal, Gothic, £6000, 1817; North Church, Established, Greek, £10,000, 1831; three churches in a cruciform group, Free, simple Lancet Gothic, with a fine brick spire 174 feet high, £5000, 1844; Roman Catholic, Gothic, £12,000, 1859; Free West, Gothic, £12,856, 1869, with a spire 175 feet high.

In 1873 there were in Aberdeen about 110 schools, with from 10,000 to 11,000 pupils in attendance. About 2500 students attend the University, Mechanics' Institution, and private schools for special branches.

Five miles south-west of Aberdeen, on the south side of the Dee, in Kincardineshire, is St Mary's Roman Catholic College of Blairs, with a president and three professors.

The Aberdeen Grammar School, dating from about 1263, is a preparatory school for the university. It has a rector and four regular masters, who teach classics, English, arithmetic, and mathematics, for the annual fee of £4, 10s. for each pupil. Writing, drawing, &c., are also taught. Nearly 200 pupils attend, who enter about the age of twelve. Like the Edinburgh High School, it has no elementary department. There are 30 bursaries. A new granite building for the school was erected, 1861–1863, in the Scotch baronial style, at the cost of £16,000, including site. It is 215 feet long and 60 feet high, and has three towers.

The Mechanics' Institution, founded 1824, and reorganised 1834, has a hall, class-rooms, and a library of 14,000 volumes, in a building erected in 1846, at a cost of £3500. During the year 1872–73, there were at the School of Science and Art 385 pupils; and at other evening classes, 538.

Aberdeen has two native banks, besides branch banks, and a National Security Savings Bank; three insurance companies, four shipping companies, three railway companies, and a good many miscellaneous companies. There are ten licensed pawnbroking establishments, with about 440,000 pledges in the year for £96,000, and with a capital of £27,000. There are seven incorporated trades, originating between 1398 and 1527, and having charitable funds for decayed members, widows, and orphans. They have a hall, built in 1847 for £8300, in the Tudor Gothic style. The hall, 60 feet long, 29 wide, and 42 high, contains curious old chairs, and curious inscriptions on the shields of the crafts.

Among the charitable institutions is Gordon's Hospital, founded in 1729 by a miser, Robert Gordon, a Dantzic merchant, of the Straloch family, and farther endowed by Alexander Simpson of Collyhill in 1816. It is managed by the Town Council and four of the Established ministers of Aberdeen, incorporated by royal charters of 1772 and 1792. The central part of the house was built in 1739, and the wings in 1830–1834, the whole costing £17,300, and being within a garden of above four acres. It now (1873) maintains and educates (in English, writing, arithmetic, physics, mathematics, drawing, music, French, &c.) 180 boys of the age 9 to 15, the sons and grandsons of decayed burgesses of guild and trade of the city; and next those of decayed inhabitants (not paupers). Expenditure for year to 31st October 1872, £4353 for 164 boys. It has a head-master, three regular, and several visiting

masters. The Boys' and Girls' Hospital, lately built for £10,000, maintains and educates 50 boys and 50 girls.

The Female Orphan Asylum, founded by Mrs Elmslie, in 1840, and managed by trustees, maintains and educates, chiefly as domestic servants, 46 girls between the ages of 4 and 16, at the yearly cost for each of about £23, 13s. Those admitted must be legitimate orphan daughters of respectable parents, who have lived three years immediately before death in Aberdeen or in the adjoining parishes of Old Machar and Nigg. The Hospital for Orphan and Female Destitute Children, endowed by John Carnegie and the trustees of the Murtle Fund, maintains and educates 50 girls, chiefly for domestic service. The Asylum for the Blind, established in 1843, on a foundation by Miss Cruickshank, maintains and educates about 10 blind children, and gives industrial employment to blind adults. There is a boys' and girls' school for 150 boys and 150 girls on Dr Bell's foundation. The Industrial Schools, begun by Sheriff Watson in 1841, and the Reformatory Schools, begun in 1857, having some 600 pupils on the roll, have greatly diminished juvenile crime in the district. The Murtle or John Gordon's Charitable Fund, founded in 1815, has an annual revenue from land of about £2400, applicable to all kinds of charity, in sums from £5 to £300. The Midbeltie Fund, founded by a bequest of £20,000, in 1848, by James Allan of Midbeltie, gives yearly pensions ranging from £5 to £15 to respectable decayed widows in the parishes of St Nicholas and Old Machar.

The two parishes in which Aberdeen is situated, viz., St Nicholas and Old Machar, have each a large poor-house. The poor of both parishes cost about £20,000 a year.

The Royal Infirmary, instituted in 1740, was rebuilt 1833–1840, in the Grecian style, at the cost of £17,000. It is a well-situated, large, commodious, and imposing building. It has three stories, the front being 166 feet long and 50 feet high, with a dome. A detached fever-house was built in 1872 for about £2500. The managers were incorporated by royal charter in 1773, and much increased in number in 1852. The institution is supported by land rents, feu-duties, legacies, donations, subscriptions, church collections, &c. Each bed has on an average 1200 cubic feet of space. There are on the average 130 resident patients, costing each on the average a shilling daily, and the number of patients treated may be stated at 1700 annually, besides outdoor patients receiving advice and medicine. The recent annual expenditure has been about £4300. There is a staff of a dozen medical officers.

The Royal Lunatic Asylum, opened in 1800, consists of two separate houses, valued in 1870 at £40,000, in an enclosure of 40 acres. It is under the same management as the Infirmary. The recent daily average of patients has been about 420, at an annual cost of £13,000. The annual rate for each pauper is £25, 10s. The General Dispensary, Vaccine, and Lying-in Institution, founded in 1823, has had as many as 6781 cases in one year. The Hospital for Incurables has a daily average of 26 patients, and the Ophthalmic and Auric Institution has had 671 cases in a year.

The Music Hall, built in 1821 and 1859 at the cost of £16,500, has a front 90 feet long, with a portico of 6 Ionic pillars 30 feet high; large, highly-decorated lobbies and rooms; and a hall 150 feet long, 68 broad, and 50 high, with a flat ceiling, and galleries. The hall holds 2000 persons seated, and has a fine organ and an orchestra for 300. Here H.R.H. Prince Albert opened the British Association, as president, 14th September 1859. A new Theatre and Opera House was built in 1872, in the mixed Gothic style, for £8400, with the stage 52½ feet by 29, and the auditorium for 1700 to 1800 persons. The front wall is of bluish granite and red and yellow freestone, with some polished Peterhead granite pillars, the rest being built of concrete.

Market Cross

In Castle Street, the City Place and Old Market Stance, is the Market Cross, a beautiful, open-arched, hexagonal structure of freestone, 21 feet diameter, and 18 feet high. It has Ionic columns and pilasters, and an entablature of twelve panels. On ten of the panels are medallions, cut in stone, in high relief, of the Scottish sovereigns from James I. to James VII. From the centre rises a composite column 12½ feet high, with a Corinthian capital, on which is the royal unicorn rampant. This cross was planned and erected about 1682 by John Montgomery, a native architect, for £100 sterling. On the north side of the same street, adjoining the municipal buildings, is the North of Scotland Bank, a Grecian building in granite, with a portico of Corinthian columns, having most elaborately carved capitals. On an eminence east of Castle Street are the military barracks for 600 men, built in 1796 for £16,000.

The principal statues in the city are those of the last Duke of Gordon—died 1836—in grey granite, 10 feet high; Queen Victoria, in white Sicilian marble, 8½ feet high; Prince Albert, bronze, natural-size, sitting posture; and a curious rough stone figure, of unknown date, supposed to be Sir William Wallace.

Bridges

The Dee to the south of the city is crossed by three bridges, the old bridge of Dee, an iron suspension bridge, and the Caledonian Railway bridge. The first, till 1832 the only access to the city from the south, consists of seven semicircular ribbed arches, is about 30 feet high, and was built early in the 16th century by Bishops Elphinstone and Dunbar. It was nearly all rebuilt 1718–1723, and from being 14½ feet wide, it was in 1842 made 26 feet wide. From Castle Street, King Street leads in the direction of the new bridge of Don (a little east of the old "Brig o' Balgownie"), of five granite arches, each 75 feet span, built for nearly £13,000 in 1827–1832.

Harbour, &c.

A defective harbour, and a shallow sand and gravel bar at its entrance, long retarded the trade of Aberdeen, but, under various Acts since 1773, they have been greatly deepened. The north pier, built partly by Smeaton, 1775–1781, and partly by Telford, 1810–1815, extends 2000 feet into the German Ocean. It is 30 feet broad, and, with the parapet, rises 15 feet above high water. It consists of large granite blocks. It has increased the depth of water on the bar from a few feet to 22 or 24 feet at spring tides, and to 17 or 18 feet at neap. The wet dock, of 29 acres, and with 6000 feet of quay, was completed in 1848, and called Victoria Dock, in honour of Her Majesty's visit to the city in that year. These and other improvements of the harbour and its entrance cost £325,000 down to 1848. By the Harbour Act of 1868, the Dee near the harbour has been diverted to the south, at the cost of £80,000, and 90 acres of new ground (in addition to 25 acres formerly made up) for harbour works are being made up on the city or north side of the river; £80,000 has been laid out in forming in the sea, at the south side of the river, a new breakwater of concrete, 1050 feet long, against south and south-east storms. The navigation channel is being widened and deepened, and the old pier or breakwater on the north side of the river mouth is to be lengthened at least 500 feet seaward. A body of 31 commissioners manage the harbour affairs.

Aberdeen Bay affords safe anchorage with off-shore winds, but not with those from the N.E., E., and S.E. On the Girdleness, the south point of the bay, a lighthouse was built in 1833, in lat. 57° 8′ N., and long. 2° 3′ W., with two fixed lights, one vertically below the other, and respectively 115 and 185 feet above mean tide. There are also fixed leading lights to direct ships entering the harbour

at night. In fogs, a steam whistle near the lighthouse is sounded ten seconds every minute. Near the harbour mouth are three batteries mounting nineteen guns.

Water. The water supplied to the city contains only $3\frac{1}{2}$ grains solid matter in a gallon, with a hardness of about 2 degrees. It is brought by gravitation, in a close brick culvert, from the Dee, 21 miles W.S.W. of the city, to a reservoir, which supplies nine-tenths of the city. The other tenth, or higher part of the city, is supplied by a separate reservoir, to which part of the water from the culvert is forced up by a hydraulic engine. Nearly 40 gallons water per head of the population are consumed daily for all purposes. The new water works cost £160,000, and were opened by Her Majesty, 16th October 1866.

The gas is made of cannel coal, and is sent through 71 miles of main pipes, which extend 5 miles from the works.

Manufactures, &c. The manufactures, arts, and trade of Aberdeen and vicinity are large and flourishing. Woollens were made as early as 1703, and knitting of stockings was a great industry in the 18th century. There are two large firms in the woollen trade, with 1550 hands, at £1000 weekly wages, and making above 1560 tons wool in the year into yarns, carpets, hand-knit hosiery, cloths, and tweeds. The linen trade, much carried on since 1749, is now confined to one firm, with 2600 hands, at £1200 wages weekly, who spin, weave, and bleach 50 tons flax and 60 tons tow weekly, and produce yarns, floorcloths, sheetings, dowlas, ducks, towels, sail-canvas, &c. The cotton manufacture, introduced in 1779, employs only one firm, with 550 hands, at £220 weekly wages, who spin 5000 bales of cotton a-year into mule yarn. The wincey trade, begun in 1839, employs 400 hands, at £200 weekly wages, who make 2,100,000 yards cloth, 27 to 36 inches broad, in the year. Paper, first made here in 1696, is now manufactured by three firms in the vicinity. The largest has 2000 hands, at £1250 weekly wages, and makes weekly 75 to 80 tons of writing paper, and $6\frac{1}{2}$ millions of envelopes, besides much cardboard and stamped paper; another firm makes weekly 77 tons coarse and card paper; and a third, 20 tons printing and other paper. The comb works of Messrs Stewart & Co., begun in 1827, are the largest in the world, employing 900 hands, at £500 weekly wages, who yearly convert 1100 tons horns, hoofs, india-rubber, and tortoise-shells into 11 millions of combs, besides spoons, cups, scoops, paper-knives, &c. Seven iron foundries and many engineering works employ 1000 men, at £925 weekly wages, and convert 6000 tons of iron a-year into marine and land steam engines and boilers, corn mills, wood-preparing machinery, machinery to grind and prepare artificial manures, besides sugar mills and frames and coffee machinery for the colonies.

The Sandilands Chemical Works, begun in 1848, cover five acres, and employ over 100 men and boys, at £90 to £100 weekly wages. Here are prepared naphtha, benzole, creosote oil, pitch, asphalt, sulphate of ammonia, sulphuric acid, and artificial manures. Paraffin wax and ozokerite are refined. An Artesian well within the works, 421 feet deep, gives a constant supply of good water, always at 51° Fahr. Of several provision-curing works, the largest employs 300 hands, chiefly females, in preserving meats, soups, sauces, jams, jellies, pickles, &c., and has in connection with it, near the city, above 230 acres of fruit, vegetable, and farm ground, and a large piggery. The products of the breweries and distilleries are mostly consumed at home. A large agricultural implement work employs 70 or 80 men and boys. Nearly 200 acres of ground, within three miles of the city, are laid out in rearing shrub and forest-tree seedlings. In 1872 about 145 acres of strawberries were reared within three miles of Aberdeen, and 80 tons of this fruit are said to have been exported.

Granite. Very durable grey granite has been quarried near Aberdeen for 300 years, and blocked and dressed paving, kerb, and building granite stones have long been exported from the district. In 1764, Aberdeen granite pavement was first used in London. About the year 1795, large granite blocks were sent for the Portsmouth docks. The chief stones of the New Thames Embankment, London, are from Kemnay granite quarries, 16 miles north-west of the city. Aberdeen is almost entirely built of granite, and large quantities of the stone are exported to build bridges, wharfs, docks, lighthouses, &c., elsewhere. Aberdeen is famed for its polishing-works of granite, especially grey and red. They employ about 1500 hands in polishing vases, tables, chimney-pieces, fountains, monuments, columns, &c., for British and foreign demand. Mr Alexander Macdonald, in 1818, was the first to begin the granite polishing trade, and the works of the same firm, the only ones of the kind till about 1850, are still the largest in the kingdom.

Fishing. In 1820, 15 vessels from Aberdeen were engaged in the northern whale and seal fishing; in 1860, one vessel, but none since. The white fishing at Aberdeen employs some 40 boats, each with a crew of 5 men. Of the 900 tons wet fish estimated to be brought to market yearly, above a third are sent fresh by rail to England. The salmon caught in the Dee, Don, and sea are nearly all sent to London fresh in ice. The herring fishing has been prosecuted since 1836, and from 200 to 350 boats are engaged in it.

Shipbuilding. Aberdeen has been famed for shipbuilding, especially for its fast clippers. Since 1855 nearly a score of vessels have been built of above 1000 tons each. The largest vessel (a sailing one) ever built here was one in 1855, of 2400 tons. In 1872 there were built 11 iron vessels of 9450 tons, and 6 wooden of 2980 tons, consuming 5900 tons iron, and costing £252,700, including £70,700 for engines and other machinery. 1400 hands were employed in shipbuilding in that year, at the weekly wages of about £1230.

Shipping. In 1872, there belonged to the port of Aberdeen 236 vessels, of 101,188 tons, twenty-four of the vessels, of 7483 tons, being steamers. They trade with most British and Irish ports, the Baltic and Mediterranean ports, and many more distant regions. In 1872, 434,108 tons shipping arrived at the port, and the custom duties were £112,414. The export trade, exclusive of coasting, is insignificant. The shore or harbour dues were £126 in 1765, and £1300 in 1800. In the year ending 30th September 1872, they were £25,520; while the ordinary harbour revenue was £37,765, expenditure £28,598, and debt £324,614. The introduction of steamers in 1821 greatly promoted industry and traffic, and especially the cattle trade of Aberdeenshire with London. These benefits have been much increased by the extension of railways. Commodious steamers ply regularly between Aberdeen and London, Hull, Newcastle, Leith, Wick, Kirkwall, and Lerwick.

Railway station. The joint railway station for the Caledonian, Great North of Scotland, and Deeside lines, was opened 1867, and is a very handsome erection, costing about £26,000. It is 500 feet long, and 102 feet broad, with the side walls 32 feet high. The arched roof of curved lattice-iron ribs, covered with slate, zinc, and glass, is all in one span, rising 72 feet high, and is very light and airy.

Societies. The Medico-Chirurgical Society of Aberdeen was founded in 1789. The hall was built in 1820 at a cost of £4000, and is adorned with an Ionic portico of four granite columns, 27 feet high. It has 42 members, and a library of 5000 volumes. The legal practitioners of Aberdeen have been styled advocates since 1633, and received royal charters in 1774, 1779, and 1862. They form a society, called the Society of Advocates, of 127 members in 1873, with a

hall built in 1871 for £5075, a library of nearly 6000 volumes, and a fund to support decayed and indigent members, and their nearest relatives. The revenue in 1872 was £2880.

Press. Aberdeen has one daily and three weekly newspapers. *The Aberdeen Journal*, established in 1748, is the oldest newspaper north of the Forth.

Public Parks. The places of out-door recreation and amusement are chiefly the following:—The Links, a grassy, benty, and sandy tract, 2 miles long and $\frac{1}{4}$ to $\frac{1}{3}$ mile broad, along the shore between the mouths of the Dee and the Don. It is mostly only a few feet above the sea, but the Broad Hill rises to 94 feet. Cattle shows, reviews, &c., are held on the Links. To the north-west of the town, a Public Recreation Park of 13 acres was laid out in 1872, at the cost of £3000, with walks, grass, trees, shrubs, and flowers.

Climate. Daily observations from 1857 to 1872 show the mean temperature of Aberdeen for the year to be 45°·8 Fahr., for the three summer months 56° Fahr., and for the three winter months 37°·3. The average yearly rainfall is 30·57 inches. Aberdeen is the healthiest of the large Scottish towns. East winds prevail in spring.

Since 1867 £50,000 has been spent in constructing main sewers throughout the city. A few acres of farm land have been irrigated by part of the sewage.

Municipality. The city is governed by a corporation, the magistrates and town council, consisting of twenty-five councillors, including a provost, six bailies, a dean of guild, a treasurer, &c. The corporation revenue in the year 1871–72 was £11,498. The police, water, and gas are managed by the council. The municipal and police burgh has an area of nearly three square miles, with 12,514 municipal electors, and with assessable property valued at £230,000 in 1873. The Parliamentary burgh has an area of nine square miles, including Old Aberdeen and Woodside, with 14,253 Parliamentary electors, and real property to the value of £309,328 in 1873. It returns one member to Parliament. The population of Aberdeen in 1396 was about 3000; in 1643, 8750; in 1708, 5556; in 1801, 26,992; in 1841, 63,262; and in 1871, 88,125; with 6718 inhabited houses, 292 uninhabited, and 77 building.

Old Aberdeen. ABERDEEN, OLD, is a small, quiet, ancient town, a burgh of barony and regality, a mile north of Aberdeen, and as far south-west of the mouth of the Don. It mostly forms one long street, 45 to 80 feet above the sea. The Don, to the north of the town, runs through a narrow, wooded, rocky ravine, and is spanned by a single Gothic arch, the "Brig o' Balgownie" of Lord Byron. The bridge rests on gneiss, and is 67 feet wide and $34\frac{1}{2}$ feet high above the surface of the river, which at ebb tide is here 19 feet deep. The bridge is the oldest in the north of Scotland, and is said to have been built about 1305. The funds belonging to the bridge amount to £24,000.

The town was formerly the see of a bishop, and had a large cathedral dedicated to St Machar. In 1137 David I. translated to Old Aberdeen the bishopric, founded at Mortlach in Banffshire in 1004 by Malcolm II. in memory of his signal victory there over the Danes. In 1153 Malcolm IV. gave the bishop a new charter.

Cathedral. The cathedral of St Machar, begun about 1357, occupied nearly 170 years in building, and did not remain entire fifty years. What is still left is the oldest part, viz., the nave and side aisles, 126 feet long and $62\frac{1}{2}$ feet broad, now used as the parish church. It is chiefly built of *outlayer* granite stones, and while the plainest Scottish cathedral, is the only one of granite in the kingdom. On the flat pannelled ceiling of the nave are 48 heraldic shields of the princes, nobles, and bishops who aided in its erection. It has been lately repaired, and some painted windows inserted, at the cost of £4280.

King's College. The chief structure in Old Aberdeen is the stately fabric of King's College near the middle of the town. It forms a quadrangle, with interior court 108 feet square, two sides of which have been rebuilt, and a projecting wing for a library added since 1860. The oldest parts, the Crown Tower and Chapel, date from about 1500. The former is 30 feet square and 60 feet high, and is surmounted by a structure about 40 feet high, consisting of a six-sided lantern and a royal crown, both sculptured, and resting on the intersections of two arched ornamented slips rising from the four corners of the top of the tower. The chapel, 120 feet long, 28 feet broad, and 37 feet high, still retains in the choir the original oak canopied stalls, miserere seat, and lofty open screen. These fittings are 300 years old, in the French flamboyant style, and are unsurpassed, in tasteful design and delicate execution, by the oak carving of any other old church in Europe. This carved woodwork owes its preservation to the Principal of Reformation times, who armed his people, and protected it from the fury of the barons of the Mearns after they had robbed the cathedral of its bells and lead. The chapel is still used for public worship during the University session.

Connected with Old Aberdeen is a brewery in the town, and a brick and coarse pottery work in the vicinity. There are also a Free church, two secondary schools, and two primary schools. Old Aberdeen has its own municipal officers, consisting of a provost, 4 bailies, and 13 councillors. The town is drained, lighted, supplied with water, and is within the Parliamentary boundary of New Aberdeen. There are several charitable institutions. Population in 1871, 1857; inhabited houses, 233. (A. C.)

ABERDEENSHIRE, a maritime county in the north-east of Scotland, between 56° 52′ and 57° 42′ N. lat. and between 1° 49′ and 3° 48′ long. W. of Greenwich. It is bounded on the north and east by the German Ocean; on the south by the counties of Kincardine, Forfar, and Perth; and on the west by those of Inverness and Banff. Its greatest length is 102 miles, and breadth 50 miles. Its circuit with sinuosities is about 300 miles, 60 being sea-coast. It is the fifth of Scotch counties in size, and is one-sixteenth of the extent of Scotland. Its area is 1970 square miles, or 1,260,625 acres, of which, in 1872, 36·6 per cent., or 585,299 acres, were cultivated, 93,339 in woods (mostly Scotch fir and larch), and 6400 in lakes. It contains 85 civil parishes and parts of 6 others, or 101 parishes, including civil and *quoad sacra*. The county is generally hilly, and mountainous in the south-west, whence, near the centre of Scotland, the Grampians send out various branches, mostly to the north-east, through the county. The run of the rivers and the general slope of the county is to the north-east and east. It is popularly divided into five districts:—First, *Mar*, mostly between the Dee and Don, and forming nearly the south half of the county. It is mountainous, especially Braemar, its west and Highland part, which contains the greatest mass of elevated land in the British Isles. Here the Dee rises amid the grandeur and wildness of lofty mountains, much visited by tourists, and composed chiefly of granite and gneiss, forming many high precipices, and showing patches of snow throughout every summer. Here rises Ben Muichdhui, the second highest mountain in Scotland and in the British Isles, 4296 feet; Braeriach, 4225; Cairntoul, 4245; Cairngorm (famed for "Cairngorm stones," a peculiar kind of rock crystal), 4090; Ben-a-Buird, 3860; Ben Avon, 3826; and Byron's "dark Lochnagar," 3786. The soil on the Dee is sandy, and on the Don loamy. The city of Aberdeen is in Mar. Districts. Second, *Formartin*, between the lower Don and Ythan, with a sandy coast, succeeded by a clayey, fertile, tilled tract, and then by low hills, moors, mosses, and tilled land. Third, *Buchan*. north of the Ythan, and next in size to

Mar, with parts of the coast bold and rocky, and with the interior bare, low, flat, undulating, and in parts peaty. On the coast, six miles south of Peterhead, are the Bullers of Buchan,—a basin in which the sea, entering by a natural arch, boils up violently in stormy weather. Buchan Ness is the eastmost point of Scotland. Fourth, *Garioch*, a beautiful, undulating, loamy, fertile valley, formerly called the granary of Aberdeen, with the prominent hill Benachie, 1676 feet, on the south. Fifth, *Strathbogie*, mostly consisting of hills (The Buck, 2211 feet; Noath, 1830 feet), moors, and mosses. The county as a whole, except the low grounds of Buchan, and the Highlands of Braemar, consists mainly of nearly level or undulating tracts, often naked and infertile, but interspersed with many rich and highly cultivated spots.

Rivers. The chief rivers are the Dee, 96 miles long; Don, 78; Ythan, 37, with mussel beds at its mouth; Ugie, 20; and Deveron, 58, partly on the boundary of Banffshire. The pearl mussel occurs in the Ythan and Don. A valuable pearl in the Scottish crown is said to be from the Ythan. Loch Muick, the largest of the few lakes in the county, 1310 feet above the sea, is only $2\frac{1}{2}$ miles long and $\frac{1}{3}$ to $\frac{1}{2}$ mile broad. The rivers have plenty of salmon and trout. There are noted chalybeate springs at Peterhead, Fraserburgh, and Pananich near Ballater.

Climate. The climate of Aberdeenshire, except in the mountainous districts, is comparatively mild, from the sea being on two sides. The mean annual temperature at Braemar is 43°·6 Fahr., and at Aberdeen 45°·8. The mean yearly rainfall varies from about 30 to 37 inches. The summer climate of the Upper Dee and Don valleys is the driest and most bracing in the British Isles, and grain is cultivated up to 1600 feet above the sea, or 400 to 500 feet higher than elsewhere in North Britain. All the crops cultivated in Scotland ripen, and the people often live to a great age.

Geology. The rocks are mostly granite; gneiss, with small tracts of syenite, mica slate, quartz rock, clay slate, grauwacke, primary limestone, old red sandstone, serpentine, and trap. Lias, greensand, and chalk flints occur. The rocks are much covered with boulder clay, gravel, sand, and alluvium. Brick clay occurs near the coast. The surface of the granite under the boulder clay often presents glacial smoothings, grooves, and roundings. Cairngorm stone, beryl, and amethyst are found in the granite of Braemar.

Plants and Animals. The tops of the highest mountains have an arctic flora. At Her Majesty's Lodge, Loch Muick, 1350 feet above the sea, grow larches, vegetables, currants, laurels, roses, &c. Some ash trees, 4 or 5 feet in girth, are growing at 1300 feet above the sea. The mole occurs at 1800 feet above the sea, and the squirrel at 1400. Trees, especially Scotch fir and larch, grow well in the county, and Braemar abounds in natural timber, said to surpass any in the north of Europe. Stumps of Scotch fir and oak found in peat in the county are often far larger than any now growing. Grouse, partridges, and hares abound in the county, and rabbits are often too numerous. Red deer abound in Braemar, the deer forest being there valued at £5000 a year, and estimated at 500,000 acres, or one-fourth the area of deer forests in Scotland.

Poor, gravelly, clayey, and peaty soils prevail much more in Aberdeenshire than good rich loams, but tile draining, bones, and guano, and the best modes of modern tillage, have greatly increased the produce. Farm-houses and steadings have greatly improved, and the best agricultural implements and machines are in general use. About two-thirds of the population depend entirely on agriculture, and oatmeal in various forms, with milk, is the chief food of farm-servants. Farms are generally small, compared with those in the south-east counties. The fields are separated by dry-stone dykes, and also by wooden and wire fences. Leases of 19 or 21 years prevail, and the five, six, or seven shift rotation is in general use. In 1872 there were 11,642 occupiers of land, with an average of 50 acres each, and paying about £536,000 in rent. Of the 585,299 acres of the county in crop in 1872, 191,880 acres were in oats, 18,930 in barley and bere, 1633 in rye, 1357 in wheat, 95,091 in turnips (being one-fifth of the turnips grown in Scotland), 8414 in potatoes, 232,178 in grasses and clover. In 1872 the county had 23,117 horses, 157,960 cattle (being above one-seventh of all the cattle in Scotland), 128,308 sheep, and 13,579 pigs. The county is unsurpassed in breeding, and unrivalled in feeding cattle, and this is more attended to than the cultivation of grain-crops. About 40,000 fat cattle are reared, and above £1,000,000 value of cattle and dead meat is sent from the county to London yearly. The capital invested in agriculture within the county is estimated at about £5,133,000.

Minerals. The great mineral wealth in Aberdeenshire is its long-famed durable granite, which is largely quarried for building, paving, causewaying, and polishing. An acre of land on being reclaimed has yielded £40 to £50 worth of causewaying stones. Gneiss is also quarried, as also primary limestone, old red sandstone, conglomerate millstone, grauwacke, clay slate, syenite, and hornblende rock. Iron ore, manganese, and plumbago occur in the county.

Fisheries. A large fishing population in villages along the coast engage in the white and herring fishery. Haddocks are salted and rock-dried (speldings), or smoked (finnans). The rivers and coasts yield many salmon. Peterhead was long the chief British port for the north whale and seal fishery, but Dundee now vies with it in this industry.

Manufactures. The manufactures and arts of the county are mainly prosecuted in or near the town of Aberdeen, but throughout the rural districts there are much milling of corn, brick and tile making, stone-quarrying, smith-work, brewing and distilling, cart and farm implement making, casting and drying of peat, timber felling, especially on Deeside and Donside, for pit-props, railway sleepers, lath, barrel staves, &c.

Trade. The chief imports into the county are, coals, lime, timber, iron, slates, raw materials of textile manufactures, wheat, cattle-feeding stuffs, bones, guano, sugar, alcoholic liquors, fruits, &c. The chief exports are granite (rough, dressed, and polished), flax, woollen, and cotton goods, paper, combs, preserved provisions, oats, barley, live and dead cattle, &c. In the county there are about 520 fairs in the year for cattle, horses, sheep, hiring servants, &c.

Railways. Aberdeenshire communicates with the south by the Caledonian Railway, and five macadamised roads across the east Grampians, the highest rising 2200 feet above the sea. About 188 miles of railway (the Great North of Scotland, Formartin and Buchan, and Deeside lines), and 2359 miles of public roads, ramify through the county Tolls over the county were abolished in 1865, and the roads are kept up by assessment. The railway lines in the county have cost on the average about £13,500 a mile. Several macadamised roads and the Great North of Scotland Railway form the main exits from the county to the north-west.

Antiquities. The chief antiquities in Aberdeenshire are Picts' houses or weems; stone foundations of circular dwellings; monoliths, some being sculptured; the so-called Druid circles; stone cists; stone and earthen enclosures; the vitrified forts of Dunnideer and Noath; cairns; crannoges; earthen mounds, as the Bass; flint arrow-heads; clay funeral urns; stone celts and hammers. Remains of Roman camps occur at Peterculter, Kintore, and Auchterless, respectively $107\frac{1}{2}$, 100, and 115 acres. Roman arms have been found. Ruins of ancient edifices occur. On the top of a conical hill called Dunnideer, in the Garioch district, are the remains of a

castle, supposed to be 700 years old, and surrounded by a vitrified wall, which must be still older. The foundations of two buildings still remain, the one in Braemar, and the other in the Loch of Cannor (the latter with the remains of a wooden bridge between it and the land), which are supposed to have belonged to Malcolm Canmore, King of Scotland. The most extensive ruins are the grand ones of Kildrummy Castle, evidently once a princely seat, and still covering nearly an acre of ground. It belonged to David Earl of Huntingdon in 1150, and was the seat of the Earls of Marr attainted in 1716. The Abbey of Deer, now in ruins, was begun by Cumyn Earl of Buchan about 1219.

storical tes.

In Roman times, Aberdeenshire formed part of Vespasiana in Caledonia, and was occupied by the Taixali, a warlike tribe. The local names are mostly Gaelic. St Columba and his pupil Drostan visited Buchan in the 6th century. In 1052 Macbeth fell near the Peel Bog in Lumphanan, and a cairn which marks the spot is still shown. In 1309 Bruce defeated Comyn, Earl of Buchan, near Inverurie, and annihilated a powerful Norman family. In 1411 the Earl of Marr defeated Donald of the Isles in the battle of Harlaw, near Inverurie, when Sir Robert Davidson, Provost of Aberdeen, was killed. In 1562 occurred the battle of Corrichie on the Hill of Fare, when the Earl of Murray defeated the Marquis of Huntly. In 1715 the Earl of Marr proclaimed the Pretender in Braemar. In 1746 the Duke of Cumberland with his army marched through Aberdeenshire to Culloden. In 1817 a base line of verification, 5 miles 100 feet long, was measured in connection with the Trigonometrical Survey of the British Isles, on the Belhelvie Links 5 to 10 miles north of Aberdeen.

inent n.

Among eminent men connected with Aberdeenshire are, Robert Gordon of Straloch, who in 1648 published the first atlas of Scotland from actual survey; the Earls Marischal, whose chief seat was Inverugie Castle; Field-Marshal Keith, born at Inverugie Castle, 1696; Dr Thomas Reid, the metaphysician, minister of New Machar 1737 to 1752; Lord Pitsligo, attainted 1745; Sir Archibald Grant of Monymusk, who introduced turnips into the county 1756, and was the first to plant wood on a great scale; Peter Garden, Auchterless, said to have died at the age of 132, about 1780; Rev. John Skinner, author of some popular Scottish songs; Morrison the hygeist; the Earl of Aberdeen, Prime Minister during the Crimean war.

tive tures.

The native Scotch population of Aberdeenshire are long-headed, shrewd, careful, canny, active, persistent, but reserved and blunt, and without demonstrative enthusiasm. They have a physiognomy distinct from the rest of the Scottish people, and have a quick, sharp, rather angry accent. The local Scotch dialect is broad, and rich in diminutives, and is noted for the use of *e* for *o* or *u*, *f* for *wh*, *d* for *th*, &c. In 1830 Gaelic was the fireside language of almost every family in Braemar, but now it is little used.

irts and ice.

Aberdeenshire has a Lord-Lieutenant and 3 Vice and 60 Deputy-Lieutenants. The Supreme Court of Justiciary sits in Aberdeen twice a-year to try cases from the counties of Aberdeen, Banff, and Kincardine. The counties of Aberdeen and Kincardine are under a Sheriff and two Sheriffs-Substitute. The Sheriff Courts are held in Aberdeen and Peterhead. Sheriff Small-Debt and Circuit Courts are held at seven places in the county. There are Burgh or Bailie Courts in Aberdeen and the other royal burghs in the county. Justice of the Peace and Police Courts are held in Aberdeen, &c. The Sheriff Courts take cognisance of Commissary business. During 1871, 994 persons were confined in the Aberdeenshire prisons. In the year 1870–71, 74 parishes in the county were assessed £53,703 for 7702 poor on the roll and 1847 casual poor.

irches.

Aberdeenshire contains 105 Established churches, 99 Free, 31 Episcopal, 15 United Presbyterian, 9 Roman Catholic, and 31 of other denominations. This includes detached parts of the two adjacent counties.

Education.

By the census of 1871, 84·83 per cent. of the children in the county, of the ages 5 to 13, were receiving education. Those formerly called the parochial schoolmasters of Aberdeenshire participate in the Dick and Milne Bequests, which contributed more salary to the schoolmasters in some cases than did the heritors. Most of the schoolmasters are Masters of Arts, and many are preachers. Of 114 parochial schools in the county before the operation of the new Education Act, 89 received the Milne Bequest of £20 a year, and 91 the Dick Bequest, averaging £30 a year, and a schoolmaster with both bequests would have a yearly income of £145 to £150, and in a few cases £250. The higher branches of education have been more taught in the schools of the shires of Aberdeen and Banff than in the other Scotch counties, and pupils have been long in the habit of going direct from the schools of these two counties to the University.

Propert

The value of property, or real rental of the lands and heritages in the county (including the burghs, except that of Aberdeen), for the year 1872–73, was £769,191. The railway and the water works in the city and county were for the same year valued at £11,133. For general county purposes for the year ending 15th May 1872, there was assessed £14,803 to maintain police, prisons, militia, county and municipal buildings, &c., and £19,320 to maintain 2359 miles of public county roads.

Proprie

The chief seats on the proprietary estates are—Balmoral Castle, the Queen; Mar Lodge and Skene House, Earl of Fife; Aboyne Castle, Marquis of Huntly; Dunecht House, Earl of Crawford and Balcarres; Keith Hall, Earl of Kintore; Slains Castle, Earl of Errol; Haddo House, Earl of Aberdeen; Castle Forbes, Lord Forbes; Philorth House, Lord Saltoun; Huntly Lodge, the Duke of Richmond. Other noted seats are—Drum, Irvine; Invercauld, Farquharson; Newe Castle, Forbes; Castle Fraser, Fraser; Cluny Castle, Gordon; Meldrum House, Urquhart; Craigston Castle, Urquhart; Pitfour, Ferguson; Ellon Castle, Gordon; Fyvie Castle, Gordon. Ten baronets and knights have residences in the county. Of the proprietors many live permanently on their estates. Their prevailing names are Gordon, Forbes, Grant, Fraser, Duff, and Farquharson.

Burghs.

Aberdeenshire has one city, Aberdeen, a royal parliamentary burgh; three other royal parliamentary burghs, Inverurie, Kintore, and Peterhead; and seven burghs of barony, Old Aberdeen, Charleston of Aboyne, Fraserburgh, Huntly, Old Meldrum, Rosehearty, and Turriff.

Parliame tary rep sentatio

The county sends two members to Parliament—one for East Aberdeenshire, with 4341 electors, and the other for West Aberdeenshire, with 3942 electors. The county has also four parliamentary burghs, which, with their respective populations in 1871, are—Aberdeen, 88,125; Peterhead, 8535; Inverurie, 2856; and Kintore, 659. The first sends one member to Parliament, and the other three unite with Elgin, Cullen, and Banff, in sending another.

Populat

By the census 1801 the county had 121,065 inhabitants, and by that of 1871, 244,603, with 53,576 families, 111 females to 100 males, 34,589 inhabited houses, 1052 uninhabited houses, and 256 building. In 1871 there were in eight towns (Aberdeen, Peterhead, Fraserburgh, Huntly, Inverurie, Old Meldrum, Turriff, and New Pitsligo), 111,978 inhabitants; in 32 villages, 19,561; and in rural districts, 113,064.

(*New Statistical Account of Scotland*, vol. xii.; the charters of the burgh; extracts from the Council Register down to 1625, and selections from the letters, guildry, and treasurer's accounts, forming 3 volumes of the Spalding Club; *Collections for a History of the Shires of A. and Banff*, edited by Joseph Robertson, Esq., 4to, Spalding Club;

Registrum Episcopatus Aberdonensis, vols. i. and ii., by Prof. Cosmo Innes, 4to, Spalding Club; *The History of A.*, by Walter Thom, 2 vols. 12mo, 1811; *Buchan*, by the Rev. John B. Pratt, 12mo, 1859; *Historical Account and Delineation of A.*, by Robert Wilson, 1822; *First Report of Royal Com. on Hist. MSS.*, 1869; *The Annals of A.*, by William Kennedy, 1818; Orem's *Description of the Chanonry, Cathedral, and King's College of Old A.*, 1724–25, 1830; *The Castellated Architecture of A.*, by Sir Andrew Leith Hay of Rannes, imp. 4to; *Specimens of Old Castellated Houses of A.*, with drawings by Giles, folio, 1838; *Lives of Eminent Men of A.*, by James Bruce, 12mo, 1841). (A. C.)

ABERDEEN, George Hamilton Gordon, Fourth Earl of, was born at Edinburgh on the 28th January 1784. He was educated at Harrow School, and at St John's College, Cambridge, where he graduated in 1804. He succeeded his grandfather in the earldom in 1801, and in the same year he made an extended tour through Europe, visiting France, Italy, and Greece. On his return he founded the Athenian Club, the membership of which was confined to those who had travelled in Greece. This explains Lord Byron's reference in the *English Bards and Scotch Reviewers* to "the travelled Thane, Athenian Aberdeen." Soon after his return he contributed a very able article to the *Edinburgh Review* (vol. vi.), on Gell's *Topography of Troy*. Another literary result of his tour was the publication in 1822 of *An Inquiry into the Principles of Beauty in Grecian Architecture*, the substance of which had appeared some years before in the form of an introduction to a translation of Vitruvius' *Civil Architecture*. In 1806, having been elected one of the representative peers for Scotland, he took his seat in the House of Lords on the Tory side. He was already on terms of intimacy with the leading members of the then predominant party, and in particular with Pitt, through the influence of his relative, the celebrated Duchess of Gordon. In 1813 he was intrusted with a delicate and difficult special mission to Vienna, the object being to induce the Emperor of Austria to join the alliance against his son-in-law Napoleon. His diplomacy was completely successful; the desired alliance was secured by the treaty of Töplitz, which the Earl signed as representative of Great Britain in September 1813. On his return at the conclusion of the war, he was raised to a British peerage, with the title of Viscount Gordon. Lord Aberdeen was a member of the Cabinet formed by the Duke of Wellington in 1828, for a short time as Chancellor of the Duchy of Lancaster, and then as Foreign Secretary. He was Colonial Secretary in the Tory Cabinet of 1834–5, and again received the seals of the Foreign Office under Sir Robert Peel's administration of 1841. The policy of non-intervention, to which he stedfastly adhered in his conduct of foreign affairs, was at once his strength and his weakness. According to the popular idea, he failed to see the limitations and exceptions to a line of policy which nearly all admitted to be as a general rule both wise and just. On the whole, his administration was perhaps more esteemed abroad than at home. It has been questioned whether any English minister ever was on terms of greater intimacy with foreign courts, but there is no substantial warrant for the charge of want of patriotism which was sometimes brought against him. On the two chief questions of home politics which were finally settled during his tenure of office, he was in advance of most of his party. While the other members of the Government yielded Catholic Emancipation and the repeal of the Corn Laws as unavoidable concessions, Lord Aberdeen spoke and voted for both measures from conviction of their justice. On the 13th June 1843, he moved the second reading of his bill "to remove doubts respecting the admission of ministers to benefices in Scotland," and it was passed into law in that session, though a similar measure had been rejected in 1840. As the first proposal did not prevent, so the passing of the Act had no effect in healing, the breach in the Established Church of Scotland which occurred in 1843. On the defeat of Lord Derby's government in 1852, the state of parties was such as to necessitate a coalition government, of which Lord Aberdeen, in consequence of the moderation of his views, was the natural chief. He had been regarded as the leader of the Peel party from the time of Sir Robert's death, but his views on the two great questions of home policy above mentioned rendered him more acceptable to the Liberals, and a more suitable leader of a coalition government than any other member of that party could have been. His administration will chiefly be remembered in connection with the Crimean war, which, it is now generally believed, might have been altogether prevented by a more vigorous policy. The incompetence of various departments at home, and the gross mismanagement of the commissariat in the terrible winter of 1854, caused a growing dissatisfaction with the government, which at length found emphatic expression in the House of Commons, when a motion submitted by Mr Roebuck, calling for inquiry, was carried by an overwhelming majority. Lord Aberdeen regarded the vote as one of no-confidence, and at once resigned. From this period Lord Aberdeen took little part in public business. In recognition of his services he received, soon after his resignation, the decoration of the Order of the Garter. He died December 13, 1860. Lord Aberdeen was twice married,—first in 1805, to a daughter of the first Marquis of Abercorn, who died in 1812, and then to the widow of Viscount Hamilton. He was succeeded in the title and estates by Lord Haddo, his son by the second marriage.

ABERDOUR, a village in the county of Fife, in Scotland, pleasantly situated on the north shore of the Firth of Forth, and much resorted to for sea-bathing. It is 10 miles N.W. of Edinburgh, with which there is a frequent communication by steamer.

ABERFELDY, a village in Perthshire, celebrated in Scottish song for its "birks" and for the neighbouring falls of Moness. It is the terminus of a branch of the Highland Railway.

ABERGAVENNY, a market town in Monmouthshire, 14 miles west of Monmouth, situated at the junction of a small stream called the Gavenny, with the river Usk. It is supposed to have been the *Gobannium* of the Romans, so named from *Gobannio*, the Gavenny. The town was formerly walled, and has the remains of a castle built soon after the Conquest, and also of a Benedictine monastery. The river Usk is here spanned by a noble stone bridge of fifteen arches. Two markets are held weekly, and elegant market buildings have recently been erected. There is a free grammar school, with a fellowship and exhibitions at Jesus College, Oxford. No extensive manufacture is carried on except that of shoes; the town owes its prosperity mainly to the large coal and iron works in the neighbourhood. Abergavenny is a polling place for the county. Population of parish (1871), 6318.

ABERNETHY, a town in Perthshire, situated in the parish of the same name, on the right bank of the Tay, 7 miles below Perth. The earliest of the Culdee houses was founded there, and it is said to have been the capital of the Pictish kings. It was long the chief seat of the Episcopacy in the country, till, in the 9th century, the bishopric was transferred to St Andrews. There still remains at Abernethy a curious circular tower, 74 feet high and 48 feet in circumference, consisting of sixty-four courses of hewn stone. A number of similar towers, though not so well

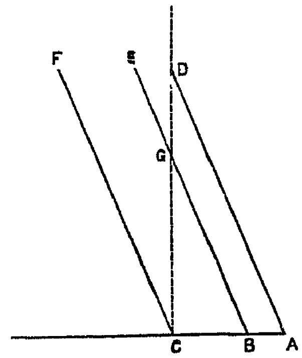
built, are to be met with in Ireland, but there is only one other in Scotland, viz., that at Brechin. Petrie argues, in his *Round Towers of Ireland*, that these structures have been used as belfries, and also as keeps.

ABERNETHY, John,—a Protestant dissenting divine of Ireland, was born at Coleraine, county Londonderry, Ulster, where his father was minister (Nonconformist), on the 19th October 1680. In his thirteenth year he entered a student at the University of Glasgow. On concluding his course at Glasgow he went to Edinburgh University, where his many brilliant gifts and quick and ready wit—thought-born, not verbal merely—struck the most eminent of his contemporaries and even his professors. Returning home, he received licence to preach from his Presbytery before he was twenty-one. In 1701 he was urgently invited to accept the ministerial charge of an important congregation in Antrim; and after an interval of two years, he was ordained there on 8th August 1703. His admiring biographer tells of an amount and kind of work done there, such as only a man of fecund brain, of large heart, of healthful frame, and of resolute will, could have achieved. In 1717 he was invited to the congregation of Usher's Quay, Dublin, as colleague with Rev. Mr Arbuckle, and contemporaneously, to what was called the Old Congregation of Belfast. The Synod assigned him to Dublin. He refused to accede, and remained at Antrim. This refusal was regarded then as ecclesiastical high-treason; and a controversy of the most intense and disproportionate character followed. The controversy and quarrel bears the name of the two camps in the conflict, the "Subscribers" and the "Non-subscribers." Out-and-out evangelical as John Abernethy was, there can be no question that he and his associates sowed the seeds of that after-struggle in which, under the leadership of Dr Henry Cooke, the Arian and Socinian elements of the Irish Presbyterian Church were thrown out. Much of what he contended for, and which the "Subscribers" opposed bitterly, has been silently granted in the lapse of time. In 1726 the "Non-subscribers," spite of an almost wofully pathetic pleading against separation by Abernethy, were cut off, with due ban and solemnity, from the Irish Presbyterian Church. In 1730, spite of being a "Non-subscriber," he was called by his early friends of Wood Street, Dublin, whither he removed. In 1731 came on the greatest controversy in which Abernethy engaged, viz., in relation to the Test Act nominally, but practically on the entire question of tests and disabilities. His stand was "against all laws that, upon account of mere differences of religious opinions and forms of worship, excluded men of integrity and ability from serving their country." He was nearly a century in advance of his century. He had to reason with those who denied that a Roman Catholic or Dissenter could be a "man of integrity and ability." His *Tracts*—afterwards collected—did fresh service, generations later. And so John Abernethy through life was ever foremost where unpopular truth and right were to be maintained; nor did he, for sake of an ignoble expediency, spare to smite the highest-seated wrongdoers any more than the hoariest errors (as he believed). He died in 1740, having been twice married. (Kippis' *Biog. Brit.*, s. v.; Dr Duchal's *Life*, prefixed to *Sermons*; *Diary* in MS., 6 vols. 4to; *History of Irish Presbyterian Church*). (A. B. G.)

ABERNETHY, John, grandson of the preceding, an eminent surgeon, was born in London on the 3d of April 1764. His father was a London merchant. Educated at Wolverhampton Grammar School, he was apprenticed in 1779 to Sir Charles Blicke, a surgeon in extensive practice in the metropolis. He attended Sir William Blizzard's anatomical lectures at the London Hospital, and was early employed to assist Sir William as "demonstrator;" he also attended Pott's surgical lectures at St Bartholomew's Hospital, as well as the lectures of the celebrated John Hunter. On Pott's resignation of the office of surgeon of St Bartholomew's, Sir Charles Blicke, who was assistant-surgeon, succeeded him, and Abernethy was elected assistant-surgeon in 1787. In this capacity he began to give lectures in Bartholomew Close, which were so well attended that the governors of the hospital built a regular theatre (1790–91), and Abernethy thus became the founder of the distinguished School of St Bartholomew's. He held the office of assistant-surgeon of the hospital for the long period of twenty-eight years, till, in 1815, he was elected principal surgeon. He had before that time been appointed surgeon of Christ's Hospital (1813), and Professor of Anatomy and Surgery to the Royal College of Surgeons (1814). Abernethy had great fame both as a practitioner and as a lecturer, his reputation in both respects resting on the efforts he made to promote the practical improvement of surgery. His *Surgical Observations on the Constitutional Origin and Treatment of Local Diseases* (1809)—known as "My Book," from the great frequency with which he referred his patients to it, and to page 72 of it in particular, under that name—was one of the earliest popular works on medical science. The views he expounds in it are based on physiological considerations, and are the more important that the connection of surgery with physiology had scarcely been recognised before the time he wrote. The leading principles on which he insists in "My Book" are chiefly these two:—1*st*, That topical diseases are often mere symptoms of constitutional maladies, and then can only be removed by general remedies; and 2*d*, That the disordered state of the constitution very often originates in, or is closely allied to deranged states of the stomach and bowels, and can only be remedied by means that beneficially affect the functions of those organs. His profession owed him much for his able advocacy of the extension in this way of the province of surgery. He had great success as a teacher from the thorough knowledge he had of his science, and the persuasiveness with which he enunciated his views. It has been said, however, that the influence he exerted on those who attended his lectures was not beneficial in this respect, that his opinions were delivered so dogmatically, and all who differed from him were disparaged and denounced so contemptuously, as to repress instead of stimulating inquiry. It ought to be mentioned, that he was the first to suggest and to perform the daring operation of securing by ligature the carotid and the external iliac arteries. The celebrity Abernethy attained in his practice was due not only to his great professional skill, but also in part to the singularity of his manners. He used great plainness of speech in his intercourse with his patients, treating them often brusquely, and sometimes even rudely. In the circle of his family and friends he was courteous and affectionate; and in all his dealings he was strictly just and honourable. He resigned his surgery at St Bartholomew's Hospital in 1827, and his professorship at the College of Surgeons two years later, on account of failing health, and died at his residence at Enfield on the 20th of April 1831. A collected edition of his works in five volumes was published in 1830. A biography, *Memoirs of John Abernethy*, by George Macilwain, F.R.C.S., appeared in 1853, and though anything but satisfactory, passed through several editions.

ABERRATION, or (more correctly) the Aberration of Light, is a remarkable phenomenon, by which stars appear to deviate a little, in the course of a year, from their true places in the heavens. It results from the eye of the observer being carried onwards by the motion of the earth on its orbit, during the time that light takes to

travel from the star to the earth. The effect of this combination of motions may be best explained by a familiar illustration. Suppose a rain-drop falling vertically is received in a tube that has a lateral motion. In order that the drop may fall freely down the axis of the tube, the latter must be inclined at such an angle as to move from the position AD to BE, and again to CF, in the times the drop moves from D to G, and from G to C. The drop in this case, since it moves down the axis all the way, must strike the bottom of the tube at C *in the direction* FC. The light proceeding from a star is not seen in its true direction, but strikes the eye obliquely, for a precisely similar reason. If lines be taken to represent the motions, so that the eye is carried from A to C during the time that light moves from D to C, the light will appear to the eye at C to come, not from D, but from F. The angle DCF, contained by the true and apparent directions of the star, is the *aberration*. It is greatest when the two motions are at right angles to each other, *i.e.*, when the star's longitude is 90° in advance of, or behind, the heliocentric longitude of the earth, or (which amounts to the same thing) 90° behind, or in advance of, the geocentric longitude of the sun. (See ASTRONOMY.) Now, in the right-angled triangle ACD, tan ADC (*i.e.*, DCF) $= \frac{AC}{DC}$; whence it appears that the tangent of the angle of aberration (or, since the angle is very small, the aberration itself) is equal to the ratio, $\frac{\text{velocity of earth in orbit}}{\text{velocity of light}}$. The rate of the earth's motion being to the velocity of light in the proportion of 1 to 10,000 nearly, the maximum aberration is small, amounting to about 20·4 seconds of arc,—a quantity, however, which is very appreciable in astronomical observations.



Aberration always takes place in the direction of the earth's motion; that is, it causes the stars to appear nearer than they really are to the point towards which the earth is at the moment moving. That point is necessarily on the ecliptic, and 90° in advance of the earth in longitude. The effect is to make a star at the pole of the ecliptic appear to move in a plane parallel to the ecliptic, so as to form a small ellipse, similar to the earth's orbit, but having its major axis parallel to the minor axis of that orbit, and *vice versâ*. As we proceed from the pole, the apparent orbits the stars describe become more and more elliptical, till in the plane of the ecliptic the apparent motion is in a straight line. The length of this line, as well as of the major axes of the different ellipses, amounts, in angular measure, to about 40″·8. The stars thus appear to oscillate, in the course of the year, 20″·4 on each side of their true position, in a direction parallel to the plane of the ecliptic, and the quantity 20″·4 is therefore called the *constant of aberration*.

For the discovery of the aberration of light, one of the finest in modern astronomy, we are indebted to the distinguished astronomer Dr Bradley. He was led to it, in 1727, by the result of observations he made with the view of determining the annual parallax of some of the stars; that is, the angle subtended at these stars by the diameter of the earth's orbit. He observed certain changes in the positions of the stars that he could not account for. The deviations were not in the direction of the apparent motion that parallax would give rise to; and he had no better success in attempting to explain the phenomenon by the nutation of the earth's axis, radiation, errors of observation, &c. At last the true solution of the difficulty occurred to him, suggested, it is said, by the movements of a vane on the top of a boat's mast. Roemer had discovered, a quarter of a century before, that light has a velocity which admits of measurement; and Bradley perceived that the earth's motion, having a perceptible relation to that of light, must affect the direction of the visual rays, and with this the apparent positions of the stars. He calculated the aberration from the known relative velocities of the earth and of light, and the results agreed entirely with his observations.

The observed effects of aberration are of importance as supplying an independent method of measuring the velocity of light, but more particularly as presenting one of the few direct proofs that can be given of the earth's motion round the sun. It is indeed the most satisfactory proof of this that astronomy furnishes, the phenomenon being quite inexplicable on any other hypothesis.

ABERYSTWITH, a municipal and parliamentary borough, market town, and seaport of Wales, in the county of Cardigan, is situated at the western end of the Vale of Rheidol, near the confluence of the rivers Ystwith and Rheidol, and about the centre of Cardigan Bay. It is the terminal station of the Cambrian Railway, and a line to the south affords direct communication with South Wales, Bristol, &c. The borough unites with Cardigan, Lampeter, &c., in electing a member of Parliament. Coal, timber, and lime are imported, and the exports are lead, oak bark, flannel, and corn. The harbour has of late been much improved; and the pier, completed in 1865, forms an excellent promenade. There are many elegant buildings, and it has been proposed to establish here a University College of Wales. On a promontory to the S.W. of the town are the ruins of its ancient castle, erected in 1277, by Edward I., on the site of a fortress of great strength, built by Gilbert de Strongbow, and destroyed by Owen Gwynedd. From its picturesque situation and healthy climate, and the suitableness of the beach for bathing, Aberystwith has risen into great repute as a watering-place, and attracts many visitors. Much of the finest scenery in Wales, such as the Devil's Bridge, &c., lies within easy reach. Population (1871), 6898.

ABETTOR, a law term implying one who instigates, encourages, or assists another to perform some criminal action. See ACCESSORY.

ABEYANCE, a law term denoting the expectancy of an estate. Thus, if lands be leased to one person for life, with reversion to another for years, the remainder for years is in abeyance till the death of the lessee.

ABGAR, the name or title of a line of kings of Edessa in Mesopotamia. One of them is known from a correspondence he is said to have had with Jesus Christ. The letter of Abgar, entreating Jesus to visit him and heal him of a disease, and offering Him an asylum from the wrath of the Jews, and the answer of Jesus promising to send a disciple to heal Abgar after His ascension, are given by Eusebius, who believed the documents to be genuine. The same belief has been held by a few moderns, but there can be no doubt whatever that the letter of Jesus at least is apocryphal. It has also been alleged that Abgar possessed a picture of Jesus, which the credulous may see either at Rome or at Genoa. Some make him the possessor of the handkerchief a woman gave Jesus, as He bore the cross, to wipe the sweat from His face with, on which, it is fabled, His features remained miraculously imprinted.

ABIAD, BAHR-EL-, a name given to the western branch of the Nile, above Khartoum. It is better known as the White Nile. See NILE.

ABIES. See FIR.

ABILA, a city of ancient Syria, the capital of the tetrarchy of Abilene, a territory whose limits and extent it is impossible now to define. The site of Abila is indicated by some ruins and inscriptions on the banks of the river Barada, between Baalbec and Damascus, about twelve miles from the latter city. Though the names Abel and Abila differ in derivation and in meaning, their similarity has given rise to the tradition that this was the scene of Abel's death.

ABILDGAARD, NIKOLAJ, called "the Father of Danish Painting," was born in 1744. He formed his style on that of Claude and of Nicolas Poussin, and was a cold theorist, inspired not by nature but by art. As a technical painter he attained remarkable success, his tone being very harmonious and even, but the effect, to a foreigner's eye, is rarely interesting. His works are scarcely known out of Copenhagen, where he won an immense fame in his own generation, and where he died in 1809. He was the founder of the Danish school of painting, and the master of Thorwaldsen and Eckersberg.

ABIMELECH (אֲבִימֶלֶךְ, *father of the king*, or rather perhaps *king-father*), occurs first in the Bible as the name of certain kings of the Philistines at Gerar (Gen. xx. 2, xxi. 22, xxvi. 1). From the fact that the name is applied in the inscription of the thirty-fourth psalm to Achish, it has been inferred with considerable probability that it was used as the official designation of the Philistinian kings. The name was also borne by a son of Gideon, judge of Israel, by his Shechemite concubine (Judges viii. 31). On the death of Gideon, who had refused the title of king both for himself and his children, Abimelech set himself to obtain the sovereignty through the influence of his mother's relatives. In pursuance of his plan he slew seventy of his brethren "upon one stone" at Ophrah, Jotham, the youngest of them, alone contriving to escape. This is one of the earliest recorded instances of a practice exceedingly common on the accession of Oriental despots. Abimelech was eventually made king, although his election was opposed by Jotham, who boldly appeared on Mount Gerizim and told the assembled Shechemites the fable of the trees desiring a king. At the end of the third year of his reign the Shechemites revolted, and under the leadership of Gaal made an unsuccessful attempt to throw off the authority of Abimelech. In Judges ix. there is an account of this insurrection, which is specially interesting owing to the full details it gives of the nature of the military operations. After totally destroying Shechem, Abimelech proceeded against Thebez, which had also revolted. Here, while storming the citadel, he was struck on the head by the fragment of a millstone thrown from the wall by a woman. To avoid the disgrace of perishing by a woman's hand, he requested his armour-bearer to run him through the body. Though the immediate cause of his death was thus a sword-thrust, his memory was not saved from the ignominy he dreaded (2 Sam. xi. 21). It has been usual to regard Abimelech's reign as the first attempt to establish a monarchy in Israel. The facts, however, seem rather to support the theory of Ewald (*Gesch.* ii. 444), that Shechem had asserted its independence of Israel, when it chose Abimelech as its king.

ABINGDON, a parliamentary and municipal borough and market town of England, in Berkshire, on a branch of the Thames, 7 miles south of Oxford, and 51 miles W.N.W. of London. It is a place of great antiquity, and was an important town in the time of the Heptarchy. Its name is derived from an ancient abbey. The streets, which are well paved, converge to a spacious area, in which the market is held. In the centre of this area stands the market-house, supported on lofty pillars, with a large hall above, appropriated to the summer assizes for the county, and the transaction of other public business. The town contains two churches, which are said to have been erected by the abbots of Abingdon, one dedicated to St Nicholas and the other to St Helena; several charitable institutions, and a free grammar school, with scholarships at Pembroke College, Oxford. In 1864 a memorial of Prince Albert was erected at Abingdon, a richly ornamented structure, surmounted by a statue of the Prince. Abingdon was incorporated by Queen Mary. It sends one member to Parliament, and is governed by a mayor, four aldermen, and twelve councillors. In the beginning of the century it manufactured much sail-cloth and sacking; but its chief trade now is in corn and malt, carpets, and coarse linen. It is a station on a branch of the Great Western Railway. Population (1871), 6571.

ABIOGENESIS, as a name for the production of living by not-living matter, has of late been superseding the less accurate phrase "Spontaneous Generation." Professor Huxley, who made use of the word in his presidential address to the British Association in 1870, distinguished Abiogenesis from "Xenogenesis" or "Heterogenesis," which occurs, or is supposed to occur, not when dead matter produces living matter, but when a living parent gives rise to offspring which passes through a totally different series of states from those exhibited by the parent, and does not return into the parent's cycle of changes. When a "living parent gives rise to offspring which passes through the same cycle of changes as itself," there occurs "Homogenesis." "Biogenesis" includes both of these. Other names for Abiogenesis are *Generatio Æquivoca*, *Generatio Primaria*, Archigenesis (Urzeugung), Archebiosis, &c. The question of Abiogenesis—whether under certain conditions living matter is produced by not-living matter—as it is one of the most fundamental, is perhaps also the oldest in Biology; but within recent years—partly because the means of accurate experimentation have been increased and the microscope improved, and partly because the question has been recognised in its important bearings on evolution, the correlation of forces, and the theory of infectious diseases—naturalists have been led to bestow more attention upon it than at any previous period. While, therefore, the doctrine of Abiogenesis cannot be said to be either finally established or refuted, it is at least reasonable to believe that we are gradually advancing to a solution. Among the older observers of phenomena bearing on the question may be named Aristotle, who, with the ancients generally, favoured Abiogenesis; Redi, the founder of the opposite view; Vallisnieri; Buffon; Needham; and Spallanzani; among later observers, Schwann and Schulze, Schrœder and Dusch, Pasteur, Pouchet, Haeckel, Huxley, Bastian, and many others. The experiments and observations made by these naturalists, and their results—the ingenious expedients employed to prevent inaccuracy—the interesting and often marvellous transformations which microscopists declare they have witnessed—will be discussed in the article HISTOLOGY; here it will be enough to note the general nature of the reasonings with which the opponents and defenders of Abiogenesis support their views. The opponents maintain that all trustworthy observations have hitherto shown living matter to have sprung from pre-existing living matter; and that the further we search and examine, the smaller becomes the number of those organisms which we cannot demonstrate to have arisen from living parents. They hold that seeming instances of spontaneous generation are usually to be explained by the germ-theory—the presence of invisible germs in the air; and they call to their aid such high authorities as Pasteur and Tyndall. The defenders of Abiogenesis, on the other

hand, while interpreting the results of past observation and experiment in their own favour, are yet less disposed to rest on these, rather preferring to argue from those wide analogies of evolution and correlation which seem to support their doctrine. Thus Haeckel expressly embraces Abiogenesis as a necessary and integral part of the theory of universal evolution; and Huxley, in the same spirit, though from the opposite camp, confesses that if it were given him to look beyond the abyss of geologically recorded time to the still more remote period when the earth was passing through physical and chemical conditions, he should expect to be a witness of the evolution of living protoplasm from not-living matter. (*Critiques and Addresses*, p. 239.) From this point of view, of course, any microscopic observations that have been made seem very limited and comparatively unimportant. The Abiogenists, indeed, are not without arguments to oppose the results of past observation that seem unfavourable to their views; they argue that, as yet, all the forms observed and shown to be produced by Biogenesis are forms possessing a certain degree of organisation, which in their case makes Abiogenesis unlikely, from the first; whereas it has not been shown that the simplest structures—the *Monera*—do not arise by Abiogenesis. But it is not so much on grounds of fact and experiment the defenders of the Abiogenesis theory are convinced of its truth, as because it seems to gain confirmation from reasonings of much wider scope; because Abiogenesis aids the theory of evolution by tracing the organic into the inorganic; because it fosters the increasing unpopularity of the hypothesis of a special "vital force;" and because, if this theory of the "perpetual origination of low forms of life, now, as in all past epochs," were established, it would agree well with the principle of uniformity, and by disclosing the existence of unknown worlds of material for development, would relieve natural selection with its assisting causes from what many consider the too Herculean labour of evolving all species from one or a very few primary forms. The fullest discussion of the subject of Abiogenesis, from the Abiogenist's point of view, is to be found in Dr Bastian's *Beginnings of Life.* Professor Huxley's address, already referred to, contains an interesting historical survey, as well as a masterly summary of facts and arguments in favour of Biogenesis. For many interesting experiments, see *Nature*, 1870–73.

ABIPONES, a tribe of South American Indians, inhabiting the territory lying between Santa Fé and St Iago. They originally occupied the Chaco district of Paraguay, but were driven thence by the hostility of the Spaniards. According to M. Dobrizhoffer, who, towards the end of last century, lived among them for a period of seven years, they have many singular customs and characteristics. They seldom marry before the age of thirty, are chaste and otherwise virtuous in their lives, though they practise infanticide, and are without the idea of God. "With the Abipones," says Darwin, "when a man chooses a wife, he bargains with the parents about the price. But it frequently happens that the girl rescinds what has been agreed upon between the parents and bridegroom, obstinately rejecting the very mention of marriage. She often runs away and hides herself, and thus eludes the bridegroom." The Abiponian women suckle those infants that are spared for the space of two years,—an onerous habit, which is believed to have led to infanticide as a means of escape. The men are brave in war, and pre-eminently expert in swimming and horsemanship. Numerically the tribe is insignificant. M. Dobrizhoffer's account of the Abiponians was translated into English by Sara Coleridge, at the suggestion of Mr Southey, in 1822.

ABJURATION. See Allegiance, Oath of.

ABKHASIA, or Abasia, a tract of Asiatic Russia, on the border of the Black Sea, comprehending between lat. 42° 30′ and 44° 45′ N. and between long. 37° 3′ and 40° 36′ E. The high mountains of the Caucasus on the N. and N.E. divide it from Circassia; on the S.E. it is bounded by Mingrelia; and on the S.W. by the Black Sea. Though the country is generally mountainous, there are some deep well-watered valleys, and the climate is mild. The soil is fertile, producing grain, grapes, and other fruits. Some of the inhabitants devote themselves to agriculture, some to the rearing of cattle and horses, and not a few support themselves by piracy and robbery. Honey is largely produced, and is exported to Turkey; and excellent arms are made. Both in ancient and in modern times there has been considerable traffic in slaves. This country was early known to the ancients, and was subdued by the Emperor Justinian, who introduced civilisation and Christianity. Afterwards the Persians, then the Georgians, and more recently the Turks, ruled over the land. Under the Turks Christianity gradually disappeared, and Mohammedanism was introduced in its stead. By the treaties of Akerman and Adrianople, Russia obtained possession of the fortresses of this territory; but till the insurrection of 1866, the chiefs had almost unlimited power. The principal town is Sukumkaleh. The population of Abkhasia is variously stated at from 50,000 to 250,000. See Palgrave's *Essays on Eastern Questions*, 1872.

ABLUTION, a ceremonial purification, practised in nearly every age and nation. It consisted in washing the body in whole or part, so as to cleanse it symbolically from defilement, and to prepare it for religious observances. Among the Jews we find no trace of the ceremony in patriarchal times, but it was repeatedly enjoined and strictly enforced under the Mosaic economy. It denoted either—(1.) Cleansing from the taint of an inferior and less pure condition, and initiation into a higher and purer state, as in the case of Aaron and his sons on their being set apart to the priesthood; or (2.) Cleansing from the soil of common life, in preparation for special acts of worship, as in the case of the priests who were commanded, upon pain of death, to wash their hands and feet before approaching the altar; or (3.) Cleansing from the pollution occasioned by particular acts and circumstances, as in the case of the eleven species of uncleanness mentioned in the Mosaic law; or (4.) The absolving or purifying one's self from the guilt of some particular criminal act, as in the case of Pilate at the trial of the Saviour. The sanitary reasons which, in a warm climate and with a dry sandy soil, rendered frequent ablution an imperative necessity, must not be allowed to empty the act of its symbolic meaning. In the Hebrew different words are used for the washing of the hands before meals, which was done for the sake of cleanliness and comfort, and for the washing or plunging enjoined by the ceremonial law. At the same time it is impossible to doubt that the considerations which made the law so suitable in a physical point of view were present to the mind of the Lawgiver when the rite was enjoined. Traces of the practice are to be found in the history of nearly every nation. The customs of the Mohammedans, in this as in other matters, are closely analogous to those of the Jews. With them ablution must in every case precede the exercise of prayer, and their law provides that in the desert, where water is not to be found, the Arabs may perform the rite with sand. Various forms of ablution practised by different nations are mentioned in the sixth book of the Æneid, and we are told that Æneas washed his ensanguined hands after the battle before touching his Penates. Symbolic ablution finds a place under the New Testament dispensation in the rite of baptism, which is observed, though with some variety of form and circum-

stances, throughout the whole Christian Church. By Roman Catholics and Ritualists, the term ablution is applied to the cleansing of the chalice and the fingers of the celebrating priest after the administration of the Lord's Supper.

ABNER (אַבְנֵר, *father of light*), first cousin of Saul (1 Sam. xiv. 50) and commander-in-chief of his army. The chief references to him during the lifetime of Saul are found in 1 Sam. xvii. 55, and xxvi. 5. It was only after that monarch's death, however, that Abner was brought into a position of the first political importance. David, who had some time before been designated to the throne, was accepted as king by Judah alone, and was crowned at Hebron. The other tribes were actuated by a feeling hostile to Judah, and, as soon as they had thrown off the Philistinian yoke, were induced by Abner to recognise Ishbosheth, the surviving son of Saul, as their king. One engagement between the rival factions under Joab and Abner respectively (2 Sam. ii. 12) is noteworthy, inasmuch as it was preceded by an encounter between twelve chosen men from each side, in which the whole twenty-four seem to have perished. In the general engagement which followed, Abner was defeated and put to flight. He was closely pursued by Asahel, brother of Joab, who is said to have been "light of foot as a wild roe." As Asahel would not desist from the pursuit, though warned, Abner was compelled to slay him in self-defence. This originated a deadly feud between the leaders of the opposite parties, for Joab, as next of kin to Asahel, was by the law and custom of the country the avenger of his blood. For some time afterwards the war was carried on, the advantage being invariably on the side of David. At length Ishbosheth lost the main prop of his tottering cause by remonstrating with Abner for marrying Rizpah, one of Saul's concubines, an alliance which, according to Oriental notions, implied pretensions to the throne. Abner was indignant at the rebuke, and immediately transferred his allegiance to David, who not only welcomed him, but promised to give him the command of the combined armies on the re-union of the kingdoms. Almost immediately after, however, Abner was slain by Joab and his brother Abishai at the gate of Hebron. The ostensible motive for the assassination was a desire to avenge Asahel, and this would be a sufficient justification for the deed according to the moral standard of the time. There can be little doubt, however, that Joab was actuated in great part by jealousy of a new and formidable rival, who seemed not unlikely to usurp his place in the king's favour. The conduct of David after the event was such as to show that he had no complicity in the act, though he could not venture to punish its perpetrators. The dirge which he repeated over the grave of Abner (2 Sam. iii. 33–4) has been thus translated:—

> Should Abner die as a villain dies?—
> Thy hands—not bound,
> Thy feet—not brought into fetters:
> As one falls before the sons of wickedness, fellest thou.

ABO, a city and seaport, and chief town of the district of the same name in the Russian province of Finland, is situated in N. lat. 60° 26′, E. long. 22° 19′, on the Aurajoki, about 3 miles from where it falls into the Gulf of Bothnia. It was a place of importance when Finland formed part of the kingdom of Sweden, and the inhabitants of the city and district are mostly of Swedish descent. By the treaty of peace concluded here between Russia and Sweden on 17th August 1743, a great part of Finland was ceded to the former. Abo continued to be the capital of Finland till 1819. In November 1827, nearly the whole city was burnt down, the university and its valuable library being entirely destroyed. Before this calamity Abo contained 1100 houses, and 13,000 inhabitants; and its university had 40 professors, more than 500 students, and a library of upwards of 30,000 volumes, together with a botanical garden, an observatory, and a chemical laboratory. The university has since been removed to Helsingfors. Abo is the seat of an archbishop, and of the supreme court of justice for South Finland; and it has a cathedral, a town-hall, and a custom-house. Sail-cloth, linen, leather, and tobacco are manufactured; shipbuilding is carried on, and there are extensive saw-mills. There is also a large trade in timber, pitch, and tar. Vessels drawing 9 or 10 feet come up to the town, but ships of greater draught are laden and discharged at the mouth of the river, which forms an excellent harbour and is protected. Population in 1867, 18,109.

ABOLITIONIST. See SLAVERY.

ABOMASUM, *caillette*, the fourth or rennet stomach of Ruminantia. From the *omasum* the food is finally deposited in the abomasum, a cavity considerably larger than either the second or third stomach, although less than the first. The base of the abomasum is turned to the *omasum*. It is of an irregular conical form. It is that part of the digestive apparatus which is analogous to the single stomach of other Mammalia, as the food there undergoes the process of chymification, after being macerated and ground down in the three first stomachs.

ABOMEY, the capital of Dahomey, in West Africa, is situated in N. lat. 7°, E. long. 2° 4′, about 60 miles N. of Whydah, the port of the kingdom. It is a clay-built town, surrounded by a moat and mud walls, and occupies a large area, part of which is cultivated. The houses stand apart; there are no regular streets; and the place is very dirty. It has four larger market-places, and trade is carried on in palm-oil, ivory, and gold, Mohammedan traders from the interior resorting to its markets. The town contains the principal palace of the king of Dahomey. It is the scene of frequent human sacrifices, a "custom" being held annually, at which many criminals and captives are slain; while on the death of a king a "grand custom" is held, at which sometimes as many as 2000 victims have perished. The slave-trade is also prosecuted, and the efforts of the British Government to induce the king to abolish it and the "customs" have proved unsuccessful. Population, about 30,000. See DAHOMEY.

ABORIGINES, originally a proper name given to an Italian people who inhabited the ancient Latium, or country now called *Campagna di Roma*. Various derivations of this name have been suggested; but there can be scarcely any doubt that the usual derivation (*ab origine*) is correct, and that the word simply indicated a settled tribe, whose origin and earlier history were unknown. It is thus the equivalent of the Greek *autochthones*. It is therefore, strictly speaking, not a proper name at all, although, from being applied to one tribe (or group of tribes), it came to be regarded as such. Who the Aborigines were, or whence they came, is uncertain; but various traditions that are recorded seem to indicate that they were an Oscan or Opican tribe that descended from the Apennines into Latium, and united with some Pelasgic tribe to form the Latins. The stories about Æneas's landing in Italy represent the Aborigines as at first opposing and then coalescing with the Trojans, and state that the united people then assumed the name of *Latins*, from their king *Latinus*. These traditions clearly point to the fact that the Latins were a mixed race, a circumstance which is proved by the structure of their language, in which we find numerous words closely connected with the Greek, and also numerous words that are of an entirely different origin. These non-Greek words are mostly related to the dialects of the

Opican tribes. In modern times the term *Aborigines* has been extended in signification, and is used to indicate the inhabitants found in a country at its first discovery, in contradistinction to colonies or new races, the time of whose introduction into the country is known.

ABORTION, in *Midwifery* (from *aborior*, I perish), the premature separation and expulsion of the contents of the pregnant uterus. When occurring before the eighth lunar month of gestation, *abortion* is the term ordinarily employed, but subsequent to this period it is designated *premature labour*. The present notice includes both these terms. As an accident of pregnancy, abortion is far from uncommon, although its relative frequency, as compared with that of completed gestation, has been very differently estimated by accoucheurs. It is more liable to occur in the earlier than in the later months of pregnancy, and it would also appear to occur more readily at the periods corresponding to those of the menstrual discharge. Abortion may be induced by numerous causes, both of a local and general nature. Malformations of the pelvis, accidental injuries, and the diseases and displacements to which the uterus is liable, on the one hand; and, on the other, various morbid conditions of the ovum or placenta leading to the death of the fœtus, are among the direct local causes of abortion. The general causes embrace certain states of the system which are apt to exercise a more or less direct influence upon the progress of utero-gestation. A deteriorated condition of health, whether hereditary or as the result of habits of life, certainly predisposes to the occurrence of abortion. Syphilis is known to be a frequent cause of the death of the fœtus. Many diseases arising in the course of pregnancy act as direct exciting causes of abortion, more particularly the eruptive fevers and acute inflammatory affections. Prolonged irritation in other organs may, by reflex action, excite the uterus to expel its contents. Strong impressions made upon the nervous system, as by sudden shocks and mental emotions, occasionally have a similar effect. Further, certain medicinal substances, particularly ergot of rye, borax, savin, tansy, and cantharides, are commonly believed to be capable of exciting uterine action, but the effects, as regards at least early pregnancy, are very uncertain, while the strong purgative medicines sometimes employed with the view of procuring abortion have no effect whatever upon the uterus, and can only act remotely and indirectly, if they act at all, by irritating the alimentary canal. In cases of poisoning with carbonic acid, abortion has been observed to take place, and the experiments of Dr Brown Sequard show that anything interfering with the normal oxygenation of the blood may cause the uterus to contract and expel its contents. Many cases of abortion occur without apparent cause, but in such instances the probability is that some morbid condition of the interior of the uterus exists, and the same may be said of many of those cases where the disposition to abort has become habitual. The tendency, however, to the recurrence of abortion in persons who have previously miscarried is well known, and should ever be borne in mind with the view of avoiding any cause likely to lead to a repetition of the accident. Abortion resembles ordinary labour in its general phenomena, excepting that in the former hemorrhage often to a large extent forms one of the leading symptoms. The treatment of abortion embraces the means to be used by rest, astringents, and sedatives, to prevent the occurrence when it merely threatens; or when, on the contrary, it is inevitable, to accomplish as speedily as possible the complete removal of the entire contents of the uterus. The artificial induction of premature labour is occasionally resorted to by accoucheurs under certain conditions involving the safety of the mother or the fœtus. For *Criminal Abortion*, see MEDICAL JURISPRUDENCE.

ABOUKIR, a small village on the coast of Egypt, 13 miles N.E. of Alexandria, containing a castle which was used as a state prison by Mehemet Ali. Near the village, and connected with the shore by a chain of rocks, is a small island remarkable for remains of ancient buildings. Stretching to the eastward as far as the Rosetta mouth of the Nile is the spacious bay of Aboukir, where Nelson fought "the Battle of the Nile," defeating and almost destroying the French fleet that had conveyed Napoleon to Egypt. It was near Aboukir that the expedition to Egypt, under Sir Ralph Abercromby, in 1801, effected a landing in the face of an opposing force.

ABRABANEL, ISAAC (called also *Abravanel*, *Abarbanel*, *Barbanella*, and *Ravanella*), a celebrated Jewish statesman, philosopher, theologian, and commentator, was born at Lisbon in 1437. He belonged to an ancient family that claimed descent from the royal house of David, and his parents gave him an education becoming so renowned a lineage. He held a high place in the favour of King Alphonso V., who intrusted him with the management of important state affairs. On the death of Alphonso in 1481, his counsellors and favourites were harshly treated by his successor John; and Abrabanel was, in consequence, compelled to flee to Spain, where he held for eight years (1484–1492), the post of a minister of state under Ferdinand and Isabella. When the Jews were banished from Spain in 1492, no exception was made in Abrabanel's favour. He afterwards resided at Naples, Corfu, and Monopoli, and in 1503 removed to Venice, where he held office as a minister of state till his death in 1508. Abrabanel was one of the most learned of the rabbis. His writings are chiefly exegetical and polemical; he displays in them an intense antipathy to Christianity, though he lived on terms of friendship with Christians. He wrote commentaries on the greater part of the Old Testament, in a clear but somewhat diffuse style, anticipating much that has been advanced as new by modern theologians.

ABRACADABRA, a meaningless word once supposed to have a magical efficacy as an antidote against agues and other fevers. Ridiculously minute directions for the proper use of the charm are given in the *Præcepta de Medicina* of Serenus Sammonicus. The paper on which the word was written had to be folded in the form of a cross, suspended from the neck by a strip of linen so as to rest on the pit of the stomach, worn in this way for nine days, and then, before sunrise, cast behind the wearer into a stream running to the east. The letters of this word were usually arranged to form a triangle in one or other of the following ways :—

ABRACADABRA	ABRACADABRA
ABRACADABR	BRACADABR
ABRACADAB	RACADAB
ABRACADA	ACADA
ABRACAD	CAD
ABRACA	A
ABRAC	
ABRA	
ABR	
AB	
A	

ABRAHAM or ABRAM, father of the Israelite race, was the first-born son of Terah, a Shemite, who left Ur of the Chaldees, in the north-east of Mesopotamia, along with Abram, Sarai, and Lot, and turned westwards in the direction of Canaan. Abram had married his half-sister Sarai, who was ten years younger than himself; and though such relationship was afterwards forbidden by the law, it was common in ancient times, both among other

peoples, and among the Hebrews themselves at least before Moses. The cause of Terah's removing from his native country is not given. Having come to Haran, he abode there till his death, at the age of 205. According to Genesis xii., Abram left Haran when he was 75 years of age, that is, before the death of his father, in consequence of a divine command, to which was annexed a gracious promise, "And I will make of thee a great nation, and I will bless thee, and make thy name great; and thou shalt be a blessing. And I will bless them that bless thee, and curse him that curseth thee; and in thee shall all families of the earth be blessed" (xii. 2, 3). Another tradition makes him leave Haran only after Terah's decease (Acts vii. 4). The later account is that Abram's departure was the result of religious considerations, because he had already become emancipated from surrounding idolatry. Perhaps the desire of a nomadic life, the love of migration natural to an Oriental, had more to do with his pilgrimage than a spiritual impulse from within; but it is likely that his culture advanced in the course of his sojournings, and that he gradually attained to purer conceptions of duty and life. Traditions subsequent to the Jehovistic represent him as driven forth by the idolatrous Chaldeans (Judith v. 6, &c.) on account of his monotheistic doctrines, and then dwelling in Damascus as its king (Josephus's *Antiquities*, i. 7). The true cause of departure may be suggested by Nicolaus of Damascus saying that he came out of Chaldea with an army. The leader of a horde, worsted in some encounter or insurrection, he emigrated at the head of his adherents in quest of better fortunes. The word *redeemed*, in Isaiah xxix. 22, out of which Ewald conjectures so much, as if Abram had been rescued from great bodily dangers and battles, does not help the portrait, because it means no more than the patriarch's migration from heathen Mesopotamia into the Holy Land. Journeying south-west to Canaan with his wife and nephew, he arrived at Sichem, at *the oak of the seer* or *prophet*, where Jehovah appeared to him, assuring him for the first time that his seed should possess the land he had come to. He travelled thence southward, pitching his tent east of Bethel. Still proceeding in the same direction, he arrived at the Negeb, or most southern district of Palestine, whence a famine forced him down to Egypt. His plea that Sarai was his sister did not save her from Pharaoh; for she was taken into the royal harem, but restored to her husband in consequence of divine chastisments inflicted upon the lawless possessor of her person, leading to the discovery of her true relationship. The king was glad to send the patriarch away under the escort and protection of his men. A similar thing is said to have subsequently happened to Sarai at Gerar with the Philistine king Abimelech (Genesis xx.), as also to Rebekah, Isaac's wife (xxvi.) The three narratives describe one and the same event in different shapes. But the more original (the junior Elohistic)[1] is that of the 20th chapter, so that Gerar was the scene, and Abimelech the offender; while the later Jehovistic narrative (xii.) deviates still more from verisimilitude. Though this occurrence, however, belongs to the southern borders of Palestine, we need not doubt the fact of Abram's sojourn in Egypt, especially as he had an Egyptian slave (Genesis xvi.) How long the patriarch remained there is not related; nor are the influences which the religion, science, and learning of that civilised land had upon him alluded to. That they acted beneficially upon his mind, enlightening and enlarging it, can scarcely be doubted. His religious conceptions were transformed. The manifold wisdom of Egypt impressed him. Intercourse with men far advanced in civilisation taught him much. Later tradition speaks of his communicating to the Egyptians the sciences of arithmetic and astronomy (Josephus i. 7); but this is founded upon the notion entertained at the time of the civilised Chaldeans of Babylon, whereas Ur of the Chaldees was a district remote from the subsequent centre of recondite knowledge. Abram received more than he imparted, for the Egyptians were doubtless his superiors in science. He found the rite of circumcision in use. There, too, he acquired great substance—flocks and herds, male and female slaves. After returning to Canaan, to his former locality, Abram and Lot separated, because of disputes between their herdsmen, there not being sufficient room for all their cattle in common. After this separation the possession of Canaan was again assured to Abram and to his seed, who should be exceedingly numerous. This is the third theocratic promise he received. He is also commanded by Jehovah to walk through it in its length and breadth as a token of inheritance,—a later Jehovistic tradition that must be judged according to its inherent verisimilitude. Abram settled again at the oak of Mamre near Hebron. This was his headquarters. After Lot had been taken prisoner in the expedition of the kings of Shinar, Ellasar, Elam, and Goyim, against the old inhabitants of Basan, Ammonitis, Moabitis, Edomitis, and others besides, Abram gave chase to the enemy, accompanied by his 318 slaves and friendly neighbours, rescuing his nephew at Hobah, near Damascus. On his return, the royal priest Melchizedek of Salem came forth to meet him with refreshments, blessed the patriarch, and received from him the tithe of the spoils. The king acted generously towards the victor, and was still more generously treated in return.

Jehovah again promised to Abram a numerous offspring, with the possession of Canaan. He also concluded a covenant with him in a solemn form, and revealed the fortunes of his posterity in Egypt, with their deliverance from bondage. In consequence of the barrenness of Sarai, she gave her handmaid Hagar to Abram, who, becoming pregnant by him, was haughtily treated by her mistress, and fled towards Egypt. But an angel met her in the desert and sent her back, telling of a numerous race that should spring from her. Having returned, she gave birth to Ishmael, in the 86th year of Abram's age.

Again did Jehovah appear to the patriarch, promising as before a multitudinous seed, and changing his name in conformity with such promise. He assured him and his posterity of the possession of Canaan, and concluded a covenant with him for all time. At the institution of circumcision on this occasion, Sarai's name was also changed, because she was to be the maternal progenitor of the covenant people through Isaac her son. Abram, and all the males belonging to him, were then circumcised. He had become acquainted with the rite in Egypt, and transferred it to his household, making it a badge of distinction between the worshippers of the true God and the idolatrous Canaanites—the symbol of the flesh's subjection to the spirit. Its introduction into the worship of the colony at Mamre indicated a decided advance in Abram's religious conceptions. He had got beyond the cruel practice of human sacrifice. The gross worship of the Canaanites was left behind; and the small remnant of it which he retained comported with a faith approaching monotheism. Amid prevailing idolatry this institution was a protection to his family and servants—a magic circle drawn around them. But, though powerful and respected wherever his name was known, he confined the rite to his own domestics, without attempting to force it on the inhabitants of the land where he sojourned. The punishment of death

[1] Three documents at least are traceable in the Pentateuch; the Elohistic, the junior Elohistic, and the Jehovistic. These were put together by a redactor. Nearly the whole of the fifth book was added by the Deuteronomist.

for neglecting it, because the uncircumcised person was thought to be a breaker of the covenant and a despiser of its Author, seems a harsh measure on the part of Abram; yet it can hardly be counted an arbitrary transference of the later Levitical severities to the progenitor of the race, since it is in the Elohist.

Accompanied by two angels, Jehovah appeared again to Abram at the oak of Mamre, accepted his proposed hospitality, and promised him a son by Sarai within a year. Though she laughed incredulously, the promise was definitely repeated. When the angels left, Jehovah communicated to Abram the divine purpose of destroying the dwellers in Siddim because of their wickedness, but acceded to the patriarch's intercession, that the cities of the plain should be spared if ten righteous men could be found in them. The two angels, who had gone before, arrived at Sodom in the evening, and were entertained by Lot, but threatened with shameful treatment by the depraved inhabitants. Seeing that the vengeance of Heaven was deserved, they proceeded to execute it, saving Lot with his wife and two daughters, and sparing Zoar as a place of refuge for them. Jehovah rained down fire and brimstone from heaven, turning all the Jordan district to desolation, so that when Abram looked next morning from the spot where Jehovah and himself had parted, he saw a thick smoke ascend from the ruins.

Abram then journeyed from Hebron to the Negeb, settled between Kadesh and Shur in Gerar, where Sarai is said to have been treated as a prior account makes her to have been in Egypt. At the patriarch's prayer the plague inflicted on the king and his wives was removed. This is a duplicate of the other story. Whatever historical truth the present narrative has belongs to an earlier period of Abram's life. His second removal to Gerar originated in the former journeying through it into Egypt. He must have remained in the neighbourhood of Hebron, his first settlement, where Isaac was born according to the Elohistic account. After the birth of the legitimate heir, succeeding events were the expulsion of Hagar and Ishmael from the paternal home, and the making of a covenant between Abimelech and Abram at Beersheba. Here Abram "called on the name of the Lord," and is said to have planted a noted tamarisk in commemoration of the event.

Abram was now commanded by God to offer up Isaac in the land of Moriah. Proceeding to obey, he was prevented by an angel just as he was about to slay his son, and sacrificed a ram that presented itself at the time. In reward of his obedience he received the promise of a numerous seed and abundant prosperity. Thence he returned to Beersheba.

Sarai died and was buried in the cave of Machpelah near Hebron, which Abram purchased, with the adjoining field, from Ephron the Hittite. The measures taken by the patriarch for the marriage of Isaac are circumstantially described. His steward Eliezer was sent to the country and kindred of Abram to find a suitable bride, which he did in Haran, whither he was divinely conducted. Rebekah appeared as the intended one; she parted from Bethuel and her family with their full approbation, was brought to Isaac, and became a maternal ancestor of the chosen people.

It is curious that, after Sarah's death, Abram should have contracted a second marriage with Keturah, and begotten six sons. The Chronicles, however, make her his concubine (1 Chron. i. 32), so that these children may have been born earlier. Probably the narrative intends to account for the diffusion of Abram's posterity in Arabia. Keturah's sons were sent away with gifts from their home into Arabia, and all the father's substance was given to Isaac. The patriarch died at the age of 175 years, and was buried by Isaac and Ishmael beside Sarai in Machpelah. The book of Genesis gives two lists of Arab tribes, descended partly from Abram and Keturah, partly from him and Hagar or Ishmael. These dwelt in Arabia Deserta and Petræa, as also in the northern half of Arabia Felix.

1. We cannot adopt the opinion of Von Bohlen and Dozy that Abram is a mythical person. He must be regarded as a historical character, though the accounts of his life have mythical elements intermingled with much that is traditional or legendary. The difficulty of separating the historic from the merely traditional, hinders the presentation of a natural portrait. Later legends have invested him with extraordinary excellence. They have made him a worshipper of Jehovah, a prophet, the friend of God, favoured with visible manifestations of His presence, and receiving repeated promises of the most far-reaching character. He is the typical ancestor of the chosen race, living under the constant guidance of God, prospering in worldly goods, delivered from imminent perils. A superhuman halo surrounds him. It is the Jehovist in particular who invests him with the marvellous and improbable, connecting him with altars and sacrifices—a cultus posterior to both his time and mental development—making him the subject of theophanies, talking familiarly to Jehovah himself, and feeding angels with flesh. The Elohist's descriptions are simpler. His patriarchs are usually colourless men, upright and plain. They have neither characteristic features nor distinct outline. Abram stands out an honest, peaceable, generous, high-minded patriarch; a prince, rich, powerful, and honoured, fitted for rule, and exercising it with prudence. We need not expect a full history of the man from writers long posterior, the representatives of popular traditions. Only fragments of the life are given, designed to show his greatness. Legend assigned ideal lineaments to the progenitor whom a remote antiquity shrouded with its hoary mantle, and thus he became a model worthy of imitation.

2. The biblical sources of his biography are three at least; and sometimes all appear in a single chapter, as in Gen. xxii., which describes the severest trial of faith. The oldest or Elohim-document is seen in verses 20–24, which link on to chap. xxi. 2–5, from the same. The rest of the chapter belongs to the junior Elohist, except verses 14–18, added by the Jehovist to connect Abram's sacrifice with Jerusalem. These different documents, out of which the general narrative was finally put together by a redactor, create diversities and contradictions. Thus the Elohist makes Abram laugh at the announcement of a son by Sarai (xvii. 17); the Jehovist, jealous for the patriarch's honour, assigns the laughter to the woman as a sign of incredulity (xviii. 12).

3. The account of the change of names given to Abram and Sarai when circumcision was instituted, cannot be regarded as historical. The Elohist says that *Abram* became *Abraham*, the latter meaning *father of much people.* But the Hebrew tongue has no word *rahâm*, and no root with the three letters רהם. Hence the Jews found the etymology a puzzle.[1] The old reading was undoubtedly *Abram* and *Sarai*, though the later Jews expressly forbade *Abram* either in speaking or writing. The difference is one of mere orthography. The forms רהם and רום are cognate ones, as are שרי and שרה. The etymologising propensity of the Elohist is well known. The names signify *father of height* and *princess* respectively.

4. The religion of Abram was not pure Jehovism. According to Exodus vi. 3, the name Jehovah was unknown before Moses. Pure Jehovism was a growth not reached

[1] See Beer's *Leben Abraham's*, pp. 150, 151.

before the prophets. It was a late development, the creed of the most spiritual teachers, not of the people generally. Abram was a distinguished Oriental sheikh, who laid aside the grossness of idolatry, and rose by degrees, through contact with many peoples and his own reflection, to the conception of a Being higher than the visible world, the God of the light and the sun. He was a civilised nomad, having wider and more spiritual aspirations than the peoples with whom he lived. As a worshipper of God, his faith was magnified by later ages throwing back their more advanced ideas into his time, because he was the founder of a favoured race, the type of Israel as they were or should be.

5. The leading idea forming the essence of the story respecting Abram's sacrifice of Isaac, presents some difficulty of explanation. The chapter did not proceed from the earliest writer, but from one acquainted with the institution of animal sacrifices. That the patriarch was familiar with human sacrifices among the peoples round about is beyond a doubt. Was he tempted from within to comply, on one occasion, with the prevailing custom; or did the disaffected Canaanites call upon him to give such proof of devotion to his God? Perhaps there was a struggle in his mind between the better ideas which led to the habitual renunciation of the barbarous rite, and scruples of the universal impropriety attaching to it. The persuasion that it could never be allowed may have been shaken at times. The general purport of the narrative is to place in a strong light the faith of one prepared to make the most costly sacrifice in obedience to the divine command, as well as God's aversion to human offerings.

6. It is impossible to get chronological exactness in Abram's biography, because it is composed of different traditions incorporated with one another, the product of different times, and all passing through the hands of a later redactor for whom the true succession of events was not of primary importance. The writers themselves did not know the accurate chronology, having to do with legends as well as facts impregnated with the legendary, which the redactor afterwards altered or adapted. The Elohist is much more chronological than the other writers. It is even impossible to tell the time when Abram lived. According to Lepsius, he entered Palestine 1700–1730 B.C.; according to Bunsen, 2886; while Schenkel gives 2130–2140 B.C. In Beer's *Leben Abraham's* his birth is given 1948 A.M., *i.e.*, 2040 B.C.

7. The Midrashim contain a good deal about Abram which is either founded on biblical accounts or spun out of the fancy. Nimrod was king of Babylon at the time. The patriarch's early announcement of the doctrine of one God, his zeal in destroying idols, including those worshipped by his father, his miraculous escape from Nimrod's wrath, his persuading Terah to leave the king's service and go with him to Canaan, are minutely told. During his life he had no fewer than ten temptations. Satan tried to ruin him, after the fiend had appeared at the great feast given when Isaac was weaned, in the form of a poor bent old man, who had been neglected. We can only refer to one specimen of rabbinic dialogue-making. God appeared to Abram by night, saying to him, "Take thy son"—(Abram interrupting), "Which? I have two of them." The voice of God—"Him who is esteemed by you as your only son." Abram—"Each of them is the only son of his mother." God's voice—"Him whom thou lovest." Abram—"I love both." God's voice—"Him whom thou especially lovest." Abram—"I cherish my children with like love." God's voice—"Now, then, take Isaac." Abram—"And what shall I begin with in him?" God's voice—"Go to the land where at my call mountains will rise up out of valleys . . . . . to Moriah, and offer thy son Isaac as a holocaust." Abram—"Is it a sacrifice I shall offer, Lord? Where is the priest to prepare it?" "Be thou invested with that dignity as Shem was formerly." Abram—"But that land counts several mountains, which shall I ascend?" "The top of the mountain where thou shalt see my glory veiled in the clouds," &c. (Beer, pp. 59, 60.)

The Arabic legends about Ibrahim are mostly taken from the Jewish fountain, very few being independent and pre-Islamite. Mohammed collected all that were current, and presented them in forms best suited to his purpose. His sources were the biblical accounts and later Jewish legends. Those about the patriarch building the Kaaba along with Ishmael, his giving this son the house and all the country in which it was, his going as a pilgrim to Mecca every year, seeing Ishmael, and then returning to his own land, Syria, his foot-print on the black stone of the temple, and similar stories, are of genuine Arabic origin. The rest are Jewish, with certain alterations. The collected narratives of the Arabic historians are given by Tabari, constituting a confused mass of legends drawn from the Old Testament, the Koran, and the Rabbins. (See Ewald's *Geschichte des Volkes Israel*, vol. i. pp. 440–484, third edition; Bertheau's *Zur Geschichte der Israeliten*, p. 206, *et seq.*; Tuch's *Kommentar ueber die Genesis*, 1838; Knobel's *Die Genesis*, 1852; Dozy's *Die Israeliten zu Mekka*, p. 16, *et seq.*; B. Beer's *Leben Abraham's nach Auffassung der jüdischen Sage*, 1859; *Chronique d'Abou Djafar Mohammed Tabari*, par L. Dubeux, tome premier, chapters 47–60; Chwolson's *Ssabier und der Ssabismus*, vol. ii.) (S. D.)

ABRAHAM-A-SANCTA-CLARA, was born at Krähenheimstetten, a village in Suabia, on the 4th of June 1642. His family name was Ulrich Megerle. In 1662 he joined the order of Barefooted Augustinians, and assumed the name by which alone he is now known. In this order he rose step by step until he became prior provincialis and definitor of his province. Having early gained a great reputation f r pulpit eloquence, he was appointed court preacher at Vienna in 1669. There the people flocked in crowds to hear him, attracted by the force and homeliness of his language, the grotesqueness of his humour, and the impartial severity with which he lashed the follies of all classes of society. The vices of courtiers and court-life in particular were exposed with an admirable intrepidity. In general he spoke as a man of the people in the language of the people, the predominating quality of his style, which was altogether unique, being an overflowing and often coarse wit. There are, however, many passages in his sermons in which he rises to loftier thought, and uses more refined and dignified language. He died at Vienna on the 1st December 1709. In his published writings Abraham-a-Sancta-Clara displayed much the same qualities as in the pulpit. Perhaps the most favourable specimen of his style is furnished in *Judas der Erzschelm*. His works have been several times reproduced in whole or part, though with many spurious interpolations, within the last thirty years, and have been very extensively read by both Protestants and Catholics. A selection was issued at Heilbronn in 1845, and a complete edition in 21 vols. appeared at Passau and Lindau, in 1835–54.

ABRANTES, a town of Portugal, Estremadura province, on the Tagus, about 70 miles N.E. of Lisbon, delightfully situated on the brow of a hill, of which the slopes are covered with olive trees, gardens, and vineyards. It has considerable trade with Lisbon, particularly in fruit, corn, and oil. The town is strongly fortified, and is an important military position. At the convention of Cintra it was surrendered to the British. Junot derived from it his title of Duke of Abrantes. Population about 6000.

ABRANTES, DUKE AND DUCHESS OF. See JUNOT.

ABRAXAS, or ABRASAX, a word engraved on certain antique stones, which were called on that account *Abraxas stones*, and were used as amulets or charms. The Basilidians, a Gnostic sect, attached importance to the word, if, indeed, they did not bring it into use. The letters of ἀβραξάς, in the Greek notation, make up the number 365, and the Basilidians gave the name to the 365 orders of spirits, which, as they conceived, emanated in succession from the Supreme Being. These orders were supposed to occupy as many heavens, each fashioned like, but inferior to that above it; and the lowest of the heavens was thought to be the abode of the spirits who formed the earth and its inhabitants, and to whom was committed the administration of its affairs. The Abraxas stones, which are frequently to be met with in the cabinets of the curious, are of very little value. In addition to the word *Abraxas* and other mystical characters, they have often engraved on them cabalistic figures. The commonest of these have the head of a fowl, and the arms and bust of a man, and terminate in the body and tail of a serpent.

ABRUZZO, originally one of the four provinces of the continental part of the kingdom of the two Sicilies, afterward subdivided into Abruzzo Ulteriore I., Abruzzo Ulteriore II., and Abruzzo Citeriore, which were so named from their position relative to Naples, and now form three of the provinces of the kingdom of Italy. The district, which was the most northerly part of the kingdom of the two Sicilies, is bounded by the Adriatic on the E., and by the provinces of Ascoli Piceno on the N., Umbria and Rome on the W., and Terra di Lavoro, Molise, and Capitanata on the S. The Abruzzi provinces have an area of nearly 4900 English square miles, and extend from N. lat. 41°40′ to 42°55′. Though presenting to the Adriatic a coast of about 80 miles in length, they have not a single good port. This territory is mostly rugged, mountainous, and covered with extensive forests, but contains also many fertile and well-watered valleys. The Apennines traverse its whole extent, running generally from N.W. to S.E., and here attaining their greatest elevation. Near Aquila is Monte Corno, the loftiest peak of that chain, called *Il gran Sasso d'Italia*, or the great rock of Italy, which rises to the height of 9813 feet. Monte Majella and Monte Velino attain the height of 9500 and 8792 feet respectively. From the main range of the Apennines a number of smaller branches run off towards the west. The country is watered by numerous small rivers, most of which fall into the Adriatic. They are often suddenly swollen by the rains, especially in the spring, and thus cause considerable damage to the lands through which they pass. The principal rivers are the Tronto, Trentino, Pescara, and Sangro. In Abruzzo Ulteriore II. is lake Celano or Lago di Fucino, the *Lacus Fucinus* of the Romans, now reduced to about one-third of its former extent. The climate varies with the elevation, but, generally speaking, is temperate and healthy. Agriculture is but little understood or attended to, although in many of the lower parts of the country the land is fertile. The rivers are not embanked, nor is irrigation practised; so that the best of the land is frequently flooded during the rainy season, and parched in the heat of summer. The principal productions are corn, hemp, flax, almonds, olives, figs, grapes, and chestnuts. In the neighbourhood of Aquila saffron is extensively cultivated, although not to such an extent as formerly. The rearing and tending of sheep is the chief occupation of the inhabitants of the highlands; and the wool, which is of a superior quality, is an important article of commerce, while the skins are sent in large quantities to the Levant. Bears, wolves, and wild boars inhabit the mountain fastnesses; and in the extensive oak forests numerous herds of swine are fed, the hams of which are in high repute. The manufactures are very inconsiderable, being chiefly woollen, linen, and silk stuffs, and earthen and wood wares. Abruzzo was of great importance to the kingdom of Naples, being its chief defence to the north, and presenting almost insurmountable difficulties to the advance of an enemy. The country is now free of the daring brigands by whom it was long infested. The inhabitants are a stout, well-built, brave, and industrious race. Their houses are generally miserable huts; their food principally maize, and their drink bad wine. The railway from Ancona to Brindisi passes through Abruzzo Ulteriore I. and Abruzzo Citeriore, skirting the coast; and a line has been projected from Pescara, by Popoli, the Lago di Fucino, and the valley of the Liris, to join the railway from Rome to Naples, and thus open up the interior of the country. The line is open for traffic between Pescara and Popoli.

ABRUZZO ULTERIORE I. is the most northerly of the three provinces, and has an area of 1283 square miles, with a population in 1871 of 245,684. The western part of the province is very mountainous, the highest crest of the Apennines dividing it from Abruzzo Ulteriore II. The valleys possess a rich soil, well watered by rivulets and brooks in the winter and spring, but these are generally dried up in the summer months. The streams run mostly into the Pescara, which bounds the province towards Abruzzo Citeriore, or into the Tronto, which is the northern boundary. The city of Teramo is the capital of the province.

ABRUZZO ULTERIORE II. is an inland district, nearly covered with mountains of various heights, one of which is the *Gran Sasso*. There are no plains; but among the mountains are some beautiful and fruitful valleys, watered by the various streams that run through them. None of the rivers are navigable. The province has an area of 2510 square miles, and in 1871 contained 332,782 inhabitants. Its chief town is Aquila.

ABRUZZO CITERIORE lies to the south and east of the other two provinces. It is the least hilly of the three, but the Apennines extend through the south-west part. They, however, gradually decline in height, and stretch away into plains of sand and pebbles. The rivers all run to the Adriatic, and are very low during the summer months. The soil is not very productive, and agriculture is in a very backward state; the inhabitants prefer the chase and fishing. The province contains 1104 square miles, with a population of 340,299 in 1871. Its chief town is Chieti.

ABSALOM (אַבְשָׁלוֹם, *father of peace*), the third son of David, king of Israel. He was deemed the handsomest man in the kingdom. His sister Tamar having been violated by Amnon, David's eldest son, Absalom caused his servants to murder Amnon at a feast, to which he had invited all the king's sons. After this deed he fled to the kingdom of his maternal grandfather, where he remained three years; and it was not till two years after his return that he was fully reinstated in his father's favour. Absalom seems to have been by this time the eldest surviving son of David, but he was not the destined heir of his father's throne. The suspicion of this excited the impulsive Absalom to rebellion. For a time the tide of public opinion ran so strong in his favour, that David found it expedient to retire beyond the Jordan. But, instead of adopting the prompt measures which his sagacious counsellor Ahithophel advised, Absalom loitered at Jerusalem till a large force was raised against him, and when he took the field his army was completely routed. The battle was fought in the forest of Ephraim; and Absalom, caught in

the boughs of a tree by the superb hair in which he gloried, was run through the body by Joab. The king's grief for his worthless son vented itself in the touching lamentation —"O my son Absalom, my son, my son Absalom! would God I had died for thee, O Absalom, my son, my son!"

ABSALON, Archbishop of Lund, in Denmark, was born in 1128, near Soroe in Zealand, his family name being Axel. In 1148 he went to study at Paris, where a college for Danes had been established. He afterwards travelled extensively in different countries; and returning to Denmark in 1157, was the year after chosen Bishop of Roeskilde or Rothschild. Eloquent, learned, endowed with uncommon physical strength, and possessing the confidence of the king, Waldemar I., known as the Great, Absalon held a position of great influence both in the church and state. In that age warlike pursuits were not deemed inconsistent with the clerical office, and Absalon was a renowned warrior by sea and land, as well as a zealous ecclesiastic, his avowed principle being that "both swords, the spiritual and the temporal, were entrusted to the clergy." To his exertions as statesman and soldier Waldemar was largely indebted for the independence and consolidation of his kingdom. In 1177 he was chosen by the chapter Archbishop of Lund and Primate of the church, but he declared himself unwilling to accept the appointment; and when an attempt was made to install him by force, he resisted, and appealed to Rome. The Pope decided that the choice of the chapter must be respected, and commanded Absalon to accept the Primacy on pain of excommunication. He was consecrated accordingly by the papal legate Galandius in 1178. He set the Cistercian monks of Soroe the task of preparing a history of the country, the most valuable result being the *Danish Chronicle* of Saxo Grammaticus, who was secretary to Absalon and his companion in an expedition against the Wendish pirates. A tower or castle which the archbishop caused to be built as a defence against these pirates, was the commencement of the present capital, Copenhagen, which from this circumstance is sometimes known in history as Axelstadt. The archbishop died in 1201, in the monastery at Soroe, and was buried in the parish church, where his grave may still be seen.

ABSCESS, in *Surgery* (from *abscedo*, to separate), a collection of pus among the tissues of the body, the result of inflammation. Abscesses are divided into acute and chronic. See SURGERY.

ABSINTHE, a liqueur or aromatised spirit, prepared by pounding the leaves and flowering tops of various species of wormwood, chiefly *Artemisia Absinthium*, along with angelica root (*Archangelica officinalis*), sweet flag root (*Acorus Calamus*), the leaves of dittany of Crete (*Origanum Dictamnus*), star-anise fruit (*Illicium anisatum*), and other aromatics, and macerating these in alcohol. After soaking for about eight days the compound is distilled, yielding an emerald-coloured liquor, to which a proportion of an essential-oil, usually that of anise, is added. The liqueur thus prepared constitutes the genuine *Extrait d'Absinthe* of the French; but much of an inferior quality is made with other herbs and essential oils, while the adulterations practised in the manufacture of absinthe are very numerous and deleterious. In the adulterated liqueur the green colour is usually produced by turmeric and indigo, but the presence of even cupric sulphate (blue vitriol) as a colouring ingredient has been frequently detected. In commerce two varieties of absinthe are recognised—common and Swiss absinthe—the latter of which is prepared with highly concentrated spirit; and when really of Swiss manufacture, is of most trustworthy quality as regards the herbs used in its preparation. The chief seat of the manufacture is in the canton of Neufchâtel in Switzerland, although absinthe distilleries are scattered generally throughout Switzerland and France. The liqueur is chiefly consumed in France, but there is also a considerable export trade to the United States of America. In addition to the quantity distilled for home consumption in France, the amount imported from Switzerland in recent years has not been less than 2,000,000 gallons yearly. The introduction of this beverage into general use in France is curious. During the Algerian war (1844–47) the soldiers were advised to mix absinthe with their wine as a febrifuge. On their return they brought with them the habit of drinking it, which is now so widely disseminated in French society, and with such disastrous consequences, that the custom is justly esteemed a grave national evil. A French physician, M. Legrand, who has studied the physiological effects of absinthe drinking, distinguishes two trains of results according as the victim indulges in violent excesses of drinking or only in continuous steady tippling. In the case of excessive drinkers there is first the feeling of exaltation peculiar to a state of intoxication. The increasing dose necessary to produce this state quickly deranges the digestive organs, and destroys the appetite. An unappeasable thirst takes possession of the victim, with giddiness, tingling in the ears, and hallucinations of sight and hearing, followed by a constant mental oppression and anxiety, loss of brain power, and, eventually, idiocy. The symptoms in the case of the tippler commence with muscular quiverings and decrease of physical strength; the hair begins to drop off, the face assumes a melancholy aspect, and he becomes emaciated, wrinkled, and sallow. Lesion of the brain follows, horrible dreams and delusions haunt the victim, and gradually paralysis overtakes him and lands him in his grave. It has been denied by a French authority, M. Moreau, that these symptoms are due to wormwood or any of the essential oils contained in absinthe, and he maintains that the strong spirit and such adulterations as salts of copper are sufficient to account for the effects of the liqueur. There is, however, no doubt that proportionately the consumption of absinthe is much more deleterious to the human frame than the drinking of brandy or other strong spirits. The use of absinthe has been prohibited in both the army and navy of France.

ABSOLUTE (from the Latin *absolvere*), having the general meaning of *loosened from*, or *unrestricted*, in which sense it is popularly used to qualify such words as "monarchy" or "power," has been variously employed in philosophy. Logicians use it to mark certain classes of names. Thus a term has been called absolute in opposition to *attributive*, when it signifies something that has or is viewed as having independent existence; most commonly, however, the opposition conveyed is to *relative*. A relative name being taken as one which, over and above the object which it denotes, implies in its signification the existence of another object, also deriving a denomination from the same fact, which is the ground of the first name (Mill), as, *e.g.*, father and son, the non-relative or absolute name is one that has its meaning for and in itself, as man. This distinction is a convenient one, although, as has been observed, it can hardly in perfect strictness be maintained. The so-called absolute name, if used with a meaning, does always stand in some relation, however variable or indefinite, and the meaning varies with the relation. Thus man, which is a word of very different meanings, as, *e.g.*, not woman, not boy, not master, not brute, and so forth, may be said to have them according to the different relations in which it admits of being viewed, or, as it has been otherwise expressed, according to the different notions whose "universe" it composes, along with its different correlatives. From this point of view there is always one relation in which a real thing must stand, namely, the

relation to its contradictory (as not man) within the universe of being; the correlatives, under less general notions, being then generally expressed positively as contraries (woman, boy, master, brute, and so forth, for man). If there is thus no name or notion that can strictly be called absolute, all knowledge may be said to be relative, or of the relative. But the knowledge of an absolute has also been held impossible, on the ground that knowing is itself a relation between a subject and an object; what is known only in relation to a mind cannot be known as absolute. This doctrine, now commonly spoken of under the name of the Relativity of Knowledge, may, indeed, be brought under the former view, in which subject-object marks the relation of highest philosophical significance within the whole universe of things. Keeping, however, the two views apart, we may say with double force that of the absolute there is no knowledge,—(1), because, to be known, a thing must be consciously discriminated from other things; and (2), because it can be known only in relation with a knowing mind. Notwithstanding, there have been thinkers from the earliest times, who, in different ways, and more or less explicitly, allow of no such restriction upon knowledge, or at least consciousness, but, on the contrary, starting from a notion, by the latter among them called the absolute, which includes within it the opposition of subject and object, pass therefrom to the explanation of all the phenomena of nature and of mind. In earlier days the Eleatics, Plato, and Plotinus, in modern times Spinoza, Leibnitz, Fichte, Schelling, Hegel, and Cousin, all have joined, under whatever different forms, in maintaining this view. Kant, while denying the absolute or unconditioned as an object of knowledge, leaves it conceivable, as an idea regulative of the mind's intellectual experience. It is against any such absolute, whether as real or conceivable, that Hamilton and Mansel have taken ground, the former in his famous review of Cousin's philosophy, reprinted in his *Discussions*, the latter in his Bampton Lectures on *The Limits of Religious Thought*, basing their arguments indifferently on the positions as to the Relativity of Knowledge indicated above. For absolute in its more strictly metaphysical use, see METAPHYSICS. (G. C. R.)

ABSOLUTION, a term used in civil and ecclesiastical law, denotes the act of setting free or acquitting. In a criminal process it signifies the acquittal of an accused person on the ground that the evidence has either disproved or failed to prove the charge brought against him. It is now little used except in Scotch law, in the forms *assoilzie* and *absolvitor*. The ecclesiastical usage of the word is essentially different from the civil. It refers to sin actually committed, and denotes the setting of a person free from its guilt, or from its penal consequences, or from both. It is invariably connected with penitence, and some form of confession, the Scripture authority, to which the Roman Catholics, the Greek Church, and Protestants equally appeal, being found in John xx. 23, James v. 16, &c. In the primitive church the injunction of James was literally obeyed, and confession was made before the whole congregation, whose presence and concurrence were reckoned necessary to the validity of the absolution pronounced by the presbyter. In the 4th century the bishops began to exercise the power of absolution in their own right, without recognising the congregations. In consequence of this the practice of private confession (*confessio auricularis*) was established, and became more and more common, until it was rendered imperative once a year by a decree of the fourth Lateran Council (1215). A distinction, indeed, was made for a time between *peccata venialia*, which might be confessed to a layman, and *peccata mortalia*, which could only be confessed to a priest; but this was ultimately abolished, and the Roman Canon Law now stands, *Nec venialia nec mortalia possumus confiteri sacramentaliter, nisi sacerdoti.* A change in the form of absolution was almost a logical sequence of the change in the nature of the confession. At first the priest acted ministerially as an intercessory, using the *formula absolutionis precativa* or *deprecativa*, which consisted of the words: *Dominus absolvat te—Misereatur tui omnipotens Deus et dimittat tibi omnia peccata tua.* This is still the only form in the Greek Church, and it finds a place in the Roman Catholic service, though it is no longer used in the act of absolution. The Romish form was altered in the 13th century, and the Council of Trent decreed the use of the *formula absolutionis indicativa*, where the priest acts judicially, as himself possessed of the power of binding and loosing, and says, *Ego absolvo te.* Where a form of absolution is used in Protestant Churches, it is simply declarative, the state being only indicated, and in no sense or degree assumed to be caused by the declaration.

ABSORPTION, in the animal economy, the function possessed by the absorbent system of vessels of taking up nutritive and other fluids. See PHYSIOLOGY.

ABSTEMII, a name formerly given to such persons as could not partake of the cup of the eucharist on account of their natural aversion to wine. Calvinists allowed these to communicate in the species of bread only, touching the cup with their lip; which was by the Lutherans deemed a profanation. Among several Protestant sects, both in Great Britain and America, *abstemii* on a somewhat different principle have recently appeared. These are total abstainers, who maintain that the use of stimulants is essentially sinful, and allege that the wine used by Christ and his disciples at the supper was unfermented. They accordingly communicate in the unfermented "juice of the grape." The difference of opinion on this point has led to a good deal of controversy in many congregations, the solution generally arrived at being to allow both wine and the pure juice of the grape to be served at the communion table.

ABSTRACTION, in *Psychology* and *Logic*, is a word used in several distinguishable but closely allied senses. First, in a comprehensive sense, it is often applied to that process by which we fix the attention upon one part of what is present to the mind, to the exclusion of another part; abstraction thus conceived being merely the negative of ATTENTION (*q. v.*) In this sense we are able in thought to *abstract* one object from another, or an attribute from an object, or an attribute perceived by one sense from those perceived by other senses. Even in cases when thoughts or images have become inseparably associated, we possess something of this power of abstracting or turning the attention upon one rather than another. Secondly, the word is used, with a more special signification, to describe that concentration of attention upon the resemblances of a number of objects, which constitutes classification. And thirdly, not to mention other less important changes of meaning, the whole process of generalisation, by which the mind forms the notions expressed by common terms, is frequently, through a curious transposition of names, spoken of as abstraction. Especially when understood in its less comprehensive connection, the process of abstraction possesses a peculiar interest. To the psychologist it is interesting, because there is nothing he is more desirous to understand than the mode of formation and true nature of what are called general notions. And fortunately, with regard to the abstractive process by which these are formed, at least in its initial stages, there is little disagreement; since every one describes it as a process of comparison, by which the mind is enabled to consider the objects confusedly pre-

sented to it in intuition, to recognise and attend exclusively to their points of agreement, and so to classify them in accordance with their perceived resemblances. Further, this process is admitted without much dispute to belong to the discursive or elaborative action of the intellect; although, perhaps — should the view of some modern psychologists be correct, that all intelligence proceeds by the establishment of relations of *likeness* and *unlikeness* —abstraction will be better conceived as thus related to intelligence in general and typical of all its processes, than as the action merely of a special and somewhat indefinite faculty. No such harmony, however, exists regarding the nature of the *product* of abstraction; for that is the subject-matter of Nominalism and Realism, which has produced more controversy, and stimulated to more subtlety of thought, than any other subject ever debated in philosophy. The concept or abstract idea has been represented in a multitude of ways: sometimes as an idea possessing an objective existence independent of particulars, even more real and permanent than theirs; sometimes as an idea composed of all the circumstances in which the particulars agree, and of no others; again, as the idea of an individual, retaining its individualising qualities, but with the accompanying knowledge that these are not the properties of the class; and yet again, as the idea of a miscellaneous assemblage of individuals belonging to a class. It is still impossible to say that the many-sided controversy is at an end. The only conclusion generally admitted seems to be, that there exists between the concept and the particular objects of intuition some very intimate relation of thought, so that it is necessary, for all purposes of reasoning, that the general and particular go hand in hand, that the idea of the class—if such exists —be capable of being applied, in every completed act of thought, to the objects comprised within the class.

To the student of ontology, also, abstraction is of special interest, since, according to many distinguished thinkers, the recognition of abstraction as a powerful and universal mental process is to explain all ontology away, and give the ontologist his eternal quietus. The thorough-going nominalist professes to discover in the mind an inveterate tendency to abstraction, and a proneness to ascribe separate existence to abstractions, amply sufficient to account for all those forms of independent reality which metaphysics defend, and to exhibit them all in their true colours as fictitious assumptions. In reply, the ontologist, strengthened by the instinct of self-preservation, commonly contends that the analogy between general notions and metaphysical principles does not hold good, and that the latter are always more than simple abstractions or mere names. Only after abstraction is understood can the question be settled.

In like manner to logic, whether regarded as the science of the formal laws of thought, or, more widely, as the science of scientific methods, a true understanding of abstraction is of the greatest importance. It is important in pure logic, because, as we have seen, every act of judgment and reasoning postulates a concept or concepts, and so presupposes abstraction. Abstraction, determining the possibility alike of reason and speech, creates those notions that bear common names; it is indispensable to the formation of classes, great or small; and just according as it ascends, increasing the extension and diminishing the intension of classes, the horizon visible to reason and to logic gradually recedes and widens. And to logic as the science of the sciences a true doctrine of abstraction is not less necessary; because the process of extending knowledge is, in all its developments, essentially the same as the first rudimentary effort to form a concept and think of particulars as members of a class: a "natural law," at least in its subjective aspect, is invariably an abstraction made by comparing phenomena—an abstraction under which phenomena are classed in order to the extension of knowledge, just as under a concept are grouped the particulars presented in intuition. As proof of this identity it is found that the same differences exist regarding the objective or subjective nature of the "natural law" as regarding that of the concept. Some affirm that the law is brought ready-made by the mind and superinduced on the facts; others, that it is never in any sense more than a mere mental conception, got by observing the facts; while there are yet others who maintain it to be such a subjective conception, but one corresponding at the same time to an external relation which is real though unknowable.

ABSURDUM, Reductio ad, a mode of demonstrating the truth of a proposition, by showing that its contradictory leads to an absurdity. It is much employed by Euclid.

ABU, a celebrated mountain of Western India, between 5000 and 6000 feet in height, situated in 24° 40′ N. lat., and 72° 48′ E. long., within the Rájputáná State of Sirohí. It is celebrated as the site of the most ancient Jain temples in India, and attracts pilgrims from all parts of the country. The Jains are the modern Indian representatives of the Buddhists, and profess the ancient theistic doctrines of that sect, modified by saint worship and incarnations. The elevations and platforms of the mountain are covered with elaborately sculptured shrines, temples, and tombs. On the top of the hill is a small round platform containing a cavern, with a block of granite, bearing the impression of the feet of Dátá-Bhrigu, an incarnation of Vishnu. This is the chief great place of pilgrimage for the Jains, Shrawaks, and Banians. The two principal temples are situated at Deulwárá, about the middle of the mountain, and five miles south-west of Guru Sikrá, the highest summit. They are built of white marble, and are pre-eminent alike for their beauty and as typical specimens of Jain architecture in India. The following description is condensed from Mr Fergusson's *History of Architecture*, vol. ii. pp. 623 to 625:—The more modern of the two was built by two brothers, rich merchants, between the years 1197 and 1247, and for delicacy of carving and minute beauty of detail stands almost unrivalled, even in this land of patient and lavish labour. The other was built by another merchant prince, Bimalá Sháh, apparently about 1032 A.D., and although simpler and bolder in style, is as elaborate as good taste would allow in a purely architectural object. It is one of the oldest as well as one of the most complete examples of Jain architecture known. The principal object within the temple is a cell lighted only from the door, containing a cross-legged seated figure of the god Paresnáth. The portico is composed of forty-eight pillars, the whole enclosed in an oblong court-yard about 140 feet by 90 feet, surrounded by a double colonnade of smaller pillars, forming porticos to a range of fifty-five cells, which enclose it on all sides, exactly as they do in a Buddhist monastery (*vihára*). In this temple, however, each cell, instead of being the residence of a monk, is occupied by an image of Paresnáth, and over the door, or on the jambs of each, are sculptured scenes from the life of the deity. The whole interior is magnificently ornamented. The Emperor Akbar, by a farmán dated in the month of Rabi-ul-ául, in the 37th year of his reign, corresponding with 1593, made a grant of the hill and temples of Abu, as well as of the other hills and places of Jain pilgrimage in the empire, to Harbijai Sur, a celebrated preceptor of the Setámbarí sect of the Jain religion. He also prohibited the slaughter of animals at these places. The farmán of this enlightened monarch declared that "it is the rule of the worshippers of God to preserve all religions."

ABU-BEKR (*father of the virgin*), was originally called Abd-el-Caaba (*servant of the temple*), and received the name by which he is known historically in consequence of the marriage of his virgin daughter Ayesha to Mohammed. He was born at Mecca in the year 573 A.D., a Koreishite of the tribe of Benn-Taim. Possessed of immense wealth, which he had himself acquired in commerce, and held in high esteem as a judge, an interpreter of dreams, and a depositary of the traditions of his race, his early accession to Islamism was a fact of great importance. On his conversion he assumed the name of Abd-Alla (*servant of God*). His own belief in Mohammed and his doctrines was so thorough as to procure for him the title El Siddik (*the faithful*), and his success in gaining converts was correspondingly great. In his personal relationship to the prophet he showed the deepest veneration and most unswerving devotion. When Mohammed fled from Mecca, Abu-Bekr was his sole companion, and shared both his hardships and his triumphs, remaining constantly with him until the day of his death. During his last illness the prophet indicated Abu-Bekr as his successor, by desiring him to offer up prayer for the people. The choice was ratified by the chiefs of the army, and ultimately confirmed, though Ali, Mohammed's son-in-law, disputed it, asserting his own title to the dignity. After a time Ali submitted, but the difference of opinion as to his claims gave rise to a controversy which still divides the followers of the prophet into the rival factions of Sunnites and Shiites. Abu-Bekr had scarcely assumed his new position under the title Khalifet-Resul-Allah (*successor of the prophet of God*), when he was called to suppress the revolt of the tribes Hedjaz and Nedjd, of which the former rejected Islamism, and the latter refused to pay tribute. He encountered formidable opposition from different quarters, but in every case he was successful, the severest struggle being that with the impostor Mosailima, who was finally defeated by Khaled at the battle of Akraba. Abu-Bekr's zeal for the spread of the new faith was as conspicuous as that of its founder had been. When the internal disorders had been repressed and Arabia completely subdued, he directed his generals to foreign conquest. The Irak of Persia was overcome by Khaled in a single campaign, and there was also a successful expedition into Syria. After the hard-won victory over Mosailima, Omar, fearing that the sayings of the prophet would be entirely forgotten when those who had listened to them had all been removed by death, induced Abu-Bekr to see to their preservation in a written form. The record, when completed, was deposited with Hafsu, daughter of Omar, and one of the wives of Mohammed. It was held in great reverence by all Moslems, though it did not possess canonical authority, and furnished most of the materials out of which the Koran, as it now exists, was prepared. When the authoritative version was completed, all copies of Hafsu's record were destroyed, in order to prevent possible disputes and divisions. Abu-Bekr died on the 23d of August 634, having reigned as Khalif fully two years. Shortly before his death, which one tradition ascribes to poison, another to natural causes, he indicated Omar as his successor, after the manner Mohammed had observed in his own case.

ABULFARAGIUS, Gregor Abulfaraj (called also Barhebræus, from his Jewish parentage), was born at Malatia, in Armenia, in 1226. His father Aaron was a physician, and Abulfaragius, after studying under him, also practised medicine with great success. His command of the Arabic, Syriac, and Greek languages, and his knowledge of philosophy and theology, gained for him a very high reputation. In 1244 he removed to Antioch, and shortly after to Tripoli, where he was consecrated Bishop of Guba, when only twenty years of age. He was subsequently transferred to the see of Aleppo, and was elected in 1266 *Maphrian* or Primate of the eastern section of the Jacobite Christians. This dignity he held till his death, which occurred at Maragha, in Azerbijan, in 1286. Abulfaragius wrote a large number of works on various subjects, but his fame as an author rests chiefly on his *History of the World*, from the creation to his own day. It was written first in Syriac, and then, after a considerable interval, an abridged version in Arabic was published by the author at the request of friends. The latter is divided into ten sections, each of which contained the account of a separate dynasty. The historic value of the work lies entirely in the portions that treat of eastern nations, especially in those relating to the Saracens, the Tartar Mongols, and the conquests of Genghis Khan. The other sections are full of mistakes, arising partly no doubt from the author's comparative ignorance of classical languages. A Latin translation of the Arabic abridgement was published by Dr Pococke at Oxford in 1663. A portion of the original text, with Latin translation, edited, by no means carefully or accurately, by Bruns and F. W. Kirsch, appeared at Leipsic in 1788.

ABULFAZL, vizier and historiographer of the great Mongol emperor, Akbar, was born about the middle of the 16th century, the precise date being uncertain. His career as a minister of state, brilliant though it was, would probably have been by this time forgotten but for the record he himself has left of it in his celebrated history. The *Akbar Nameh*, or *Book of Akbar*, as Abulfazl's chief literary work is called, consists of two parts,—the first being a complete history of Akbar's reign, and the second, entitled *Ayin-i-Akbari*, or *Institutes of Akbar*, being an account of the religious and political constitution and administration of the empire. The style is singularly elegant, and the contents of the second part possess a unique and lasting interest. An excellent translation of that part by Mr Francis Gladwin was published in Calcutta, 1783–6. It was reprinted in London very inaccurately, and copies of the original edition are now exceedingly rare and correspondingly valuable. Abulfazl died by the hand of an assassin, while returning from a mission to the Deccan in 1602. Some writers say that the murderer was instigated by the heir-apparent, who had become jealous of the minister's influence.

ABULFEDA, Ismael ben-Ali, Emad-eddin, the celebrated Arabian historian and geographer, born at Damascus in the year 672 of the Hegira (1273 A.D.), was directly descended from Ayub, the father of the emperor Saladin. In his boyhood he devoted himself to the study of the Korán and the sciences, but from his twelfth year he was almost constantly engaged in military expeditions, chiefly against the crusaders. In 1285 he was present at the assault of a stronghold of the Knights of St John, and he took part in the sieges of Tripoli, Acre, and Roum. In 1298 the princedom of Hamah and other honours, originally conferred by Saladin upon Omar, passed by inheritance to Abulfeda; but the succession was violently disputed by his two brothers, and the Court availed itself of the opportunity to supersede all the three, and to abolish the principality. The sultan Melik-el-Nassir ultimately (1310) restored the dignity to Abulfeda, with additional honours, as an acknowledgment of his military services against the Tartars and Bibars, the sultan's rival. He received an independent sovereignty, with the right of coining money, &c., and had the title Melik Mowayyad (*victorious prince*) conferred upon him. For twenty years, till his death in October 1331, he reigned in tranquillity and splendour, devoting himself to the duties of government and to the composition of the works to which he is chiefly indebted for his fame. He was a munificent patron

of men of letters, who repaired in large numbers to his court. Abulfeda's chief historical work is *An Abridgement of the History of the Human Race*, in the form of annals, extending from the creation of the world to the year 1328. A great part of it is compiled from the works of previous writers, and it is difficult to determine accurately what is the author's and what is not. Up to the time of the birth of Mohammed, the narrative is very succinct; it becomes more full and valuable the nearer the historian approaches his own day. It is the only source of information on many facts connected with the Saracen empire, and altogether is by far the most important Arabian history we now possess. Various translations of parts of it exist, the earliest being a Latin rendering of the section relating to the Arabian conquests in Sicily, by Dobelius, Arabic professor at Palermo, in 1610. This is preserved in Muratori's *Rerum Italicarum Scriptores*, vol. i. The history from the time of Mohammed was published with a Latin translation by Reiske, under the title *Annales Moslemici* (5 vols., Copenhagen, 1789–94), and a similar edition of the earlier part was published by Fleischer at Leipsic in 1831, under the title *Abulfedæ Historia Ante-Islamitica*. His *Geography* is chiefly valuable in the historical and descriptive parts relating to the Moslem empire. From his necessarily imperfect acquaintance with astronomy, his notation of latitude and longitude, though fuller than that of any geographer who preceded him, can in no case be depended on, and many of the places whose position he gives with the utmost apparent precision cannot be now identified. A complete edition was published by MM. Reinaud and De Slane at Paris in 1840; and Reinaud published a French translation, with notes and illustrations, in 1848. MSS. of both Abulfeda's great works are preserved in the Bodleian Library and in the National Library of France.

ABULGHAZI-BAHADUR (1605–1663), a khan of Khiva, of the race of Genghis-Khan, who, after abdicating in favour of his son, employed his leisure in writing a history of the Mongols and Tartars. He produced a valuable work, which has been translated into German, French, and Russian.

ABUNA, the title given to the archbishop or metropolitan of Abyssinia.

ABUSHEHR. See BUSHIRE.

ABU-SIMBEL, or IPSAMBUL, the ancient *Aboccis* or *Abuncis*, a place in Nubia, on the left bank of the Nile, about 50 miles S.W. of Derr, remarkable for its ancient Egyptian temples and colossal figures hewn out of the solid rock. For a description of these see NUBIA.

ABU-TEMAN, one of the most highly esteemed of Arabian poets, was born at Djacem in the year 190 of the Hegira (806 A.D.) In the little that is told of his life i' is difficult to distinguish between truth and fable. He seems to have lived in Egypt in his youth, and to have been engaged in servile employment, but his rare poetic talent speedily raised him to a distinguished position at the court of the caliphs of Bagdad. Arabian historians assert that a single poem frequently gained for him many thousand pieces of gold, and the rate at which his contemporaries estimated his genius may be understood from the saying, that "no one could ever die whose name had been praised in the verses of Abu-Teman." Besides writing original poetry, he made three collections of select pieces from the poetry of the East, of the most important of which, called *Hamasa*, Sir William Jones speaks highly. Professor Carlyle quoted this collection largely in his *Specimens of Arabic Poetry* (1796). An edition of the text, with Latin translation, was published by Freytag at Bonn (1828–51), and a meritorious translation in German verse by Rückert appeared in 1846. Abu-Teman died 845 A.D.

ABYDOS (1.), in *Ancient Geography*, a city of Mysia, in Asia Minor, situated on the Hellespont, which is here scarcely a mile broad. It probably was originally a Thracian town, but was afterwards colonised by Milesians. Nearly opposite, on the European side of the Hellespont, stood Sestos; and it was here that Xerxes crossed the strait on his celebrated bridge of boats when he invaded Greece. Abydos was celebrated for the vigorous resistance it made when besieged by Philip II. of Macedon; and is famed in story for the loves of Hero and Leander. The old castle of the Dardanelles, built by the Turks, lies a little southward of Sestos and Abydos.

ABYDOS (2.), in *Ancient Geography*, a town of Upper Egypt, a little to the west of the Nile, between Ptolemais and Diospolis Parva, famous for the palace of Memnon and the temple of Osiris. Remains of these two edifices are still in existence. In the temple of Osiris Mr Bankes discovered in 1818 the tablet of Abydos, containing a double series of twenty-six shields of the predecessors of Rameses the Great. This tablet is now deposited in the British Museum.

ABYSSINIA

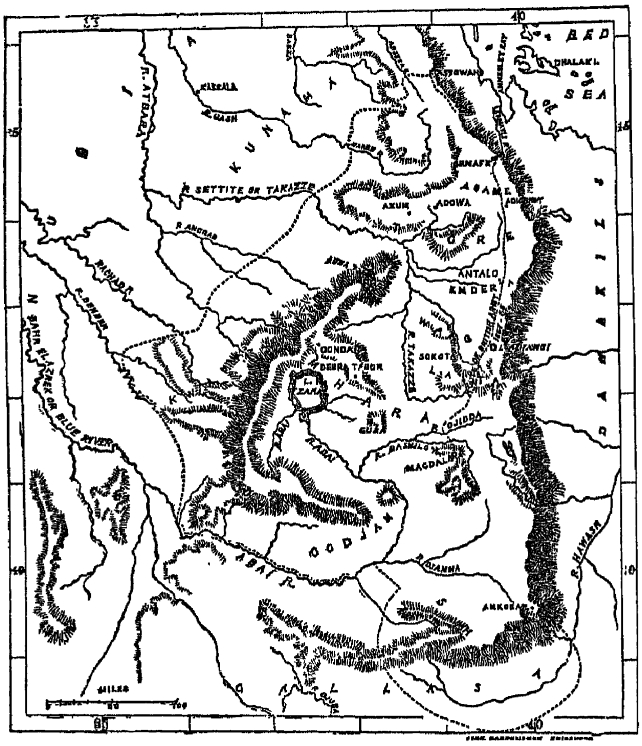
ABYSSINIA is an extensive country of Eastern Africa, the limits of which are not well defined, and authorities are by no means agreed respecting them. It may, however, be regarded as lying between 7° 30′ and 15° 40′ N. lat., and 35° and 40° 30′ E. long., having, N. and N.W., Nubia; E., the territory of the Danakils; S., the country of the Gallas; and W., the regions of the Upper Nile.[1] It has an area of about 200,000 square miles, and a population of from 3,000,000 to 4,000,000.

The name Abyssinia, or more properly Habessinia, is derived from the Arabic word *Habesch*, which signifies mixture or confusion, and was applied to this country by the Arabs on account of the mixed character of the people. This was subsequently Latinised by the Portuguese into *Abassia* and *Abassinos*, and hence the present name. The Abyssinians call themselves *Itiopyavan*, and their country *Itiopia*, or *Manghesta Itiopia*, the kingdom of Ethiopia.

The country of Abyssinia rises rather abruptly from the low arid district on the borders of the Red Sea in lofty ranges of mountains, and slopes away more gradually to the westward, where the tributaries of the Nile have formed numerous deep valleys. It consists for the most part of extensive and elevated table-lands, with mountain ranges extending in different directions, and intersected by numerous valleys. The table-lands are generally from 6000 to 9000 feet above the level of the sea, but in the south there are

[1] It is usual to include in Abyssinia the flat country which lies between it and the Red Sea, and to regard the latter as forming its boundary on the east. This, however, is not strictly correct. Abyssinia proper comprises only the mountainous portion of this territory, the low lying portion being inhabited by distinct and hostile tribes, and claimed by the Viceroy of Egypt as part of his dominions. The low country is very unhealthy, the soil dry and arid, and with few exceptions uncultivated, whereas the highlands are generally salubrious, well watered, and in many parts very fertile. This arid track of country is only a few miles broad at Massowah, in the north, but widens out to 200 or 300 miles at Tajurrah, in the south. It is, in a great measure, owing to Abyssinia being thus cut off from intercourse with the civilised world by this inhospitable region, which has for three centuries been in the hands of enemies, that it is at present so far sunk in ignorance and barbarism.

of considerable extent, which attain a height of more than 10,000 feet. The mountains in various parts of the country rise to 12,000 and 13,000 feet above the sea, and some of the peaks of Samen are said to reach to 15,000 feet, and to be always covered with snow. The average height of the range which divides the streams flowing to the east from those that flow westward is about 8000 feet, rising to 10,000 or 11,000 in the south, and sinking in the north. The whole country presents the appearance of having been broken up and tossed about in a remarkable manner, the mountains assuming wild and fantastic forms, with sides frequently abrupt and precipitous, and only accessible by very difficult passes. The Samen range of mountains are the highest in Abyssinia, and together with the Lamalmon and Lasta mountains form a long but not continuous chain, running from north to south.



Sketch Chart of Abyssinia.

The principal rivers of Abyssinia are tributaries of the Nile. The western portion of the country may be divided into three regions, drained respectively by the Mareb, the Atbara, and the Abai. The most northern of these rivers is the Mareb, which rises in the mountains of Taranta, flows first south, then west, and afterwards turns to the north, where it is at length, after a course of upwards of 500 miles, lost in the sand, but in the rainy season it falls into the Atbara. The Atbara, or Takazza, rises in the mountains of Lasta, and flowing first north, then west, and again turning to the north, at length falls into the Nile, after a course of about 800 miles. The Abai, Bahr-el-Azrek or Blue River, the eastern branch of the Nile, and considered by Bruce to be the main stream of that river, rises from two mountains near Geesh, in lat. 10° 59′ 25″ N., long. 36° 55′ 30″ E., about 10,000 feet above the level of the sea. It flows first north to the Lake of Dembea or Tzana, then takes a long semicircular sweep round the province of Godjam, and afterwards flows northward to about the 15th degree of N. lat., where it unites with the Bahr-el-Abiad, which has now been ascertained to be the true Nile. The Hawash, the principal river of eastern Abyssinia, rises about lat. 9° 30′ N., long. 38° E., and, flowing in a north-easterly direction towards the Red Sea, is lost in Lake Aussa, lat. 11° 25′ N., long. 41° 40′ E. The principal lake of Abyssinia is the Dembea, which lies between 11° 30′ and 12° 30′ N. lat., and 37° and 37° 35′ E. long., being about 60 miles in length by 40 in width, and containing a number of small islands. It is fed by numerous small streams. The lake of Ashangi, in lat. 12° 35′ N., long. 39° 40′ E., is about 4 miles long by 3 broad, and upwards of 8000 feet above the sea.

The fundamental rocks of Tigré, and probably of all Abyssinia, are metamorphic. They compose the mass of the table-land, and while they occupy no inconsiderable portion of its surface, they are exposed, in Tigré at least, in every deep valley. The metamorphics vary greatly in mineral character, "every intermediate grade being found between the most coarsely crystalline granite and a slaty rock so little altered that the lines of the original bedding are still apparent. Perhaps the most prevalent form of rock is a rather finely crystalline gneiss. Hornblende-schist and mica-schist are met with, but neither of the minerals from which they are named appears to be so abundant as in some metamorphic tracts. On the other hand, a compact felspathic rock, approaching felsite in composition, is prevalent in places, as in the Suru defile, between Komayli and Senafé." There are a few exceptions, but as a general rule it may be asserted that in the neighbourhood of the route followed by the British army, so much of the country as is more than 8000 feet above the sea consists of bedded traps, and this is probably the case in general over Abyssinia. "Between the traps and the metamorphics a series of sandstones and limestones intervene, one group of the former underlying the latter. The limestone alone is fossiliferous, and is of Jurassic age." "On the route to Magdala volcanic rocks were first met with at Senafé, where several hills consist of trachyte, passing into claystone and basalt. Trap hills, chiefly of trachyte, are dotted over the country to the southward as far as Fokāda, a distance of nearly 30 miles. Here a great range of bedded traps commences, and extends for about 25 miles to the south, passing to the west of Adigerat." At Meshek, two marches south of Antalo, "the route entered high ranges entirely composed of trap, and thence no other rocks were seen as far as Magdala." "The trappean rocks belong to two distinct and unconformable groups. The lower of these is much inclined, while the higher rests on its upturned and denuded edges." Denudation has evidently been going on to a great extent in this country. One of its most striking features are the deep ravines which have been worked out by the action of the streams, sometimes to the depth of 3000 or 4000 feet. "How much of the Abyssinian highlands has been removed by these great torrents, and spread as an alluvial deposit over the basin of the Nile?" "Probably over the whole of northern Abyssinia there existed at least 4000 feet of bedded traps, of which now only a few vestiges remain."—*W. T. Blanford.*

Abyssinia is said to enjoy "probably as salubrious a climate as any country on the face of the globe."—*Parkyns.* The heat is by no means oppressive, a fine light air counteracting the power of the sun; and during the rainy season, the sky being cloudy, the weather is always agreeable and cool, while the rain itself is not very severe. In certain of the low valleys, however, malarious influences prevail before and after the rainy season, and bring on dangerous fevers. On the higher parts the cold is sometimes intense, particularly at night. The natural division of the seasons is into a cold, a hot, and a rainy season. The cold season may be said to extend from October to February, the hot from the beginning of March to the middle of June, and the wet or monsoon period from this time to the end of September. The rainy season is of importance, not only in equalising the temperature, increasing

the fertility, and keeping up the water supply of the country, but, as Sir S. Baker has shown, it plays a most important part in the annual overflow of the Nile.

On the summits and slopes of the highest mountains the vegetation is of a thoroughly temperate and even English character; the plateaux have a flora of the same character; while on the lower slopes of the hills and in the ravines occur many trees and shrubs of warmer climes. "The general appearance of the plateaux and plains is that of a comparatively bare country, with trees and bushes thinly scattered over it, and clumps and groves only occurring round villages and churches. But the glens and ravines in the plateau sides, each with its little bright spring, are often thickly wooded, and offer a delicious contrast to the open country."—*Markham.* This refers more particularly to the northern portion of the country, that drained by the Mareb; the central and southern parts are much more fertile and productive. Here the fertility is so great that in some parts three crops are raised annually. Agriculture receives considerable attention, and large quantities of maize, wheat, barley, peas, beans, &c., are grown. Very extensively cultivated is *teff* (*Poa abyssinica*), a herbaceous plant with grains not larger than the head of a pin, of which is made the bread in general use throughout the country. The low grounds produce also a kind of corn called *tocussa*, of which a black bread is made, which constitutes the food of the lower classes. Coffee grows wild on the western mountains, and the vine and sugar-cane are cultivated in favourable localities. Cotton is also grown to a considerable extent. Among the fruit-trees are the date, orange, lemon, pomegranate, and banana. Myrrh, balsam, and various kinds of valuable medicinal plants are common.

Most of the domestic animals of Europe are found here. The cattle are in general small, and the oxen belong to the humped race. The famous Galla oxen have horns sometimes four feet long. The sheep belong to the short and fat-tailed race, and are covered with wool. Goats are very common, and have sometimes horns two feet in length. The horses are strong and active. Of wild animals the spotted hyæna is among the most numerous, as well as the fiercest and most destructive, not only roaming in immense numbers over the country, but frequently entering the towns, and even the houses of the inhabitants. The elephant and rhinoceros are numerous in the low grounds. The Abyssinian rhinoceros has two horns; its skin, which has no folds, is used for shields, and for lining drinking vessels, being regarded as an antidote to poison. Crocodiles and hippopotami are plentiful in the rivers; lions, panthers, and leopards are seen occasionally, and buffaloes frequently. Among other animals may be mentioned as common various species of antelopes, wild swine, monkeys, hares, squirrels, several species of hyrax, jackals, &c.

The birds of Abyssinia are very numerous, and many of them remarkable for the beauty of their plumage. Great numbers of eagles, vultures, hawks, and other birds of prey are met with; and partridges, snipes, pigeons, parrots, thrushes, and swallows are very plentiful. Among insects the most numerous and useful is the bee, honey everywhere constituting an important part of the food of the inhabitants, and several of the provinces paying a large proportion of their tribute in this article. Of an opposite class is the locust, the ravages of which here, as in other parts of Northern Africa, are terrible. Serpents are not numerous, but several species are poisonous.

The inhabitants of Abyssinia form a number of different tribes, and evidently belong to several distinct races. The majority are of the Caucasian race, and are in general well-formed and handsome, with straight and regular features, lively eyes, hair long and straight or somewhat curled, and colour dark olive, approaching to black. Rüppell regards them as identical in features with the Bedouin Arabs. The tribes inhabiting Tigré, Amhara, Agow, &c., belong to this race. The Galla race, who came originally from the south, have now overrun the greater part of the country, constituting a large portion of the soldiery, and, indeed, there are few of the chiefs who have not an intermixture of Galla blood in their veins. They are fierce and turbulent in character, and addicted to cruelty. Many of them are still idolaters, but most of them have now adopted the Mohammedan faith, and not a few of them the Christianity of the Abyssinians. They are generally large and well-built, of a brown complexion, with regular features, small deeply-sunk but very bright eyes, and long black hair. A race of Jews, known by the name of Falashas, inhabit the district of Samen. They affirm that their forefathers came into the country in the days of Rehoboam, but it seems more probable that they arrived about the time of the destruction of Jerusalem. From the 10th century they enjoyed their own constitutional rights, and were subject to their own kings, who, they pretend, were descended from King David, until the year 1800, when the royal race became extinct, and they then became subject to Tigré.

The prevailing religion of Abyssinia is a very corrupted form of Christianity. This is professed by the majority of the people, as well as by the reigning princes of the different states. There are also scattered over the country many Mohammedans, and some Falashas or Jews. Christianity was introduced into this country about the year 330, but since that time it has been so corrupted by errors of various kinds as to have become little more than a dead formality mixed up with much superstition and Judaism. Feasts and fast-days are very frequent, and baptism and the Lord's supper are dispensed after the manner of the Greek Church. The children are circumcised, and the Mosaic commandments with respect to food and purification are observed. The eating of animals which do not chew the cud and which have not cloven hoofs is prohibited. The ecclesiastical body is very numerous, consisting of priests of various kinds, with monks and nuns, and is looked upon with great awe and reverence. If a priest be married previous to his ordination, he is allowed to remain so; but no one can marry after having entered the priesthood. The primate or chief bishop is called *Abuna* (*i.e.*, our father), and is nominated by the patriarch of Cairo, whom they acknowledge as their spiritual father. The churches are rude edifices, chiefly of a circular form, with thatched roofs, the interior being divided into three compartments,—an outer one for the laity, one within for the priests, and in the centre the Holy of Holies, exactly after the manner of a Jewish temple. The worship consists merely in reading passages of Scripture and dispensing the Lord's supper, without any preaching. Like the Greek Church, they have no images of any kind in their places of worship, but paintings of the saints are very common—their faces always in full, whatever may be the position of their bodies. They have innumerable saints, but above all is the Virgin, whom they regard as queen of heaven and earth, and the great intercessor for the sins of mankind. Their reverence for a saint is often greater than for the Almighty, and a man who would not hesitate to invoke the name of his Maker in witness to a falsehood may decline so to use the name of St Michael or St George. Legends of saints and works of religious controversy form almost their entire literature. "At present," says Bishop Gobat, "the Christians of Abyssinia are divided into three parties, so inimical to each other that they curse one another, and will no longer partake of the sacrament together. It is one single point of theology that disunites them—the unceasing dispute concerning the unction of Jesus Christ."

In manners the Abyssinians are rude and barbarous.

Engaged as they are in continual wars, and accustomed to bloodshed, human life is little regarded among them. Murders and executions are frequent, and yet cruelty is said not to be a marked feature of their character; and in war they seldom kill their prisoners. When one is convicted of murder, he is handed over to the relatives of the deceased, who may either put him to death or accept a ransom. When the murdered person has no relatives, the priests take upon themselves the office of avengers. The Abyssinians are irritable, but easily appeased; and are a gay people, fond of festive indulgences. On every festive occasion, as a saint's day, birth, marriage, &c., it is customary for a rich man to collect his friends and neighbours, and kill a cow and one or two sheep. The principal parts of the cow are eaten raw while yet warm and quivering, the remainder being cut into small pieces, and cooked with the favourite sauce of butter and red pepper paste. The raw meat in this way is considered to be very superior in taste and much tenderer than when cold. "I can readily believe," says Mr Parkyns," that raw meat would be preferred to cooked meat by a man who from childhood had been accustomed to it." The statement by Bruce respecting the cutting of steaks from a live cow has frequently been called in question, but there can be no doubt that Bruce actually saw what he narrates, though it would appear to have been a very exceptional case. Mr Parkyns was told by a soldier, "that such a practice was not uncommon among the Gallas, and even occasionally occurred among themselves, when, as in the case Bruce relates, a cow had been stolen or taken in foray." The principal drinks are *mése*, a kind of mead, and *bousa*, a sort of beer made from fermented cakes. Their dress consists of a large folding mantle and close-fitting drawers; and their houses are very rude structures of a conical form, covered with thatch. Marriage is a very slight connection among them, dissolvable at any time by either of the parties; and polygamy is by no means uncommon. Hence there is little family affection, and what exists is only among children of the same father and mother. Children of the same father, but of different mothers, are said to be "always enemies to each other."—*Gobat.*

Abyssinia is one of the most ancient monarchies in the world, and has been governed from time immemorial by an emperor. For many years, however, until the accession of the late Emperor Theodore, he had been a mere puppet in the hands of one or other of his chiefs. Each chief is entire master of all sources of revenue within his territory, and has practically full power of life and death. His subjection consists in an obligation to send from time to time presents to his superior, and to follow him to war with as large a force as he can muster. For several generations the emperor had been little better than a prisoner in his palace at Gondar, his sole revenue consisting of a small stipend and the tolls of the weekly markets of that city, the real power being in the hands of the ras or vizier of the empire, who was always the most powerful chief for the time. If at any time a chief "has found himself strong enough to march upon the capital, he has done so, placed upon the throne another puppet emperor, and been by him appointed ras or vizier, till a rival stronger than himself could turn him out and take his place."—*Dr Beke.*

The three principal provinces of Abyssinia are Tigré in the north, Amhara (in which Gondar the capital is situated) in the centre, and Shoa in the south. The governors of these have all at different times assumed the title of Ras. Three other provinces of some importance are Lasta and Waag, whose capital is Sokota; Godjam, to the south of Lake Dembea; and Kivara, to the west of that lake, the birth-place of the Emperor Theodore The two provinces of Tigré and Shoa have generally been in a state of rebellion from or acknowledged independence of the central power at Gondar. The geographical position of Tigré enhances its political importance, as it lies between Gondar and the sea at Massowah, and thus holds as it were the gate of the capital. The province of Shoa is almost separated from that of Amhara by the Wolla Gallas, a Mohammedan tribe, and for a long time the former had been virtually independent, and governed by a hereditary line of princes, to one of whom the Indian government sent a special embassy under Major Harris in 1841.

The principal towns are Gondar in Amhara, the former capital of the kingdom, and containing about 7000 inhabitants, and Debra Tabor in Amhara, formerly a small village, but which rose to be a place of considerable size in consequence of the Emperor Theodore having fixed upon it as his residence, and near it was Gaffat, where the European workmen resided. It was burned by the emperor when he set out on his fatal march to Magdala. Adowa is the capital of Tigré, and the second city in the empire, having about 6000 inhabitants. Antalo is also one of the principal towns of Tigré, and the capital of Enderta. Near Antalo is Chelicut. Sokota, the capital of Lasta Waag, is a town of considerable size. The capital of Shoa is Ankobar, and near it is Angolala, also a place of considerable size. The capital of Agamé is Adigerat.

The language of the religion and literature of the country is the Geez, which belongs to the Ethiopic class of languages, and is the ancient language of Tigré; of this the modern Tigré is a dialect. The Amharic, the language of Amhara, is that of the court, the army, and the merchants, and is that too which travellers who penetrate beyond Tigré have ordinarily occasion to use. But the Agow in its various dialects is the language of the people in some provinces almost exclusively, and in others, where it has been superseded by the language of the dominant race, it still exists among the lowest classes. This last is believed to be the original language of the people; and from the affinity of the Geez, Amharic, and cognate dialects, to the Arabic, it seems probable that they were introduced by conquerors or settlers from the opposite shores of the Red Sea. The Gallas, who have overrun a great part of Abyssinia, have introduced their own language into various parts of the country, but in many cases they have adopted the language of the people among whom they have come. The literature of Abyssinia is very poor, and contains nothing of much value. During the late war the libraries in connection with the religious communities were found to contain only modern works of little interest. On the capture of Magdala, a large number of MSS. were found there, which had been brought by Theodore from Gondar and other parts. Of these 359 were brought home for examination, and are now deposited in the British Museum. The oldest among them belong to the 15th and 16th centuries, but the great bulk of them are of the 17th and 18th, and some are of the present century. They are mostly copies of the Holy Scriptures, canonical and apocryphal, including the Book of Enoch, prayer and hymn books, missals, lives of saints, and translations of various of the Greek fathers.

The trade and manufactures of Abyssinia are insignificant, the people being chiefly engaged in agriculture and pastoral pursuits. Cotton cloths, the universal dress of the country, are made in large quantities. The preparation of leather and parchment is also carried on to some extent, and manufactures of iron and brass. "The Abyssinians are, I think," says Mr Markham, "capable of civilisation. Their agriculture is good, their manufactures are not to be despised; but the combined effects of isolation, Galla inroads, and internal anarchy, have thrown them back for centuries." The foreign trade of Abyssinia is carried on entirely through Massowah. Its principal imports are lead,

tin, copper, silk, gunpowder, glass wares, Persian carpets, and coloured cloths. The chief exports are gold, ivory, slaves, coffee, butter, honey, and wax.

Abyssinia, or at least the northern portion of it, was included in the ancient kingdom of Ethiopia. The connection between Egypt and Ethiopia was in early times very intimate, and occasionally the two countries were under the same ruler, so that the arts and civilisation of the one naturally found their way into the other. In early times, too, the Hebrews had commercial intercourse with the Ethiopians; and according to the Abyssinians, the Queen of Sheba, who visited Solomon, was a monarch of their country, and from her son Menilek the kings of Abyssinia are descended. During the captivity many of the Jews settled here, and brought with them a knowledge of the Jewish religion. Under the Ptolemies, the arts as well as the enterprise of the Greeks entered Ethiopia, and led to the establishment of Greek colonies. A Greek inscription at Adulis, no longer extant, but copied by Cosmos, and preserved in his *Topographia Christiana*, records that Ptolemy Euergetes, the third of the Greek dynasty in Egypt, invaded the countries on both sides of the Red Sea, and, having reduced most of the provinces of Tigré to subjection, returned to the port of Adulis, and there offered sacrifices to Jupiter, Mars, and Neptune. Another inscription, not so ancient, found at Axum, and copied by Salt and others, states that Aeizanas, king of the Axomites, the Homerites, &c., conquered the nation of the Bogos, and returned thanks to his father, the god Mars, for his victory. The ancient kingdom of Auxume flourished in the first or second century of our era, and was at one time nearly coextensive with the modern Abyssinia. The capital Auxume and the seaport Adulis were then the chief centres of the trade with the interior of Africa in gold dust, ivory, leather, aromatics, &c. At Axum, the site of the ancient capital, many vestiges of its former greatness still exist; and the ruins of Adulis, which was once a seaport on the Bay of Annesley, are now about 4 miles from the shore. Christianity was introduced into the country by Frumentius, who was consecrated first bishop of Abyssinia by St Athanasius of Alexandria about A.D. 330. Subsequently the monastic system was introduced, and between 470 and 480 a great company of monks appear to have entered and established themselves in the country. Since that time Monachism has been a power among the people, and not without its influence on the course of events. In 522 the king of the Homerites, on the opposite coast of the Red Sea, having persecuted the Christians, the Emperor Justinian requested the king of Abyssinia, Caleb or Elesbaan, to avenge their cause. He accordingly collected an army, crossed over into Arabia, and conquered Yemen, which remained subject to Abyssinia for 67 years. This was the most flourishing period in the annals of the country. The Ethiopians possessed the richest part of Arabia, carried on a large trade, which extended as far as India and Ceylon, and were in constant communication with the Greek empire. Their expulsion from Arabia, followed by the conquest of Egypt by the Mohammedans in the middle of the 7th century, changed this state of affairs, and the continued advances of the followers of the Prophet at length cut them off from almost every means of communication with the civilised world; so that, as Gibbon says, "encompassed by the enemies of their religion, the Ethiopians slept for near a thousand years, forgetful of the world by whom they were forgotten." About A.D. 960, a Jewish princess, Judith, conceived the bloody design of murdering all the members of the royal family, and of establishing herself in their stead. During the execution of this project, the infant king was carried off by some faithful adherents, and conveyed to Shoa, where his authority was acknowledged, while Judith reigned for 40 years over the rest of the kingdom, and transmitted the crown to her descendants. In 1268 the kingdom was restored to the royal house in the person of Icon Imlac.

Towards the close of the 15th century the Portuguese missions into Abyssinia commenced. A belief had long prevailed in Europe of the existence of a Christian kingdom in the far east, whose monarch was known as Prester John, and various expeditions had been sent in quest of it. Among others who had engaged in this search was Pedro de Covilham, who arrived in Abyssinia in 1490, and, believing that he had at length reached the far-famed kingdom, presented to the Negus, or emperor of the country, a letter from his master the king of Portugal, addressed to Prester John. Covilham remained in the country, but in 1507 an Armenian named Matthew was sent by the Negus to the king of Portugal to request his aid against the Turks. In 1520 a Portuguese fleet, with Matthew on board, entered the Red Sea in compliance with this request, and an embassy from the fleet visited the country of the Negus, and remained there for about six years. One of this embassy was Father Alvarez, from whom we have the earliest and not the least interesting account of the country. Between 1528 and 1540 armies of Mohammedans, under the renowned general Mohammed Gragn, entered Abyssinia from the low country, and overran the kingdom, obliging the emperor to take refuge in the mountain fastnesses. In this extremity recourse was again had to the Portuguese, and Bermudez, who had remained in the country after the departure of the embassy, was ordained successor to the Abuna, and sent on this mission. In consequence a Portuguese fleet, under the command of Stephen de Gama, was sent from India and arrived at Massowah. A force of 450 musqueteers, under the command of Christopher de Gama, younger brother of the admiral, marched into the interior, and being joined by native troops were at first successful against the Turks, but were subsequently defeated, and their commander taken prisoner and put to death. Soon afterwards, however, Mohammed Gragn was shot in an engagement, and his forces totally routed. After this, quarrels arose between the Negus and the Catholic primate Bermudez, who wished the former publicly to profess himself a convert to Rome. This the Negus refused to do, and at length Bermudez was obliged to make his way out of the country. The Jesuits who had accompanied or followed Bermudez into Abyssinia, and fixed their head-quarters at Fremona, were oppressed and neglected, but not actually expelled. In the beginning of the following century Father Paez arrived at Fremona, a man of great tact and judgment, who soon rose into high favour at court, and gained over the emperor to his faith. He directed the erection of churches, palaces, and bridges in different parts of the country, and carried out many useful works. His successor Mendez was a man of much less conciliatory manners, and the feelings of the people became more strongly excited against the intruders, till at length, on the death of the Negus, and the accession of his son Facilidas in 1633, they were all sent out of the country, after having had a footing there for nearly a century and a half. The French physician Poncet, who went there in 1698, was the only European that afterwards visited the country before Bruce in 1769.

It was about the middle of the 16th century that the Galla tribes first entered Abyssinia from the south; and notwithstanding frequent efforts to dislodge them, they gradually extended and strengthened their positions till they had overrun the greater part of the country. The power of the emperor was thus weakened, independent chiefs set themselves up in different parts, until at length he became little better than a puppet in the hands of the most powerful of his chiefs. In 1805 the country was visited by Lord Valentia and Mr Salt, and again by Salt in 1810. In

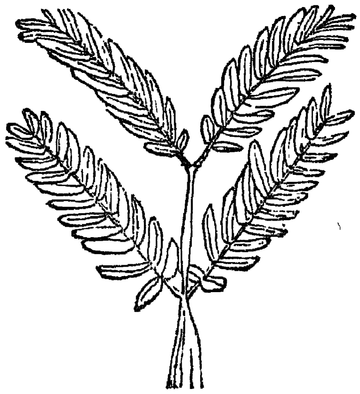
1829 Messrs Gobat and Kugler were sent out as missionaries by the Church Missionary Society, and were well received by the Ras of Tigré. Mr Kugler died soon after his arrival, and his place was subsequently supplied by Mr Isenberg, who was followed by Messrs Blumhardt and Krapf. In 1830 Mr Gobat proceeded to Gondar, where he also met with a favourable reception. In 1833 he returned to Europe, and published a journal of his residence here. In the following year he went back to Tigré, but in 1836 he was compelled to leave from ill health. In 1838 other missionaries were obliged to leave the country, owing to the opposition of the native priests. Messrs Isenberg and Krapf went south, and established themselves at Shoa. The former soon after returned to England, and Mr Krapf remained in Shoa till March 1842. Dr Rüppel, the German naturalist, visited the country in 1831, and remained nearly two years. MM. Combes and Tamisier arrived at Massowah in 1835, and visited districts which had not been traversed by Europeans since the time of the Portuguese. In 1839 the French Government sent out a scientific commission under M. Lefebvre. Its labours extended over five years, and have thrown great light on the condition and productions of the country. In 1841 a political mission was sent by the Governor-General of India to Shoa, under the direction of Major Harris, who subsequently published an account of his travels. One who has done much to extend our geographical knowledge of this country is Dr Beke, who was there from 1840 to 1843. Mr Mansfield Parkyns was there from 1843 to 1846, and has written the most interesting book on the country since the time of Bruce. Bishop Gobat having conceived the idea of sending lay missionaries into the country, who would engage in secular occupations as well as carry on missionary work, Dr Krapf and Mr Flad arrived in 1855 as pioneers of that mission. Six came out at first, and they were subsequently joined by others. Their work, however, was more valuable to Theodore than their preaching, so that he employed them as workmen to himself, and established them at Gaffat, near his capital. Mr Stern arrived in Abyssinia in 1860, but returned to Europe, and came back in 1863, accompanied by Mr and Mrs Rosenthal.

Lij Kassa, who came subsequently to be known as the Emperor Theodore, was born in Kuara, a western province of Abyssinia, about the year 1818. His father was of noble family, and his uncle was governor of the provinces of Dembea, Kuara, and Chelga. He was educated in a convent, but, preferring a wandering life, he became leader of a band of malcontents. On the death of his uncle he was made governor of Kuara, but, not satisfied with this, he seized upon Dembea, and having defeated several generals sent against him, peace was restored on his receiving Tavavitch, daughter of Ras Ali, in marriage. This lady is said to have been his good genius and counsellor, and during her life his conduct was most exemplary. He next turned his arms against the Turks, but was defeated; and the mother of Ras Ali having insulted him in his fallen condition, he proclaimed his independence. The troops sent against him were successively defeated, and eventually the whole of the possessions of Ras Ali fell into his hands. He next defeated the chief of Godjam, and then turned his arms against the governor of Tigré, whom he totally defeated in February 1855. In March of the same year he took the title of Theodore III., and caused himself to be crowned king of Ethiopia by the Abuna. Theodore was now in the zenith of his career. He is described as being generous to excess, free from cupidity, merciful to his vanquished enemies, and strictly continent, but subject to violent bursts of anger, and possessed of unyielding pride and fanatical religious zeal. He was also a man of education and intelligence, superior to those among whom he lived, with natural talents for governing, and gaining the esteem of others. He had further a noble bearing and majestic walk, a frame capable of enduring any amount of fatigue, and is said to have been "the best shot, the best spearman, the best runner, and the best horseman in Abyssinia." Had he contented himself with what he now possessed, the sovereignty of Amhara and Tigré, he might have maintained his position; but he was led to exhaust his strength against the Gallas, which was probably one of the chief causes of his ruin. He obtained several victories over that people, ravaged their country, took possession of Magdala, which he afterwards made his principal stronghold, and enlisted many of the chiefs and their followers in his own ranks. He shortly afterwards reduced the kingdom of Shoa, and took Ankobar, the capital; but in the meantime his own people were groaning under his heavy exactions, rebellions were breaking out in various parts of his provinces, and his good queen was now dead. He lavished vast sums of money upon his army, which at one time amounted to 100,000 or 150,000 fighting men; and in order to meet this expenditure, he was forced to exact exorbitant tributes from his people. The British consul, Plowden, who was strongly attached to Theodore, having been ordered by his Government in 1860 to return to Massowah, was attacked on his way by a rebel named Garred, mortally wounded, and taken prisoner. Theodore attacked the rebels, and in the action the murderer of Mr Plowden was slain by his friend and companion Mr Bell, but the latter lost his life in preserving that of Theodore. The deaths of the two Englishmen were terribly avenged by the slaughter or mutilation of nearly 2000 rebels. Theodore soon after married his second wife Terunish, the proud daughter of the late governor of Tigré, who felt neither affection nor respect for the upstart who had dethroned her father, and the union was by no means a happy one. In 1862 he made a second expedition against the Gallas, which was stained with atrocious cruelties. Theodore had now given himself up to intoxication and lust. When the news of Mr Plowden's death reached England, Captain Cameron was appointed to succeed him as consul, and arrived at Massowah in February 1862. He proceeded to the camp of the king, to whom he presented a rifle, a pair of pistols, and a letter in the Queen's name. In October Captain Cameron was dismissed by Theodore, with a letter to the Queen of England, which reached the Foreign Office on the 12th of February 1863. For some reason or other this letter was put aside and no answer returned, and to this in no small degree is to be attributed the difficulties that subsequently arose with that country. After forwarding the letter, Captain Cameron, hearing that the Christians of Bogos had been attacked by the Shangallas and other tribes under Egyptian rule, proceeded to that district, and afterwards went to Kassala, the seat of the Egyptian administration in that quarter. Thence he went to Metemeh, where he was taken ill, and in order to recruit his health he returned to Abyssinia, and reached Jenda in August 1863. In November despatches were received from England, but no answer to the emperor's letter, and this, together with the consul's visit to Kassala, greatly offended him, and in January 1864 Captain Cameron and his suite, with Messrs Stern and Rosenthal, were cast into prison. When the news of this reached England, the Government resolved, when too late, to send an answer to the emperor's letter, and selected Mr Hormuzd Rassam to be its bearer. He arrived at Massowah in July 1864, and immediately despatched a messenger requesting permission to present himself before the emperor. Neither to this nor a subsequent application was any answer returned till August 1865, when a curt note was received, stating that Consul Cameron had been released, and if Mr Rassam still

desired to visit the king, he was to proceed by the route of Metemeh. They reached Metemeh on 21st November, and five weeks more were lost before they heard from the emperor, whose reply was now courteous, informing them that the governors of all the districts through which they had to march had received orders to furnish them with every necessary. They left Metemeh on the 28th December, and on 25th January following arrived at Theodore's camp in Damot. They were received with all honour, and were afterwards sent to Kuarata, on Lake Dembea, there to await the arrival of the captives. The latter reached this on 12th March, and everything appeared to proceed very favourably. A month later they started for the coast, but had not proceeded far when they were all brought back and put into confinement. Theodore then wrote a letter to the Queen, requesting European workmen and machinery to be sent to him, and despatched it by Mr Flad. The Europeans, although detained as prisoners, were not at first unkindly treated; but in the end of June they were sent to Magdala, where they were soon afterwards put in chains. They suffered hunger, cold, and misery, and were in constant fear of death, till the spring of 1868, when they were relieved by the British troops. In the meantime the power of Theodore in the country was rapidly waning. In order to support his vast standing army, the country was drained of its resources: the peasantry abandoned the fertile plains, and took refuge in the fastnesses, and large fertile tracts remained uncultivated. Rebellions broke out in various parts of the country, and desertions took place among his troops, till his army became little more than a shadow of what it once was. Shoa had already shaken off his yoke; Godjam was virtually independent; Walkeit and Samen were under a rebel chief; and Lasta Waag and the country about Lake Ashangi had submitted to Wagsham Gobaze, who had also overrun Tigré, and appointed Dejach Kassai his governor. The latter, however, in 1867 rebelled against his master, and assumed the supreme power of that province. This was the state of matters when the English troops made their appearance in the country. With a view if possible to effect the release of the prisoners by conciliatory measures, Mr Flad was sent back, with some artisans and machinery, and a letter from the Queen, stating that these would be handed over to his Majesty on the release of the prisoners and their return to Massowah. This, however, failed to influence the emperor, and the English Government at length saw that they must have recourse to arms. In July 1867, therefore, it was resolved to send an army into Abyssinia to enforce the release of the captives, and Sir Robert Napier was appointed commander-in-chief. A reconnoitring party was despatched beforehand, under Colonel Merewether, to select the landing-place and anchorage, and explore the passes leading into the interior. They also entered into friendly relations with the different chiefs in order to secure their co-operation. The landing-place selected was Mulkutto, on Annesley Bay, the point of the coast nearest to the site of the ancient Adulis, and we are told that "the pioneers of the English expedition followed to some extent in the footsteps of the adventurous soldiers of Ptolemy, and met with a few faint traces of this old world enterprise."—*C. R. Markham.* The force amounted to upwards of 16,000 men, besides 12,640 belonging to the transport service, and followers, making in all upwards of 32,000 men. The task to be accomplished was to march over 400 miles of a mountainous and little-known country, inhabited by savage tribes, to the camp or fortress of Theodore, and compel him to deliver up his captives. The commander-in-chief landed on 7th January 1868, and soon after the troops began to move forward through the pass of Senafé, and southward through the districts of Agamé, Tera, Endarta, Wojerat, Lasta, and Wadela. In the meantime Theodore had been reduced to great straits. His army was rapidly deserting him, and he could hardly obtain food for his followers. He resolved to quit his capital Debra Tabor, which he burned, and set out with the remains of his army for Magdala. During this march he displayed an amount of engineering skill in the construction of roads, of military talent, and fertility of resource, that excited the admiration and astonishment of his enemies. On the afternoon of the 10th of April a force of about 3000 men suddenly poured down upon the English in the plain of Arogié, a few miles from Magdala. They advanced again and again to the charge, but were each time driven back, and finally retired in good order. Early next morning Theodore sent Lieut. Prideaux, one of the captives, and Mr Flad, accompanied by a native chief, to the English camp to sue for peace. Answer was returned, that if he would deliver up all the Europeans in his hands, and submit to the Queen of England, he would receive honourable treatment. The captives were liberated and sent away, and along with a letter to the English general was a present of 1000 cows and 500 sheep, the acceptance of which would, according to Eastern custom, imply that peace was granted. Through some misunderstanding, word was sent to Theodore that the present would be accepted, and he felt that he was now safe; but in the evening he learned that it had not been received, and despair again seized him. Early next morning he attempted to escape with a few of his followers, but subsequently returned. The same day (13th April) Magdala was stormed and taken, and within they found the dead body of the emperor, who had fallen by his own hand. The inhabitants and troops were subsequently sent away, the fortifications destroyed, and the town burned. The queen Terunish having expressed her wish to go back to her own country, accompanied the British army, but died during the march, and her son Alam-ayahu, the only legitimate son of the emperor, was brought to England, as this was the desire of his father. The success of the expedition was in no small degree owing to the aid afforded by the several native chiefs through whose country it passed, and no one did more in this way than Prince Kassai of Tigré. In acknowledgment of this several pieces of ordnance, small arms, and ammunition, with much of the surplus stores, were handed over to him, and the English troops left the country in May 1868. Soon after this Prince Kassai declared his independence; and in a war which broke out between him and Wagsham Gobaze, the latter was defeated, and his territory taken possession of by the conqueror. In 1872 Kassai was crowned king of Abyssinia with great ceremony at Axam, under the title of King Johannes. In that year the governor of Massowah, Munzinger Bey, a Swiss, by command of the Viceroy of Egypt, marched an armed force against the Bogos country. The king solicited the aid of England, Germany, and Russia against the Egyptians, whose troops, however, were after a time withdrawn. Sir Bartle Frere, in the blue-book published respecting his mission to Zanzibar, is of the opinion that England, having regard to the passage to India by the Red Sea, should not have wholly abandoned Abyssinia. (D. K.)

(See Travels of Bruce, 1768–73; Lord Valentia, Salt, 1809–10; Combes et Tamisier, 1835–37; Ferret et Galinier, 1839–43; Rüppell, 1831–33; MM. Th. Lefebvre, A. Petit, et Quartin-Dillon, 1839–43; Major Harris; Gobat; Dr C. Beke; Isenberg and Krapf, 1839–42; Mansfield Parkyns; Von Heuglin, 1861-62; H. A. Stern, 1860 and 1868; Dr Blanc, 1868; A. Rassam, 1869; C. R. Markham, 1869; W. T. Blanford, 1870; *Record of the Expedition to Abyssinia*, compiled by order of the Secretary of State for War, by Major T. J. Holland and Captain H. Hozier, 2 vols. 4to, and plates, 1870; various Parliamentary Papers, 1867–68.)

ACACIA, a genus of shrubs and trees belonging to the natural family Leguminosæ and the section Mimoseæ. The flowers are small, arranged in rounded or elongated clusters. The leaves are compound pinnate in general. In some instances, however, more especially in the Australian species, the leaf-stalks become flattened, and serve the purpose of leaves; the plants are hence called leafless Acacias, and as the leaf-stalks are often placed with their edges towards the sky and earth, they do not intercept light so fully as ordinary trees. There are about 420 species of Acacias widely scattered over the warmer regions of the globe. They abound in Australia and Africa. Various species, such as *Acacia vera*, *arabica*, *Ehrenbergii*, and *tortilis*, yield gum arabic; while *Acacia Verek*, *Seyal*, and *Adansonii* furnish a similar gum, called gum Senegal. These species are for the most part natives of Arabia, the north-eastern part of Africa, and the East Indies. The wattles of Australia are species of Acacia with astringent barks. *Acacia dealbata* is used for tanning. An astringent medicine, called catechu or cutch, is procured from several species, but more especially from *Acacia Catechu*, by boiling down the wood and evaporating the solution so as to get an extract. The bark of *Acacia arabica*, under the name of *Babul* or *Babool*, is used in Scinde for tanning. *Acacia formosa* supplies the valuable Cuba timber called sabicu. *Acacia Seyal* is the plant which is supposed to be the shittah tree of the Bible, which supplied shittim-wood. The pods of *Acacia nilotica*, under the name of neb-neb, are used by tanners. The seeds of *Acacia Niopo* are roasted and used as snuff in South America. The seeds of all the varieties of Acacia in South Australia to the west, called Nundo, are used as food after being roasted. *Acacia melanoxylon*, black wood of Australia, sometimes called light wood, attains a great size; its wood is used for furniture, and receives a high polish. *Acacia homalophylla*, myall wood, yields a fragrant timber, used for ornamental purposes. A kind of Acacia is called in Australia Bricklow. In common language the term Acacia is often applied to species of the genus Robinia, which belongs also to the Leguminous family, but is placed in a different section. *Robinia Pseudo-acacia*, or false Acacia, is cultivated in the milder parts of Britain, and forms a large tree, with beautiful pink pea-like blossoms. The tree is sometimes called the Locust tree.



Leaf of *Acacia heterophylla.*

ACADEMY

ACADEMY, ἀκαδήμεια,[1] a suburb of Athens to the north, forming part of the Ceramicus, about a mile beyond the gate named Dypilum. It was said to have belonged to the hero Academus, but the derivation of the word is unknown. It was surrounded with a wall by Hipparchus, and adorned with walks, groves, and fountains by Cimon, the son of Miltiades, who at his death bequeathed it as a public pleasure-ground to his fellow-citizens. The Academy was the resort of Plato, who possessed a small estate in the neighbourhood. Here he taught for nearly fifty years, till his death in 348 B.C.; and from these "groves of the Academy where Plato taught the truth,"[2] his school, as distinguished from the Peripatetics, received the name of the Academics.

The same name (Academia) was in after times given by Cicero to his villa or country-house near Puteoli. There was composed his famous dialogue, *The Academic Questions.*

Of the academic school of philosophy, in so far as it diverged from the doctrines of its great master (see PLATO), we must treat very briefly, referring the reader for particulars to the founders of the various schools, whose names we shall have occasion to mention.

The Academy lasted from the days of Plato to those of Cicero. As to the number of successive schools, the critics are not agreed. Cicero himself and Varro recognised only two, the old and the new; Sextus Empiricus adds a third, the middle; others a fourth, that of Philo and Charmidas; and some even a fifth, the Academy of Antiochus.

Of the old Academy, the principal leaders were Speusippus, Plato's sister's son, and his immediate successor; Xenocrates of Chalcedon, who with Speusippus accompanied Plato in his journey to Sicily; Polemo, a dissolute young Athenian, who came to laugh at Xenocrates, and remained to listen (Horace, *Sat.*, ii. 3, 253); Crates, and Crantor, the latter of whom wrote a treatise, περὶ πένθους, praised by Cicero. Speusippus, like the Pythagoreans, with whom Aristotle compares him, denied that the Platonic Good could be the first principle of things, for (he said) the Good is not like the germ which gives birth to plants and animals, but is only to be found in already existing things. He therefore derived the universe from a primeval indeterminate unit, distinct from the Good; from this unit he deduced three principles—one for numbers, one for magnitude, and one for the soul. The Deity he conceived as that living force which rules all and resides everywhere. Xenocrates, though like Speusippus infected with Pythagoreanism, was the most faithful of Plato's successors. He distinguished three essences: the sensible, the intelligible, and a third, compounded of the other two. The sphere of the first is all below the heavens, of the second all beyond the heavens, of the third heaven itself. To each of these three spheres one of our faculties corresponds. To the sensible, sense; to the intelligible, intellect or reason; to the mixed sphere, opinion (δόξα). So far he closely follows the psychology and cosmogeny of his master; but Cicero notes as the characteristic of both Speusippus and Xenocrates, the abandonment of the Socratic principle of hesitancy.

Of the remaining three, the same writer (who is our principal authority for the history of the Academic school) tells us that they preserved the Platonic doctrine, but emphasised the moral part. On the old Academy he pronounces the following eulogium (*De Fin.* v. 3); "Their writings and method contain all liberal learning, all history, all polite discourse; and besides, they embrace such a variety of arts, that no one can undertake any noble career without their aid. . . . . In a word, the Academy is, as it were, the workshop of every artist." Modern criticism has not endorsed this high estimate. They preserved, it is true, and

[1] The bye-form ἑκαδημία, which occurs in Diogenes Laertius, is probably a rationalistic attempt to interpret the word, such as we commonly meet with in the writings of Plato.

[2] Horace, *Ep.* ii. 2. 45.

elaborated many details of the Platonic teaching, which we could ill have spared; but of Plato's originality and speculative power, of his poetry and enthusiasm, they inherited nothing; "nor amid all the learning which has been profusely lavished upon investigating their tenets, is there a single deduction calculated to elucidate distinctly the character of their progress or regression."[1] There is a saying of Polemo's, which will illustrate their virtual abandonment of philosophy proper: "We should exercise ourselves in business, not in dialectical speculation."

Arcesilaus, the successor of Crates, the disciple of Theophrastus and Polemo, was the founder of the second or middle Academy. He professed himself the strict follower of Plato, and seems to have been sincerely of opinion that his was nothing but a legitimate development of the true Platonic system. He followed the Socratic method of teaching in dialogues; and, like Socrates, left no writings,—at least the ancients were not acquainted with any. But we have no evidence that he maintained the ideal theory of Plato, and from the general tendency of his teaching it is probable that he overlooked it. He affirmed that neither our senses nor our mind can attain to any certainty; in all we must suspend our judgment; probability is the guide of life. Cicero tells us that he was more occupied in disputing the opinions of others than in advancing any of his own. Arcesilaus is, in fact, the founder of that academic scepticism which was developed and systematised by Carneades, the founder of the third or new Academy. He was the chief opponent of the Stoics and their doctrine of certitude. This is attested by a well-known saying of his: "If there had been no Chrysippus, there would have been no Carneades." To the Stoical theory of perception, the φαντασία καταληπτική, by which they expressed a conviction of certainty arising from impressions so strong as to amount to science, he opposed the doctrine of ἀκαταληψία, which denied any necessary correspondence between perceptions and the objects perceived. But while denying the possibility of any knowledge of things in themselves, he saved himself from absolute scepticism by the doctrine of probability or verisimilitude, which may serve as a practical guide in life. Thus he announced as his criterion of truth an imagination or impression (φαντασία) at once credible, irrefragable, and attested by comparison with other impressions. The wise man might be permitted to hold an opinion, though he allowed that that opinion might be false. In ethics, however, he appeared as the pure sceptic. On his visit to Rome as an ambassador from Athens, he alternately maintained and denied in his public disputations the existence of justice, to the great scandal of Cato and all honest citizens.

On the fourth and fifth Academies, we need not dwell long. Philo and Antiochus both taught Cicero, and without doubt communicated to him that mild scepticism, that eclecticism compounded of almost equal sympathy with Plato and Zeno, which is the characteristic of his philosophical writings. The Academy exactly corresponded to the moral and political wants of Rome. With no genius for speculation, the better Romans of that day were content to embrace a system which, though resting on no philosophical basis, and compounded of heterogeneous dogmas, offered notwithstanding a secure retreat from religious scepticism and political troubles. "My words," says Cicero, speaking as a true Academician, "do not proclaim the truth, like a Pythian priestess; but I conjecture what is probable, like a plain man; and where, I ask, am I to search for anything more than verisimilitude?" And again: "The characteristic of the Academy is never to interpose one's judgment, to approve what seems most probable, to compare together different opinions, to see what may be advanced on either side, and to leave one's listeners free to judge without pretending to dogmatise."

[1] Archer Butler. *Lect. on Anc. Phil.* ii. 315.

ACADEMY, in its modern acceptation, signifies a society or corporate body of learned men, established for the advancement of science, literature, or the arts.

The first institution of this sort we read of in history was that founded at Alexandria by Ptolemy Soter, which he named the Museum, μουσεῖον. After completing his conquest of Egypt, he turned his attention to the cultivation of letters and science, and gathered about him a large body of literary men, whom he employed in collecting books and treasures of art. This was the origin of the library of Alexandria, the most famous of the ancient world. Passing by the academies which were founded by the Moors at Grenada, Corduba, and as far east as Samarcand, the next instance of an academy is that founded by Charlemagne at the instigation of the celebrated Alcuin, for promoting the study of grammar, orthography, rhetoric, poetry, history, and mathematics. In order to equalise all ranks, each member took the pseudonym of some ancient author or celebrated person of antiquity. For instance, Charlemagne himself was David, Alcuin became Flaccus Albinus. Though none of the labours of this academy have come down to us, it undoubtedly exerted considerable influence in modelling the language and reducing it to rules.

In the following century Alfred founded an academy at Oxford. This was rather a grammar school than a society of learned men, and from it the University of Oxford originated.

But the academy which may be more justly considered as the mother of modern European academies is that of *Floral Games*, founded at Toulouse in the year 1325, by Clemens Isaurus. Its object was to distribute prizes and rewards to the troubadours. The prizes consisted of flowers of gold and silver. It was first recognised by the state in 1694, and confirmed by letters-patent from the king, and its numbers limited to thirty-six. It has, except during a few years of the republic, continued to the present day, and distributes annually the following prizes:—An amaranth of gold for the best ode, a silver violet for a poem of sixty to one hundred Alexandrine lines, a silver eglantine for the best prose composition, a silver marigold for an elegy, and a silver lily presented in the last century by M. de Malpeyre for a hymn to the Virgin.

It was the Renaissance which was *par excellence* the era of academies, and as the Italians may be said to have discovered anew the buried world of literature, so it was in Italy that the first and by far the most numerous academies arose. The earliest of these was the *Platonic* Academy, founded at Florence by Cosmo de Medici for the study of the works of Plato, though subsequently they added the explanation of Dante and other Italian authors.

Marsilius Ficinus, its principal ornament, in his *Theologica Platonica*, developed a system, chiefly borrowed from the later Platonists of the Alexandrian school, which, as it seemed to coincide with some of the leading doctrines of Christianity, was allowed by the church. His Latin translation of Plato is at once literal, perspicuous, and correct; and as he had access to MSS. of Plato now lost, it has in several places enabled us to recover the original reading. After the expulsion of the Medici from Florence, the Platonic Academy was dissolved.

In giving some account of the principal academies of Europe, which is all that this article professes to do, we shall, as far as possible, arrange them under different heads, according to—1*st*, The object which they were designed to promote; 2*d*, The countries to which they belong. This classification, though, perhaps, the best available, is

necessarily imperfect, inasmuch as several of those we shall mention were at once literary and scientific, and many associations for similar objects were known by some other name. Thus, with the doubtful exception of the Royal Academy of Arts, England has no academies in the proper sense of the word. For those institutions in England which answer to Italian academies, we must refer the reader to the article SOCIETY.

I. SCIENTIFIC ACADEMIES.—*Italy.*—The first society for the prosecution of physical science was that established at Naples, 1560, under the presidency of Baptista Porta. It was called *Academia Secretorum Naturæ* or *de Secreti.* It arose from a meeting of some scientific friends, who assembled at Porta's house, and called themselves the *Otiosi.* No member was admitted who had not made some useful discovery in medicine or natural philosophy. The name suggested to an ignorant public the prosecution of magic and the black arts. Porta went to Rome to justify himself before Paul III. He was acquitted by the Pope, but the academy was dissolved, and he was ordered to abstain for the future from the practice of all illicit arts.

At Rome he was admitted to the *Lincei,* an academy founded by Federigo Cesi, the Marcese di Monticelli. The device of the Lincei was a lynx with its eyes turned towards heaven tearing a Cerberus with its claws, intimating that they were prepared to do battle with error and falsehood. Their motto was the verse of Lucretius describing rain dropping from a cloud—"Redit agmine dulci." Besides Porta, Galileo and Colonna were enrolled among its members. The society devoted itself exclusively to physical science. Porta, under its auspices, published his great work, *Magiæ Naturalis libri xx.,* 1589, in fol.; his *Phytognomonica,* or, the occult virtue of plants; his *De Humana Physiognomia,* from which Lavater largely borrowed; also various works on optics and pneumatics, in which he approached the true theory of vision. He is even said by some to have anticipated Galileo in the invention of the telescope.

But the principal monument still remaining of the zeal and industry of Cesi and his academy is the *Phytobasanos,* a compendium of the natural history of Mexico, written by a Spaniard, Hernendez. During fifty years the MS. had been neglected, when Cesi discovered it, and employed Terentio, Fabro, and Colonna, all Lynceans, to edit it and enrich it with notes and emendations. Cesi's own great work, *Theatrum Naturæ,* was never published. The MS. still exists in the Albani Library at Rome. After Cesi's death, 1630, the academy languished for some years under the patronage of Urban VIII. An academy of the same name was inaugurated at Rome 1784, and still flourishes. It numbers among its members some of our English philosophers. But the fame of the *Lincei* was far outstripped by that of the *Accademia del Cimento,* established in Florence 1657, under the patronage of the Grand Duke Ferdinand II., at the instigation of his brother Leopold, acting under the advice of Viviani, one of the greatest geometers of Europe. The object of this academy was (as the name implies) to make *experiments* and relate them, abjuring all preconceived notions. Unfortunately for science, it flourished for only ten years. Leopold in 1667 was made a cardinal, and the society languished without its head. It has, however, left a record of its labours in a volume containing an account of the experiments, published by the secretary in 1667. It is in the form of a beautifully printed folio, with numerous full print pages of illustrations. It contains, among others, those on the supposed incompressibility of water, on the pressure of the air, and on the universal gravity of bodies. Torricelli, the inventor of the barometer, was one of its members.

Passing by numerous other Italian Academies of Science, we come to those of modern times.

The Royal Academy of Sciences at Turin originated in 1757 as a private society; in 1759 it published a volume of *Miscellanea Philosophico-Mathematica Societatis privatæ Taurinensis;* shortly after it was constituted a Royal Society by Charles Emanuel III., and in 1783 Victor Amadeus III. made it a Royal Academy of Sciences. It consists of 40 members, residents of Turin, 20 non-resident, and 20 foreign members. It publishes each year a quarto volume of proceedings, and has crowned and awarded prizes to many learned works.

France.—The *Old Academy of Sciences* originated in much the same way as the French Academy. A private society of scientific men had for some thirty years been accustomed to meet first at the house of Montmort, the mâitre des requêtes, afterwards at that of Thevenot, a great traveller and man of universal genius, in order to converse on their studies, and communicate their discoveries. To this society belonged, among others, Descartes, Gassendi, Blaise Pascal, and his father. Hobbes, the philosopher of Malmesbury, was presented to it during his visit to Paris in 1640. Colbert, just as Richelieu in the case of the French Academy, conceived the idea of giving an official status to this body of learned men. Seven eminent mathematicians, among whom were Huyghens and De Bessy, the author of a famous treatise on magic squares, were chosen to form the nucleus of the new society. A certain number of chemists, physicians, and anatomists were subsequently added. Pensions were granted by Louis XIV. to each of the members, and a fund for instruments and experimentations placed at their disposal. They commenced their session the 22d December 1666 in the Royal Library. They met twice a week—the mathematicians on the Wednesdays, the physicists (as the naturalists and physiologists were then called) on the Saturdays. Duhamel was appointed secretary by the king. This post he owed more to his polished Latinity than to his scientific attainments, all the proceedings of the society being recorded in Latin. A treasurer was also nominated, who, notwithstanding his pretentious title, was nothing more than conservator of the scientific instruments, &c. At first the academy was rather a laboratory and observatory than an academy proper. Experiments were undertaken in common and results discussed. Several foreign *savants,* in particular the Danish astronomer Rœmer, joined the society, attracted by the liberality of the Grand Monarque; and the German physician and geometer Tschirnhausen and Sir Isaac Newton were made foreign associates. The death of Colbert, who was succeeded by Louvois, exercised a disastrous effect on the fortunes of the academy. The labours of the academicians were diverted from the pursuit of pure science to such works as the construction of fountains and cascades at Versailles, and the mathematicians were employed to calculate the odds of the games of lansquenet and bassett. In 1699 the academy was reconstituted by M. de Pontchartrain, under whose department as secretary of state the academies came. By its new constitution it consisted of ten honorary members, men of high rank, who interested themselves in science, fifteen pensionaries, who were the working members, viz., three geometricians, and the same number of astronomers, mechanicians, anatomists, and chemists. Each section of three had two associates attached to it, and besides, each pensionary had the power of naming a pupil. There were eight foreign and four free associates. The officers were, a president and a vice-president, named by the king from among the honorary members, and a secretary and treasurer chosen from the pensionaries, who held their offices for life. Fontenelle, a man of wit, and rather a populariser of sciences than an original investigator, succeeded Duhamel as

secretary. The constitution, as is evident, was purely aristocratical, and unlike that of the French Academy, in which the principle of equality among the members was never violated. Science was not yet strong enough to dispense with the patronage of the great. The two leading spirits of the academy at this period were Clairaut and Réaumur. Clairaut was the first to explain capillary attraction, and predicted within a few days of the correct time the return of Halley's comet. His theory on the figure of the earth was only superseded by Laplace's *Mécanique Céleste.* Réaumur was principally distinguished by his practical discoveries, and a thermometer in common use at the present day bears his name.

To trace the subsequent fortunes of this academy would far exceed our limits, being equivalent to writing the history of the rise and progress of science in France. It has reckoned among its members Laplace, Buffon, Lagrange, D'Alembert, Lavoisier, and Jussieu, the father of modern botany. Those of our readers who wish for further information we would refer to M. Alfred Maury's excellent history.

On 21st December 1792, the old Academy of Sciences met for the last time. Many of the members fell by the guillotine, many were imprisoned, more reduced to indigence. The aristocracy of talent was almost as much detested and persecuted by the Revolution as that of rank.

In 1795 the Convention decided on founding an Institute, which was to replace all the academies. The first class of the Institute corresponded closely to the old academy. See INSTITUTE.

In 1816 the Academy was reconstituted as a branch of the Institute. The new academy has reckoned among its members, besides many other brilliant names, Carnot the engineer, the physicians Fresnel, Ampère, Arago, Biot, the chemists Gay-Lussac and Thénard, the zoologists G. Cuvier and the two Geoffroy Saint-Hilaires.

The French had also considerable academies in most of their large towns. Montpellier, for example, had a Royal Academy of Sciences, founded in 1706 by Louis XIV., on nearly the same footing as that at Paris, of which, indeed, it was in some measure the counterpart. It was reconstituted in 1847, and organised under three sections—medicine, science, and letters. It has continued to publish annual reports of considerable value. Toulouse also had an academy under the denomination of Lanternists; and there were analogous institutions at Nîmes, Arles, Lyons, Dijon, Bordeaux, and other places. Of these several, we believe, are still in existence, if not in activity.

Before passing on to German academies, we may here notice a private scientific and philosophical society, the precursor of the French Academy of Sciences. It does not appear to have had any distinguishing name; but the promoter of it was Eusebius Renaudot, Counsellor and Physician in Ordinary to the King of France, and Doctor Regent of the Faculty of Physic at Paris, by whom a full account of its conferences was published, translated into English by G. Havers, 1664. In the preface it is said to be "a production of an assembly of the choicest wits of France." We will quote a few of the subjects of these discussions in order to show the character of the society:—"Why the loadstone draws iron;" "Whether the soul's immortality is demonstrable by natural reason;" "Of the little hairy girl lately seen in this city." On subjects of popular superstition their views were far in advance of the time. Of judicial astrology it is said, "Why should we seek in heaven the causes of accidents which befall us if we can find them on earth?" Of the philosopher's stone—"This most extravagant conceit, that it is the panacea, joined to the other absurdities of that chimerical art, makes us believe that it is good for nothing but to serve for imaginary consolation to the miserable."

Germany.—The *Collegium Curiosum* was a scientific society, founded by J. C. Sturm, professor of mathematics and natural philosophy in the University of Altorff, in Franconia, in 1672, on the plan of the Accademia del Cimento. It originally consisted of 20 members, and continued to flourish long after the death of its founder. The early labours of the society were devoted to the repetition (under varied conditions) of the most notable experiments of the day, or to the discussion of the results. Two volumes of proceedings were published by Sturm in 1676 and 1685 respectively. The *Programma Invitatorium* is dated June 3, 1672; and Sturm therein urges that, as the day of disputatious philosophy had given way to that of experimental philosophy, and as, moreover, scientific societies had been founded at Florence, London, and Rome, it would therefore seem desirable to found one in Germany, for the attainment of which end he requests the co-operation of the learned.

The work of 1676, entitled *Collegium Experimentale sive Curiosum*, commences with an account of the diving-bell, "a new invention;" next follow chapters on the camera obscura, the Torricellian experiment, the air-pump, microscope, telescope, &c. The two works have been pronounced by a competent authority[1] to constitute a nearer approach to a text-book of the physics of the period than any preceding work.

The *Royal Academy of Sciences at Berlin* was founded in 1700 by Frederic I. after Leibnitz' comprehensive plan, but was not opened till 1711. Leibnitz was the first president. Under Maupertuis, who succeeded him, it did good service. Its present constitution dates from January 24, 1812. It is divided into four sections—physical, mathematical, philosophical, and historical. Each section is under a paid secretary elected for life; each secretary presides in turn for a quarter of a year. The members are—1*st*, Regular members who are paid; these hold general meetings every Thursday, and sectional meetings every Monday. 2*d*, Foreign members, not to exceed 24 in number. 3*d*, Honorary members and correspondents. Since 1811 it has published yearly, *Mémoires de l'Académie Royale des Sciences et Belles Lettres à Berlin.* For its scientific and philosophical attainments the names of W. and A. v. Humboldt, Ideles, Savigny, Schleiermacher, Bopp, and Ranke, will sufficiently vouch.

The *Academy of Sciences at Mannheim* was established by Charles Theodore, Elector Palatine, in the year 1755. The plan of this institution was furnished by Schæpflin, according to which it was divided into two classes, the historical and physical. In 1780 a sub-division of the latter took place into the physical, properly so-called, and the meteorological. The meteorological observations are published separately, under the title of *Ephemerides Societatis Meteorologicæ Palatinæ.* The historical and physical memoirs are published under the title of *Acta Academiæ Theodoro-Palatinæ.*

The *Electoral Bavarian Academy of Sciences at Munich* was established in 1759, and publishes its memoirs under the title of *Abhandlungen der Baierischen Akademie.* Soon after the Elector of Bavaria was raised to the rank of king, the Bavarian government, by his orders, directed its attention to a new organisation of the Academy of Sciences of Munich. The design of the king was, to render its labours more extensive than those of any similar institution in Europe, by giving to it, under the direction of the ministry, the immediate superintendence over all the establishments for public instruction in the kingdom of Bavaria. The Privy-Councillor Jacobi, a man of most excellent character, and of considerable scientific attainments, was appointed president.

[1] Mr G. F. Rodwell, in the *Chemical News*, June 21, 1867.

The *Electoral Academy at Erfurt* was established by the Elector of Mentz, in the year 1754. It consists of a protector, president, director, assessors, adjuncts, and associates. Its object is to promote the useful sciences. The memoirs were originally published in Latin, but afterwards in German. The Hessian Academy of Sciences at Giessen publish their transactions under the title of *Acta Philosophico-Medica Academiæ Scientiarum Principalis Hessiacæ.* In the Netherlands there are scientific academies at Flushing and Brussels, both of which have published their transactions.

Russia.—The *Imperial Academy of Sciences at St Petersburg* was projected by the Czar Peter the Great. Having in the course of his travels observed the advantage of public societies for the encouragement and promotion of literature, he formed the design of founding an academy of sciences at St Petersburg. By the advice of Wolff and Leibnitz, whom he consulted on this occasion, the society was accordingly regulated, and several learned foreigners were invited to become members. Peter himself drew the plan, and signed it on the 10th of February 1724; but he was prevented, by the suddenness of his death, from carrying it into execution. His decease, however, did not prevent its completion; for on the 21st of December 1725, Catharine I. established it according to Peter's plan, and on the 27th of the same month the society assembled for the first time. On the 1st of August 1726, Catharine honoured the meeting with her presence, when Professor Bulfinger, a German naturalist of great eminence, pronounced an oration upon the advances made in the theory of magnetic variations, and also on the progress of research in so far as regarded the discovery of the longitude. A short time afterwards the empress settled a fund of £4982 per annum for the support of the academy; and 15 members, all eminent for their learning and talents, were admitted and pensioned, under the title of professors in the various branches of science and literature. The most distinguished of these professors were Nicholas and Daniel Bernouilli, the two De Lisles, Bulfinger, and Wolff.

During the short reign of Peter II. the salaries of the members were discontinued, and the academy utterly neglected by the Court; but it was again patronised by the Empress Anne, who even added a seminary for the education of youth under the superintendence of the professors. Both institutions flourished for some time under the direction of Baron Korf; but upon his death, towards the end of Anne's reign, an ignorant person being appointed president, many of the most able members quitted Russia. At the accession of Elizabeth, however, new life and vigour were infused into the academy. The original plan was enlarged and improved; some of the most learned foreigners were again drawn to St Petersburg; and, what was considered as a good omen for the literature of Russia, two natives, Lomonosof and Rumovsky, men of genius and abilities, who had prosecuted their studies in foreign universities, were enrolled among its members. Lastly, the annual income was increased to £10,659, and sundry other advantages were conferred upon the institution.

The Empress Catharine II., with her usual zeal for promoting the diffusion of knowledge, took this useful society under her immediate protection. She altered the court of directors greatly to the advantage of the whole body, corrected many of its abuses, and infused a new vigour and spirit into their researches. By Catharine's particular recommendation the most ingenious professors visited the various provinces of her vast dominions; and as the funds of the academy were not sufficient to defray the whole expense of these expeditions, the empress supplied the deficiency by a grant of £2000, which was renewed as occasion required.

The purpose and object of these travels will appear from the instructions given by the academy to the several persons who engaged in them. They were ordered to institute inquiries respecting the different sorts of earths and waters; the best methods of cultivating barren and desert spots; the local disorders incident to men and animals, together with the most efficacious means of relieving them; the breeding of cattle, particularly of sheep; the rearing of bees and silk-worms; the different places and objects for fishing and hunting; minerals of all kinds; the arts and trades; and the formation of a *Flora Russica*, or collection of indigenous plants. They were particularly instructed to rectify the longitude and latitude of the principal towns; to make astronomical, geographical, and meteorological observations; to trace the courses of rivers; to construct the most exact charts; and to be very distinct and accurate in remarking and describing the manners and customs of the different races of people, their dresses, languages, antiquities, traditions, history, religion; in a word, to gain every information which might tend to illustrate the real state of the whole Russian empire. More ample instructions cannot well be conceived; and they appear to have been very zealously and faithfully executed. The consequence was that, at that time, no country could boast, within the space of so few years, such a number of excellent publications on its internal state, its natural productions, its topography, geography, and history, and on the manners, customs, and languages of the different tribes who inhabit it, as issued from the press of this academy. In its researches in Asiatic languages, and general knowledge of Oriental customs and religions, it proved itself the worthy rival of our own Royal Asiatic Society.

The first transactions of this society were published in 1728, and entitled *Commentarii Academiæ Scientiarum Imperialis Petropolitanæ ad annum* 1726, with a dedication to Peter II. The publication was continued under this form until the year 1747, when the transactions were called *Novi Commentarii Academiæ*, &c.; and in 1777, the academy again changed the title into *Acta Academiæ Scientiarum Imperialis Petropolitanæ*, and likewise made some alteration in the arrangements and plan of the work. The papers, which had been hitherto published in the Latin language only, were now written indifferently either in that language or in French, and a preface added, entitled *Partie Historique*, which contains an account of its proceedings, meetings, the admission of new members, and other remarkable occurrences. Of the *Commentaries*, 14 volumes were published: the first of the *New Commentaries* made its appearance in 1750, and the twentieth in 1776. Under the new title of *Acta Academiæ*, a number of volumes have been given to the public; and two are printed every year. These transactions abound with ingenious and elaborate disquisitions upon various parts of science and natural history; and it may not be an exaggeration to assert, that no society in Europe has more distinguished itself for the excellence of its publications, particularly in the more abstruse parts of pure and mixed mathematics.

The academy is still composed, as at first, of 15 professors, besides the president and director. Each of these professors has a house and an annual stipend of from £200 to £600. Besides the professors, there are four adjuncts, with pensions, who are present at the sittings of the society, and succeed to the first vacancies. The direction of the academy is generally entrusted to a person of distinction.

The buildings and apparatus of this academy are on a vast scale. There is a fine library, consisting of 36,000 curious books and manuscripts; together with an extensive museum, in which the various branches of natural history, &c., are distributed in different apartments. The latter is extremely rich in native productions, having been consi-

derably augmented by the collections made by Pallas, Gmelin, Guldenstaedt, and other professors, during their expeditions through the various parts of the Russian empire. The stuffed animals and birds occupy one apartment. The chamber of rarities, the cabinet of coins, &c., contain innumerable articles of the highest curiosity and value. The motto of the society is exceedingly modest; it consists of only one word, *Paulatim*.

Sweden.—The *Academy of Sciences at Stockholm*, or the *Royal Swedish Academy*, owes its institution to six persons of distinguished learning, among whom was the celebrated Linnæus. They originally met on the 2d of June 1739, when they formed a private society, in which some dissertations were read; and in the end of the same year their first publication made its appearance. As the meetings continued and the members increased, the society attracted the notice of the king; and, accordingly, on the 31st of March 1741, it was incorporated under the name of the Royal Swedish Academy. Not receiving any pension from the crown, it is merely under the protection of the king, being directed, like our Royal Society, by its own members. It has now, however, a large fund, which has chiefly arisen from legacies and other donations; but a professor of experimental philosophy, and two secretaries, are still the only persons who receive any salaries. Each of the members resident at Stockholm becomes president by rotation, and continues in office during three months. There are two kinds of members, native and foreign; the election of the former take places in April, that of the latter in July; and no money is paid at the time of admission. The dissertations read at each meeting are collected and published four times in the year: they are written in the Swedish language, and printed in octavo, and the annual publications make a volume. The first 40 volumes, which were completed in 1779, are called the *Old Transactions*.

Denmark.—The *Royal Academy of Sciences at Copenhagen* owes its institution to the zeal of six individuals, whom Christian VI., in 1742, ordered to arrange his cabinet of medals. These persons were John Gram, Joachim Frederic Ramus, Christian Louis Scheid, Mark Woldickey, Eric Pontopidan, and Bernard Moelman, who, occasionally meeting for this purpose, extended their designs; associated with them others who were eminent in several branches of science; and forming a kind of literary society, employed themselves in searching into, and explaining the history and antiquities of their country. The Count of Holstein, the first president, warmly patronised this society, and recommended it so strongly to Christian VI. that, in 1743, his Danish majesty took it under his protection, called it the Royal Academy of Sciences, endowed it with a fund, and ordered the members to join to their former pursuits natural history, physics, and mathematics. In consequence of the royal favour the members engaged with fresh zeal in their pursuits; and the academy has published 15 volumes in the Danish language, some of which have been translated into Latin.

England.—In 1616 a scheme for founding a Royal Academy was started by Edmund Bolton, an eminent scholar and antiquary. Bolton, in his petition to King James, which was supported by George Villiers, Marquis of Buckingham, proposed that the title of the academy should be "King James, his Academe or College of honour." In the list of members occurs the name of Sir Kenelm Digby, one of the original members of the Royal Society. The death of the king proved fatal to the undertaking. In 1635 a second attempt was made to found an academy, under the patronage of Charles I., with the title of "Minerva's Musæum," for the instruction of young noblemen in the liberal arts and sciences, but the project was soon dropped. About 1645 some of the more ardent followers of Bacon used to meet, some in London, some at Oxford, for the discussion of subjects connected with experimental science. This was the origin of the Royal Society, which received its charter in 1662. See Royal Society.

Ireland.—The *Royal Irish Academy* arose out of a society established at Dublin about the year 1782, and consisting of a number of gentlemen, most of whom belonged to the university. They held weekly meetings, and read essays in turn on various subjects. The members of this society afterwards formed a more extensive plan, and, admitting only such names as might add dignity to their new institution, became the founders of the *Royal Irish Academy*. They professed to unite the advancement of science with the history of mankind and polite literature. The first volume of their transactions (for 1787) appeared in 1788, and seven volumes were afterwards published. A society was formed in Dublin, similar to the Royal Society in London, as early as the year 1683; but the distracted state of the country proved unpropitious to the cultivation of philosophy and literature.

Holland.—The *Royal Academy of Sciences at Amsterdam*, erected by a royal ordinance 1852, succeeded the Royal Institute of the Low Countries, founded by Louis Napoleon, King of Holland, 1808. In 1855 it had published 192 volumes of proceedings, and received an annual subsidy of 14,000 florins from the state.

Spain.—The *Academy of Sciences at Madrid*, founded 1774, after the model of the French Academy.

Portugal.—The *Academy of Sciences at Lisbon* is divided into three classes—natural history, mathematics, and national literature. It consists of 24 ordinary and 36 extraordinary members. Since 1779 it has published *Memorias de Letteratura Portugueza; Memorias Economicas; Colleçao de Livros ineditos di Historia Portugueza.*

II. Academies of Belles Lettres.—*Italy.*—Italy in the 16th century was remarkable for the number of its literary academies. Tiraboschi, in his *History of Italian Literature*, has given a list of 171; and Jarkius, in his *Specimen Historiæ Academiarum Conditarum*, enumerates nearly 700. Many of these, with a sort of Socratic irony, gave themselves names expressive of ignorance or simply ludicrous. Such were the *Lunatici* of Naples, the *Estravaganti*, the *Fulminales*, the *Trapessati*, the *Drowsy*, the *Sleepers*, the *Anxious*, the *Confused*, the *Unstable*, the *Fantastic*, the *Transformed*, the *Ætherial*. "The first academies of Italy chiefly directed their attention to classical literature; they compared manuscripts; they suggested new readings, or new interpretations; they deciphered inscriptions or coins; they sat in judgment on a Latin ode, or debated the propriety of a phrase. Their own poetry had, perhaps, never been neglected; but it was not till the writings of Bembo furnished a new code of criticism in the Italian language, that they began to study it with the same minuteness as modern Latin." "They were encouragers of a numismatic and lapidary erudition, elegant in itself, and throwing for ever little specks of light on the still ocean of the past, but not very favourable to comprehensive observation, and tending to bestow on an unprofitable pedantry the honours of real learning."[1] The Italian nobility, excluded as they mostly were from politics, and living in cities, found in literature a consolation and a career. Such academies were oligarchical in their constitution; they encouraged culture, but tended to hamper genius and extinguish originality. Of their academies, by far the most celebrated was the *Accademia della Crusca* or *Furfuratorum*; that is, of Bran, or of the Sifted. The title was borrowed from a previous society at Perugia, the *Accademia degli Scossi*, of the Well-shaken. Its device

[1] Hallam's *Int. to Lit. of Europe*, vol. i. 654, and vol. ii. 509.

was a sieve; its motto, "Il più bel fior ne coglie," it collects the finest flour of it; its principal object the purification of the language. Its great work was the *Vocabulario della Crusca*, the first edition of which was published 1613. It was composed avowedly on Tuscan principles, and regarded the 14th century as the Augustan period of the language. Beni assailed it in his *Anti-Crusca*, and this exclusive Tuscan spirit has disappeared in subsequent editions. The Accademia della Crusca is now incorporated with two older societies—the Accademia degli Apatici (the Impartials) and the Accademia Fiorentina.

Among the numerous other literary academies of Italy we may mention the Academy of Naples, founded about 1440 by Alfonso, the king; the *Academy of Florence*, founded 1540, to illustrate and perfect the Tuscan tongue, especially by a close study of Petrarch; the *Intronati* of Siena, 1525; the *Infiammati* of Padua, 1534; the *Rozzi* of Siena, suppressed by Cosmo, 1568.

The *Academy of Humourists, Umoristi*, had its origin at Rome in the marriage of Lorenzo Marcini, a Roman gentleman, at which several persons of rank were guests. It was carnival time, and so to give the ladies some diversion, they betook themselves to the reciting of verses, sonnets, speeches, first *extempore*, and afterwards premeditately, which gave them the denomination of *Belli Humori*. After some experience, and coming more and more into the taste of these exercises, they resolved to form an academy of belles lettres, and changed the title of *Belli Humori* for that of *Humoristi*.

In 1690 the *Academy* or *Society of Arcadians* was established at Rome, for the purpose of reviving the study of poetry. The founder Crescimbeni is the author of a well-known history of Italian poetry. It numbered among its members many princes, cardinals, and other ecclesiastics; and, to avoid disputes about pre-eminence, all appeared masked after the manner of Arcadian shepherds. Within ten years from its first establishment the number of *academicians* amounted to 600.

The *Royal Academy of Savoy* dates from 1719, and was made a royal academy by Charles Felix in 1848. Its emblem is a gold orange tree full of flowers and fruit; its motto "Flores fructusque perennes," being the same as those of the famous *Florimentane* Academy, founded at Annecy by St Francis de Sales. It has published valuable memoirs on the history and antiquities of Savoy.

Germany.—Of the German literary academies, the most celebrated was *Die Fruchtbringende Gesellschaft*, the Fruitful Society, established at Weimar 1617. Five princes enrolled their names among the original members. The object was to purify the mother tongue. The German academies copied those of Italy in their quaint titles and petty ceremonials, and exercised little permanent influence on the language or literature of the country.

France.—The *French Academy* was established by order of the king in the year 1635, but in its original form it came into existence some four or five years earlier. About the year 1629 certain literary friends in Paris agreed to meet weekly at the house of one of their number. These meetings were quite informal, but the conversation turned mostly on literary topics; and when, as was often the case, one of the number had composed some work, he read it to the rest, and they gave their opinions upon it. The place of meeting was the house of M. Conrard, which was chosen as being the most central. The fame of these meetings, though the members were bound over to secrecy, reached at length the ears of Cardinal Richelieu, who conceived so high an opinion of them, that he at once promised them his protection, and offered to incorporate them by letters patent. Nearly all the members would have preferred the charms of privacy, but, considering the risk they would run in incurring the cardinal's displeasure, and that by the letter of the law all meetings of any sort or kind were prohibited, they expressed their gratitude for the high honour the cardinal thought fit to confer on them. They proceeded at once to organise their body, settle their laws and constitution, appoint officers, and choose their name. Their officers consisted of a director and a chancellor, both chosen by lot, and a permanent secretary, chosen by votes. They elected besides a publisher, not a member of the body. The director presided at the meetings, being considered as *primus inter pares*, and performing much the same part as the speaker in the English House of Commons. The chancellor kept the seals, and sealed all the official documents of the academy. The office of the secretary explains itself. The cardinal was *ex officio* protector. The meetings were weekly as before.

The letters patent were at once granted by the king, but it was only after violent opposition and long delay that the president, who was jealous of the cardinal's authority, consented to grant the verification required by the old constitution of France.

The object for which the academy was founded, as set forth in its statutes, was the purification of the French language. "The principal function of the academy shall be to labour with all care and diligence to give certain rules to our language, and to render it pure, eloquent, and capable of treating the arts and sciences" (Art. 24). They proposed "to cleanse the language from the impurities it has contracted in the mouths of the common people, from the jargon of the lawyers, from the misusages of ignorant courtiers, and the abuses of the pulpit."—*Letter of Academy to Cardinal Richelieu.*

Their numbers were fixed at forty. The original members who formed the nucleus of the body were eight, and it was not till 1639 that the full number was completed. Their first undertaking consisted of essays written by all the members in rotation. To judge by the titles and specimens which have come down to us, these possessed no special originality or merit, but resembled the ἐπιδείξεις of the Greek rhetoricians. They next, at the instance of Cardinal Richelieu, undertook a criticism of Corneille's *Cid*, the most popular work of the day. It was a rule of the academy that no work could be criticised except at the author's request. It was only the fear of incurring the cardinal's displeasure which wrung from Corneille an unwilling consent. The critique of the academy was re-written several times before it met with the cardinal's approbation. After six months of elaboration, it was published under the title, *Sentiments de l'Académie Françoise sur le Cid.* This judgment did not satisfy Corneille, as a saying attributed to him on the occasion shows. "*Horatius*," he said, referring to his last play, "was condemned by the Duumviri, but he was absolved by the people." But the crowning labour of the academy, commenced in 1639, was a dictionary of the French language. By the twenty-sixth article of their statutes, they were pledged to compose a dictionary, a grammar, a treatise on rhetoric, and one on poetry. M. Chapelain, one of the original members and leading spirits of the academy, pointed out that the dictionary would naturally be the first of these works to be undertaken, and drew up a plan of the work, which was to a great extent carried out. A catalogue was to be made of all the most approved authors, prose and verse: these were to be distributed among the members, and all words and phrases of which they approved to be marked by them in order to be incorporated in the dictionary. For this they resolved themselves into two committees, which sat on other than the regular days. M. de Vaugelas[1]

[1] A *bon mot* of his is worth recording. When returning thanks for

was appointed editor in chief. To remunerate him for his labours, he received from the cardinal a pension of 2000 francs. The first edition of this dictionary appeared in 1694, the last *Complément* in 1854.

Instead of following the history of the French Academy,—which, like its two younger sisters, the Academy of Sciences and the Academy of Inscriptions, was suppressed in 1793, and reconstituted in 1795, as a class of the Institute,—a history which it would be impossible to treat adequately in the limit of an article, we will attempt briefly to estimate its influence on French literature and language, and point out its principal merits and defects. To begin with its merits, it may justly boast that there is hardly a single name of the first rank among French *littérateurs* that it has not enrolled among its members. Molière, it is true, was rejected as a player; but we can hardly blame the academy for a social prejudice which it shared with the age; and it is well known that it has, as far as was in its power, made the *amende honorable.* In the *Sàlle des Séances* is placed the bust of the greatest of modern comedians, with the inscription, "Rien ne manque à sa gloire; il manquait à la notre." Descartes was excluded from the fact of his residing in Holland. Scarron was confined by paralysis to his own house. Pascal is the only remaining exception, and Pascal was better known to his contemporaries as a mathematician than a writer. His *Lettres Provinciales* were published anonymously; and just when his fame was rising he retired to Port-Royal, where he lived the life of a recluse. On the other hand, it cannot be denied that the *fauteuils* have often been occupied by men of no mark in literature. Nor is the academy wholly exonerated by M. Livet's ingenious defence, that there are but eight marshals in the French army, and yet the number has never appeared too restricted; for its most ardent admirers will not assert that it has, as a rule, chosen the forty most distinguished living authors. Court intrigue, rank, and *finesse* have too often prevailed over real merit and honesty. Though his facts are incorrect, there is much truth in Courier's caustic satire:—"Dans une compagnie de gens faisant profession d'esprit ou de savoir, nul ne veut près de soi un plus habile que soi, mais bien un plus noble, un plus riche: un duc et pair honore l'Académie Française, qui ne veut point de Boileau,[1] refuse la Bruyère, fait attendre Voltaire, mais reçoit tout d'abord Chapelain et Conrart."

We have next to consider the influence of the French Academy on the language and literature, a subject on which the most opposite opinions have been advanced. On the one hand, it has been asserted that it has corrected the judgment, purified the taste, and formed the language of French writers, and that to it we owe the most striking characteristics of French literature, its purity, delicacy, and flexibility. Thus Mr Matthew Arnold, in his well-known *Essay on the Literary Influence of Academies*, has pronounced a glowing panegyric on the French Academy as a high court of letters, and rallying point for educated opinion, as asserting the authority of a master in matters of tone and taste. To it he attributes in a great measure that thoroughness, that openness of mind, that absence of vulgarity which he finds everywhere in French literature; and to the want of a similar institution in England he traces that eccentricity, that provincial spirit, that coarseness, which, as he thinks, is barely compensated by English genius. Thus, too, M. Renan, one of its most distinguished living members, says that it is owing to the academy "qu'on peut tout dire sans appareil scholastique avec la langue des gens du monde." "Ah ne dites," he exclaims, "qu'ils n'ont rien fait, ces obscures beaux esprits dont la vie se passe à instruire le procès des mots, à peser les syllables. Ils ont fait un chef-d'œuvre—la langue française." On the other hand, its inherent defects have been so well summed up by M. Lanfrey, that we cannot do better than quote from his recent *History of Napoleon.* "This institution," he says, speaking of the French Academy, "had never shown itself the enemy of despotism. Founded by the monarchy and for the monarchy, eminently favourable to the spirit of intrigue and favouritism, incapable of any sustained or combined labour, a stranger to those great works pursued in common which legitimise and glorify the existence of scientific bodies, occupied exclusively with learned trifles, fatal to emulation, which it pretends to stimulate, by the compromises and calculations to which it subjects it, directed in everything by petty considerations, and wasting all its energy in childish tournaments, in which the flatteries that it showers on others are only the foretaste of the compliments it expects in return for itself, the French Academy seems to have received from its founders the special mission to transform genius into *bel esprit*, and it would be hard to produce a man of talent whom it has not demoralised. Drawn in spite of itself towards politics, it alternately pursues and avoids them; but it is specially attracted by the gossip of politics, and whenever it has so far emancipated itself as to go into opposition, it does so as the champion of ancient prejudices. If we examine its influence on the national genius, we shall see that it has given it a flexibility, a brilliancy, a polish, which it never possessed before; but it has done so at the expense of its masculine qualities, its originality, its spontaneity, its vigour, its natural grace. It has disciplined it, but it has emasculated, impoverished, and rigidified it. It sees in taste, not a sense of the beautiful, but a certain type of correctness, an elegant form of mediocrity. It has substituted pomp for grandeur, school routine for individual inspiration, elaborateness for simplicity, *fadeur* and the monotony of literary orthodoxy for variety, the source and spring of intellectual life; and in the works produced under its auspices we discover the rhetorician and the writer, never the man. By all its traditions the academy was made to be the natural ornament of a monarchical society. Richelieu conceived and created it as a sort of superior centralisation applied to intellect, as a high literary court to maintain intellectual unity, and protest against innovation. Bonaparte, aware of all this, had thought of re-establishing its ancient privileges; but it had in his eyes one fatal defect—*esprit.* Kings of France could condone a witticism even against themselves, a *parvenu* could not."

In conclusion, we would briefly state our own opinion. The influence of the French Academy has been conservative rather than creative. While it has raised the general standard of writing, it has tended to hamper and crush originality. It has done much by its example for style, but its attempts to impose its laws on language have, from the nature of the case, failed. For, however perfectly a dictionary or a grammar may represent the existing language of a nation, an original genius is certain to arise—a Victor Hugo, or an Alfred de Musset, who will set at defiance all dictionaries and academic rules.

Spain.—The *Royal Spanish Academy at Madrid* held its first meeting in July 1713, in the palace of its founder, the Duke d'Escalona. It consisted at first of 8 academicians, including the duke; to which number 14 others were afterwards added, the founder being chosen president or director. In 1714 the king granted them the royal confirmation and protection. Their device is a crucible in

his pension, the cardinal remarked, "Well, Monsieur, you will not forget the word *pension* in your dictionary." "No, Monseigneur," replied Vaugelas, "and still less the word *gratitude.*"

[1] Boileau was elected to the French Academy 1684, La Bruyère in 1693.

the middle of the fire, with this motto, *Limpia, fixa, y da esplendor*—"It purifies, fixes, and gives brightness." The number of its members was limited to 24; the Duke d'Escalona was chosen director for life, but his successors were elected yearly, and the secretary for life. Their object, as marked out by the royal declaration, was to cultivate and improve the national language. They were to begin with choosing carefully such words and phrases as have been used by the best Spanish writers; noting the low, barbarous, or obsolete ones; and composing a dictionary wherein these might be distinguished from the former.

Sweden.—The *Royal Swedish Academy* was founded in the year 1786, for the purpose of purifying and perfecting the Swedish language. A medal is struck by its direction every year in honour of some illustrious Swede. This academy does not publish its transactions.

Belgium.—Belgium has always been famous for its literary societies. The little town of Diest boasts that it possessed a society of poets in 1302, and the Catherinists of Alost date from 1107. Whether or not there is any foundation for these claims, it is certain that numerous *Chambers of Rhetoric* (so academies were then called) existed in the first years of the rule of the house of Burgundy.

The present *Royal Academy of Belgium* was founded by the Count of Coblenzl at Brussels, 1769. Count Stahrenberg obtained for it in 1772 letters patent from Maria Theresa, who also granted pensions to all the members, and a fund for printing their works. All academicians were *ipso facto* ennobled. It was reorganised, and a class of fine arts added in 1845 through the agency of M. Van de Weyer, the learned Belgian ambassador at London. It has devoted itself principally to national history and antiquities.

III. Academies of Archæology and History.—*Italy.*—Under this class the *Academy of Herculaneum* properly ranks. It was established at Naples about 1755, at which period a museum was formed of the antiquities found at Herculaneum, Pompeii, and other places, by the Marquis Tanucci, who was then minister of state. Its object was to explain the paintings, &c., which were discovered at those places; and for this purpose the members met every fortnight, and at each meeting three paintings were submitted to three academicians, who made their report on them at their next sitting. The first volume of their labours appeared in 1775, and they have been continued under the title of *Antichità di Ercolano.* They contain engravings of the principal paintings, statues, bronzes, marble figures, medals, utensils, &c., with explanations. In the year 1807, an Academy of History and Antiquities, on a new plan, was established at Naples by Joseph Bonaparte. The number of members was limited to forty; twenty of whom were to be appointed by the king, and these twenty were to present to him, for his choice, three names for each of those wanted to complete the full number. Eight thousand ducats were to be annually allotted for the current expenses, and two thousand for prizes to the authors of four works which should be deemed by the academy most deserving of such a reward. A grand meeting was to be held every year, when the prizes were to be distributed, and analyses of the works read. The first meeting took place on the 25th of April 1807; but the subsequent changes in the political state of Naples prevented the full and permanent establishment of this institution. In the same year an academy was established at Florence for the illustration of Tuscan antiquities, which published some volumes of memoirs.

France.—The old *Academy of Inscriptions and Belles Lettres* was an off-shoot from the French Academy, which then at least contained the *élite* of French learning. Louis XIV. was of all French kings the one most occupied with his own aggrandisement. Literature, and even science, he only encouraged so far as they redounded to his own glory. Nor were literary men inclined to assert their independence. Boileau well represented the spirit of the age when, in dedicating his tragedy of *Berenice* to Colbert, he wrote—"The least things become important if in any degree they can serve the glory and pleasure of the king." Thus it was that the Academy of Inscriptions arose. At the suggestion of Colbert, a company (a committee we should now call it) had been appointed by the king, chosen from the French Academy, charged with the office of furnishing inscriptions, devices, and legends for medals. It consisted of four academicians: Chapelain, then considered the poet laureate of France, one of the authors of the critique on the *Cid* (see above); l'abbé de Bourzeis; François Carpentier, an antiquary of high repute among his contemporaries; and l'abbé de Capagnes, who owed his appointment more to the fulsome flattery of his odes than his really learned translations of Cicero and Sallust. This company used to meet in Colbert's library in the winter, at his country-house at Sceaux in the summer, generally on Wednesdays, to serve the convenience of the minister, who was constantly present. Their meetings were principally occupied with discussing the inscriptions, statues, and pictures intended for the decoration of Versailles; but M. Colbert, a really learned man and an enthusiastic collector of manuscripts, was often pleased to converse with them on matters of art, history, and antiquities. Their first published work was a collection of engravings, accompanied by descriptions, designed for some of the tapestries at Versailles. Louvois, who succeeded Colbert as a superintendent of buildings, revived the company, which had begun to relax its labours. Félibien, the learned architect, and the two great poets Racine and Boileau, were added to their number. A series of medals was commenced, entitled *Médailles de la Grande Histoire*, or, in other words, the history of le Grand Monarque.

But it was to M. de Portchartrain, comptroller-general of finance and secretary of state, that the academy owed its institution. He added to the company Renaudot and Tourreil, both men of vast learning, the latter tutor to his son, and put at its head his nephew, l'abbé Bignon, librarian to the king. By a new regulation, dated the 16th July 1701, the *Royal Academy of Inscriptions and Medals* was instituted, being composed of ten honorary members, ten pensioners, ten associates, and ten pupils. On its constitution we need not dwell, as it was an almost exact copy of that of the Academy of Science. Among the regulations we find the following, which indicates clearly the transition from a staff of learned officials to a learned body:—"The academy shall concern itself with all that can contribute to the perfection of inscriptions and legends, of designs for such monuments and decorations as may be submitted to its judgment; also with the description of all artistic works, present and future, and the historical explanation of the subject of such works; and as the knowledge of Greek and Latin antiquities, and of these two languages, is the best guarantee for success in labours of this class, the academicians shall apply themselves to all that this division of learning includes, as one of the most worthy objects of their pursuit."

Among the first honorary members we find the indefatigable Mabillon (excluded from the pensioners by reason of his orders), Père La Chaise, the king's confessor, and Cardinal Rohan; among the associates Fontenelle, and Rollin, whose *Ancient History* was submitted to the academy for revision. In 1711 they completed *L'Histoire Métallique du Roi*, of which Saint-Simon was asked to

write the preface. In 1716 the regent changed its title to that of the *Academy of Inscriptions and Belles Lettres*, a title which better suited its new character.

In the great battle between the Ancients and the Moderns which divided the learned world in the first half of the 18th century, the Academy of Inscriptions naturally espoused the cause of the Ancients, as the Academy of Sciences did that of the Moderns. During the earlier years of the French Revolution the academy continued its labours uninterruptedly; and on the 22d of January 1793, the day after the death of Louis XVI., we find in the *Proceedings* that M. Bréquigny read a paper on the projects of marriage between Queen Elizabeth and the Dukes of Anjou and Alençon. In the same year were published the 45th and 46th vols. of the *Mémoires de l'Académie*. On the 2d of August of the same year the last *séance* of the old academy was held. More fortunate than its sister Academy of Sciences, it lost only three of its members by the guillotine. One of these was the astronomer Sylvain Bailly. Three others sat as members of the Convention; but for the honour of the academy, we must add that all three were distinguished by their moderation.

In the first draught of the new Institute, October 25, 1795, no class corresponded exactly to the old Academy of Inscriptions; but most of the members who survived found themselves re-elected either in the 2d class of moral and political science, under which history and geography were included as sections, or more generally under the 3d class of literature and fine arts, which embraced ancient languages, antiquities, and monuments.

In 1816 the academy received again its old name. The *Proceedings* of the Society embrace a vast field, and are of very various merits. Perhaps the subjects on which it has shown most originality are comparative mythology, the history of science among the ancients, and the geography and antiquities of France. The old academy has reckoned among its members De Sacy the Orientalist, Dansse de Villoison the philologist, Du Perron the traveller, Sainte-Croix and Du Theil the antiquarians, and Le Beau, who has been named the last of the Romans. The new academy has already inscribed on its lists the well-known names of Champollion, A. Rémusat, Raynouard, Burnouf, and Augustin Thierry.

Celtic Academy.—In consequence of the attention of several literary men in Paris having been directed to Celtic antiquities, a *Celtic Academy* was established in that city in the year 1800. Its objects were, first, the elucidation of the history, customs, antiquities, manners, and monuments of the Celts, particularly in France; secondly, the etymology of all the European languages, by the aid of the Celto-British, Welsh, and Erse; and, thirdly, researches relating to Druidism. The attention of the members was also particularly called to the history and settlements of the Galatæ in Asia. Lenoir, the keeper of the museum of French monuments, was appointed president. The academy still exists as *La Société Royale des Antiquaires de France.*

IV. Academies of Medicine and Surgery.—*Germany.*—The Academy of *Naturæ Curiosi*, called also the *Leopoldine Academy*, was founded in 1662, by J. L. Bausch, a physician of Leipsic, who, imitating the example of the English, published a general invitation to medical men to communicate all extraordinary cases that occurred in the course of their practice. The works of the *Naturæ Curiosi* were at first published separately; but this being attended with considerable inconvenience, a new arrangement was formed, in 1770, for publishing a volume of observations annually. From some cause, however, the first volume did not make its appearance until 1784, when it came forth under the title of *Ephemerides.* In 1687, the Emperor Leopold took the society under his protection, and established it at Vienna; hence the title of *Leopoldine* which it in consequence assumed. But though it thus acquired a name, it had no fixed place of meeting, and no regular assemblies; instead of which there was a kind of bureau or office, first established at Breslau, and afterwards removed to Nuremberg, where communications from correspondents were received, and persons properly qualified admitted as members. By its constitution the Leopoldine Academy consists of a president, two adjuncts or secretaries, and colleagues or members, without any limitation as to numbers. At their admission the last come under a two fold obligation—first, to choose some subject for discussion out of the animal, vegetable, or mineral kingdom, provided it has not been previously treated of by any colleague of the academy; and, secondly, to apply themselves to furnish materials for the annual *Ephemerides.* Each member also bears about with him the symbol of the academy, consisting of a gold ring, whereon is represented a book open, with an eye on one side, and on the other the academical motto of *Nunquam otiosus.*

The *Academy of Surgery* at Vienna was instituted by the present emperor, under the direction of the celebrated Brambella. In it there were at first only two professors: and to their charge the instruction of a hundred and thirty young men was committed, thirty of whom had formerly been surgeons in the army. But latterly the number both of teachers and pupils was considerably increased. Gabrielli was appointed to teach pathology and practice; Boecking, anatomy, physiology, and physics; Streit, medical and pharmaceutical surgery; Hunczowsky, surgical operations, midwifery, and *chirurgia forensis;* and Plenk, chemistry and botany. To these was also added Beindel, as prosecutor and extraordinary professor of surgery and anatomy. Besides this, the emperor provided a large and splendid edifice in Vienna, which affords accommodation both for the teachers, the students, pregnant women, patients for clinical lectures, and servants. For the use of this academy the emperor also purchased a medical library, which is open every day; a complete set of chirurgical instruments; an apparatus for experiments in natural philosophy; a collection of natural history; a number of anatomical and pathological preparations; a collection of preparations in wax, brought from Florence; and a variety of other useful articles. Adjoining the building there is also a good botanical garden. With a view to encourage emulation among the students of this institution, three prize medals, each of the value of 40 florins, are annually bestowed on those who return the best answers to questions proposed the year before. These prizes, however, are not entirely founded by the emperor, but are in part owing to the liberality of Brendellius, formerly protochirurgus at Vienna.

France.—Royal Academy of Medicine.—Medicine is a science which has always engaged the attention of the kings of France. Charlemagne established a school of medicine in the Louvre, and various societies have been founded, and privileges granted to the faculty by his successors. The *Royal Academy of Medicine* succeeded to the old Royal Society of Medicine and the Academy of Surgery. It was erected by a royal ordinance, dated December 20, 1820. It was divided into three sections—medicine, surgery, and pharmacy. In its constitution it closely resembled the Academy of Sciences (*vid. sup.*) Its function was to preserve or propagate vaccine matter, and answer inquiries addressed to it by the Government on the subject of epidemics, sanitary reform, and public health generally. It has maintained an enormous correspondence in all quarters of the globe, and published extensive minutes.

V. Academies of the Fine Arts.—*Russia.*—The

academy at St Petersburg was established by the Empress Elizabeth, at the suggestion of Count Shuvaloff, and annexed to the Academy of Sciences. The fund for its support was £4000 per annum, and the foundation admitted forty scholars. Catharine II. formed it into a separate institution, augmented the annual revenue to £12,000, and increased the number of scholars to three hundred; she also constructed, for the use and accommodation of the members, a large circular building, which fronts the Neva. The scholars are admitted at the age of six, and continue until they have attained that of eighteen. They are clothed, fed, and lodged at the expense of the crown; and are all instructed in reading and writing, arithmetic, the French and German languages, and drawing. At the age of fourteen they are at liberty to choose any of the following arts, divided into four classes, viz., first, painting in all its branches of history portraits, war-pieces, and landscapes, architecture, mosaic, enamelling, &c.; secondly, engraving on copperplates, seal-cutting, &c.; thirdly, carving on wood, ivory, and amber; fourthly, watch-making, turning, instrument making, casting statues in bronze and other metals, imitating gems and medals in paste and other compositions, gilding, and varnishing. Prizes are annually distributed to those who excel in any particular art; and, from those who have obtained four prizes, twelve are selected, who are sent abroad at the charge of the crown. A certain sum is paid to defray their travelling expenses; and when they are settled in any town, they receive an annual salary of £60, which is continued during four years. There is a small assortment of paintings for the use of the scholars; and those who have made great progress are permitted to copy the pictures in the imperial collection. For the purpose of design, there are models in plaster, all done at Rome, of the best antique statues in Italy, and of the same size with the originals, which the artists of the academy were employed to cast in bronze.

France.—The *Academy of Painting and Sculpture at Paris* was founded by Louis XIV. in 1648, under the title of Académie Royale des Beaux Arts, to which was afterwards united the Academy of Architecture, erected 1671. The academy is composed of painters, sculptors, architects, engravers, and musical composers. From among the members of the society, who are painters, is chosen the director of the French Académie des Beaux Arts at Berne, also instituted by Louis XIV. in 1677. The director's province is to superintend the studies of the painters, sculptors, &c., who, having been chosen by competition, are sent to Italy at the expense of the Government, to complete their studies in that country. Most of the celebrated French painters have begun their career in this way.

The *Royal Academy of Music* is the name which, by a strange perversion of language, is given in France to the grand opera. In 1571 the poet Baïf established in his house an academy or school of music, at which ballets and masquerades were given. In 1645 Mazarin brought from Italy a troupe of actors, and established them in the Rue du Petit Bourbon, where they executed Jules Strozzi's "Achille in Sciro," the first opera performed in France. After Molière's death in 1673, his theatre in the Palais Royal was given to Sulli, and there were performed all Gluck's great operas; there Vestris danced, and there was produced Jean Jacques Rousseau's "Devin du Village."

Italy.—In 1778 an Academy of Painting and Sculpture was established at Turin. The meetings were held in the palace of the king, who distributed prizes among the most successful members. In Milan an Academy of Architecture was established so early as the year 1380, by Galeas Visconti. About the middle of the last century an Academy of the Arts was established there, after the example of those at Paris and Rome. The pupils were furnished with originals and models, and prizes were distributed annually. The prize for painting was a gold medal, and no prize was bestowed till all the competing pieces had been subjected to the examination and criticism of competent judges. Before the effects of the French Revolution reached Italy this was one of the best establishments of the kind in that kingdom. In the hall of the academy were some admirable pieces of Correggio, as well as several ancient paintings and statues of great merit,—particularly a small bust of Vitellius, and a statue of Agrippina, of most exquisite beauty, though it wants the head and arms. The Academy of the Arts, which had been long established at Florence, fell into decay, but was restored in the end of last century. In it there are halls for nude and plaster figures, for the use of the sculptor and the painter. The hall for plaster figures had models of all the finest statues in Italy, arranged in two lines; but the treasures of this and the other institutions for the fine arts were greatly diminished during the occupancy of Italy by the French. In the saloon of the Academy of the Arts at Modena there are many casts of antique statues; but after being plundered by the French it dwindled into a petty school for drawings from living models; it contains the skull of Correggio. There is also an Academy of the Fine Arts in Mantua, and another at Venice.

Spain.—In Madrid an Academy for Painting, Sculpture, and Architecture, was founded by Philip V. The minister for foreign affairs is president. Prizes are distributed every three years. In Cadiz a few students are supplied by Government with the means of drawing and modelling from figures; and such as are not able to purchase the requisite instruments are provided with them.

Sweden.—An Academy of the Fine Arts was founded at Stockholm in the year 1733 by Count Tessin. In its hall are the ancient figures of plaster presented by Louis XIV. to Charles XI. The works of the students are publicly exhibited, and prizes are distributed annually. Such of them as display distinguished ability obtain pensions from Government, to enable them to reside in Italy for some years, for the purposes of investigation and improvement. In this academy there are nine professors, and generally about four hundred students. In the year 1705 an Academy of Painting, Sculpture, and Architecture was established at Vienna, with the view of encouraging and promoting the fine arts.

England.—The *Royal Academy of Arts in London* was instituted for the encouragement of designing, painting, sculpture, &c., in the year 1768, with Sir J. Reynolds for its president. This academy is under the immediate patronage of the queen, and under the direction of forty artists of the first rank in their several professions. It furnishes, in winter, living models of different characters to draw after; and in summer, models of the same kind to paint after. Nine of the ablest academicians are annually elected out of the forty, whose business it is to attend by rotation, to set the figures, to examine the performance of the students, and to give them necessary instructions. There are likewise professors of painting, sculpture, architecture, anatomy, and chemistry, who annually read public lectures on the subjects of their several departments; besides a president, a council, and other officers. The admission to this academy is free to all students properly qualified to reap advantage from the studies cultivated in it; and there is an annual exhibition at Burlington House of paintings, sculptures, and designs, open to all artists of distinguished merit.

The *Academy of Ancient Music* was established in London in 1710, by several persons of distinction, and other

amateurs, in conjunction with the most eminent masters of the time, with the view of promoting the study and practice of vocal and instrumental harmony. This institution, which had the advantage of a library, consisting of the most celebrated compositions, both foreign and domestic, in manuscript and in print, and which was aided by the performances of the gentlemen of the chapel royal, and the choir of St Paul's, with the boys belonging to each, continued to flourish for many years. In 1731 a charge of plagiarism brought against Bononcini, a member of the academy, for claiming a madrigal of Lotti of Venice as his own, threatened the existence of the institution. Dr Greene, who had introduced the madrigal into the academy, took part with Bononcini, and withdrew from the society, taking with him the boys of St Paul's. In 1734 Mr Gates, another member of the society, and master of the children of the royal chapel, also retired in disgust; so that the institution was thus deprived of the assistance which the boys afforded it in singing the soprano parts. From this time the academy became a seminary for the instruction of youth in the principles of music and the laws of harmony. Dr Pepusch, who was one of its founders, was active in accomplishing this measure; and by the expedient of educating boys for their purpose, and admitting auditor members, the subsistence of the academy was continued. The *Royal Academy of Music* was formed by the principal nobility and gentry of the kingdom, for the performance of operas, composed by Handel, and conducted by him at the theatre in the Haymarket. The subscription amounted to £50,000, and the king, besides subscribing £1000, allowed the society to assume the title of *Royal Academy*. It consisted of a governor, deputy-governor, and twenty directors. A contest between Handel and Senesino, one of the performers, in which the directors took the part of the latter, occasioned the dissolution of the academy, after it had subsisted with reputation for more than nine years. The present *Royal Academy of Music* dates from 1822, and was incorporated in 1830 under the patronage of the queen. It instructs pupils of both sexes in music, charging 33 guineas per annum; but many receive instruction free. It also gives public concerts. In this institution the leading instrumentalists and vocalists of England have received their education. (See *Musical Directory* published by Rudall, Carte, and Co.)

ACADEMY is a term also applied to those royal collegiate seminaries in which young men are educated for the navy and army. In our country there are three colleges of this description—the Royal Naval College at Portsmouth, the Royal Military Academy at Woolwich, and the Royal Military College, Sandhurst.

(F. S.)

ACADIE, or ACADIA, the name borne by Nova Scotia while it remained a French settlement.

ACALEPHÆ (from ἀκαλήφη, a nettle), a name given to the animals commonly known as *jelly-fish*, *sea-blubber*, *Medusæ*, *sea-nettles*, &c.

ACANTHOCEPHALA (from ἄκανθα, a thorn, and κεφαλή, the head), a group of parasitic worms, having the heads armed with spines or hooks.

ACANTHOPTERYGII (from ἄκανθα, a thorn, and πτέρυξ, a wing), an order of fishes, having bony skeletons with prickly spinous processes in the dorsal fins.

ACANTHUS, a genus of plants belonging to the natural order Acanthaceæ. The species are natives of the southern parts of Europe. The most common species is the *Acanthus mollis* or *Brankursine*. It has large, deeply-cut, hairy, shining leaves, which are supposed to have suggested the decoration of the Corinthian column. Another species, *Acanthus spinosus*, is so called from its spiny leaves.

ACAPULCO, a town and port in Mexico, on a bay of the Pacific Ocean, about 190 miles S.S.W. of Mexico, in N. lat. 16° 50′, W. long. 99° 46′. The harbour, which is the best on the Pacific coast, is almost completely land-locked. It is easy of access, and the anchorage is so secure that heavily-laden ships can lie close to the rocks which surround it. The town lies N.W. of the harbour, and is defended by the castle of San Diego, which stands on an eminence. During a part of the dry season the air is infected with the putrid effluvia of a morass eastward of the town. This, together with the heat of the climate, aggravated by the reflection of the sun's rays from the granite rocks that environ the town, renders it very unhealthy, especially to Europeans, though a passage cut through the rocks, to let in the sea breeze, has tended to improve its salubrity. Acapulco was in former times the great depôt of the trade of Spain with the East Indies. A galleon sailed from this port to Manilla in the Philippine Islands, and another returned once a year laden with the treasures and luxuries of the East. On the arrival of this galleon a great fair was held, to which merchants resorted from all parts of Mexico. The trade between Acapulco and Manilla was annihilated when Mexico became independent; and, from this cause, and also on account of the frequent earthquakes by which the town has been visited, it had sunk to comparative insignificance, when the discovery of gold in California gave its trade a fresh impetus. It is now the most important seaport in Mexico, and is regularly touched at by the Pacific mail steamers. Besides having a large transit trade, it exports wool, skins, cocoa, cochineal, and indigo; and the imports include cottons, silks, and hardware. Population about 5000.

ACARNANIA, a province of ancient Greece, now called Carnia. It was bounded on the N. by the Ambracian gulf, on the N.E. by Amphilochia, on the W. and S.W. by the Ionian Sea, and on the E. by Ætolia. It was a hilly country, with numerous lakes and tracts of rich pasture, and its hills are to the present day crowned with thick wood. It was celebrated for its excellent breed of horses. The Acarnanians, according to Mr Grote, though admitted as Greeks to the Pan-Hellenic games, were more akin in character and manners to their barbarian neighbours of Epirus. Up to the time of the Peloponnesian war, they are mentioned only as a race of rude shepherds, divided into numerous petty tribes, and engaged in continual strife and rapine. They were, however, favourably distinguished from their Ætolian neighbours by the fidelity and steadfastness of their character. They were good soldiers, and excelled as slingers. At the date above mentioned they begin, as the allies of the Athenians, to make a more prominent figure in the history of Greece. The chief town was Stratos, and subsequently Leucas.

ACARUS (from ἄκαρι, a mite), a genus of Arachnides, represented by the cheese mite and other forms.

ACCELERATION is a term employed to denote generally the rate at which the velocity of a body, whose motion is not uniform, either increases or decreases. As the velocity is continually changing, and cannot therefore be estimated, as in uniform motion, by the space actually passed over in a certain time, its value at any instant has to be measured by the space the body would describe in the unit of time, supposing that at and from the instant in

question the motion became and continued uniform. If the motion is such that the velocity, thus measured, increases or decreases by equal amounts in equal intervals of time, it is said to be *uniformly* accelerated or retarded. In that case, if f denote the amount of increase or decrease of velocity corresponding to the unit of time, the whole of such increase or decrease in t units of time will evidently be ft, and therefore if u be the initial and v the final velocity for that interval, $v = u \pm ft$,—the upper sign applying to accelerated, the lower to retarded, motion. To find the distance or space, s, gone over in t units of time, let t be divided into n equal intervals. The velocities at the end of the successive intervals will be $u \pm f\frac{t}{n}$, $u \pm f\frac{2t}{n}$, $u \pm f\frac{3t}{n}$, &c. Let it now be supposed that during each of these small intervals the body has moved uniformly with its velocity at the end of the interval, then (since a body moving uniformly for x seconds with a velocity of y feet per second will move through xy feet) the spaces described in the successive intervals would be the product of the velocities given above by $\frac{t}{n}$, and the whole space in the time t would be the sum of these spaces; *i.e.*,

$$s = u\frac{t}{n}(1+1\ldots\text{ repeated } n \text{ times}) \pm f\cdot\frac{t^2}{n^2}(1+2+3\ldots\ldots+n)$$

$$= ut \pm f\cdot\frac{t^2}{n^2}\cdot\frac{n(n+1)}{2} = ut \pm \frac{1}{2}ft^2\left(1+\frac{1}{n}\right).$$

It is evident, however, that as the increase or decrease of velocity takes place continuously, this sum will be too large; but the greater n is taken, or (which is the same thing) the smaller the intervals are during which the velocity is supposed to be uniform, the nearer will the result be to the truth. Hence making n as large as possible, or $\frac{1}{n}$ as small as possible, *i.e.*, $=0$, we obtain as the correct expression $s = ut \pm \frac{1}{2}ft^2$. In the case of motion from rest, $u=0$, and the above formulæ become $v = ft$, $s = \frac{1}{2}ft^2$.

We have a familiar instance of uniformly accelerated and uniformly retarded motion in the case of bodies falling and rising vertically near the earth's surface, where, if the resistance of the air be neglected, the velocity of the body is increased or diminished, in consequence of the earth's attraction, by a uniform amount in each second of time. To this amount is given the name of the acceleration of gravity (usually denoted by the letter g), the value of which, in our latitudes and at the surface of the sea, is very nearly $32\frac{1}{6}$ feet per second. Hence the space a body falls from rest in any number of seconds is readily found by multiplying $16\frac{1}{12}$ feet by the square of the number of seconds. For a fuller account of accelerating force,—expressed in the notation of the Differential Calculus by $f = \pm\frac{dv}{dt}$ or $f = \pm\frac{d^2s}{dt^2}$,—the reader is referred to the article DYNAMICS.

ACCENT, in reading or speaking, is the stress or pressure of the voice upon a *syllable* of a word. The derivation of the term (Lat. *accentus, quasi adcantus*) clearly shows that it was employed by the classical grammarians to express the production of a musical effect. Its origin is therefore to be sought in the natural desire of man to gratify the ear by modulated sound, and probably no language exists in which it does not play a more or less important part. "Only a machine," says Professor Blackie (*Place and Power of Accent in Language*, in the *Transactions of the Royal Society of Edinburgh*, 1871), "could produce a continuous series of sounds in undistinguished monotonous repetitions like the *tŭm, tŭm, tŭm*, of a drum; a rational being using words for a rational purpose to manifest his thoughts and feelings, necessarily accents both words and sentences in some way or other." That the accentuation of some languages is more distinct, various, and effective than that of others is beyond question, but there are none, so far as we know, in which its power is not felt. The statement sometimes made, that the French have no accent in their words, can only mean that their accent is less emphatic or less variously so than that of certain other nations. If it means more, it is not merely an error, but an absurdity. From this conception of the subject, it is obvious that accent must be fundamentally the same thing in all languages, and must aim more or less successfully at the same results, however diverse the rules by which it is governed. But there are, nevertheless, important differences between the conditions under which accent operated in the classical, and those in which it operates in modern tongues. It did not wholly determine the rhythm, nor in the least affect the metre of classical verse; it did not fix the quantity or length of classical syllables. It was a musical element superadded to the measured structure of prose and verse.

Passing over the consideration of the accentual system of the Hebrews with the single remark, that it exhibits, though with more elaborate and complicated expression, most of the characteristics both of Greek and English accent, we find that the Greeks employed three grammatical accents, viz., the *acute accent* (´), which shows when the tone of the voice is to be raised; the *grave accent* (`), when it is to be depressed; and the *circumflex accent* (^), composed of both the acute and the grave, and pointing out a kind of undulation of the voice. The Latins have made the same use as the Greeks of these three accents, and various modern nations, French, English, &c., have also adopted them. As to the Greek accents, now seen both in manuscripts and printed books, there has been great dispute about their antiquity and use. But the following things seem to be undoubtedly taught by the ancient grammarians and rhetoricians:—(1.) That by *accent* (προσῳδία, τόνος) the Greeks understood the elevation or falling of the voice on a particular syllable of a word, either absolutely, or in relation to its position in a sentence, accompanied with an *intension* or *remission* of the vocal utterance on that syllable (ἐπίτασις, ἄνεσις), occasioning a marked predominance of that syllable over the other syllables of the word. The predominance thus given, however, had no effect whatever on the quantity —long or short—of the accented syllable. The accented syllable in Greek as in English, might be long or it might be short; elevation and emphasis of utterance being one thing, and prolongation of the vocal sound quite another thing, as any one acquainted with the first elements of music will at once perceive. The difficulty which many modern scholars have experienced in conceiving how a syllable could be accented and not lengthened, has arisen partly from a complete want of distinct ideas on the nature of the elements of which human speech is composed, and partly also from a vicious practice which has long prevailed in the English schools, of reading Greek, not according to the laws of its own accentuation, but according to the accent of Latin handed down to us through the Roman Catholic Church. For the rules of Latin accentuation are, as Quintilian and Cicero and the grammarians expressly mention, very different from the Greek; and the long syllable of a word has the accent in Latin in a hundred cases, where the musical habit of the Greek ear placed it upon the short. There is, besides, a vast number of words in Greek accented on the last syllable (like *voluntee'r, ambusca'de*, in English), of which not a single instance occurs in the Latin lan-

guage. Partly, however, from ignorance, partly from carelessness, and partly perhaps from stupidity, our scholars transferred the pronunciation of the more popular learned language to that which was less known; and with the help of time and constant usage, so habituated themselves to identify the accented with the long syllable, according to the analogy of the Latin, that they began seriously to doubt the possibility of pronouncing otherwise. English scholars have long ceased to recognise its existence, and persist in reading Greek as if the accentual marks meant nothing at all. Even those who allow (like Mr W. G. Clark and Professor Munro) that ancient Greek accent denoted an elevation of voice or tone, are still of opinion that it is impossible to reproduce it in modern times. "Here and there," says the former (*Cambridge Journal of Philology*, vol. i. 1868), "a person may be found with such an exquisite ear, and such plastic organs of speech, as to be able to reproduce the ancient distinction between the length and tone of syllables accented and unaccented, and many not so gifted may fancy that they reproduce it when they do nothing of the kind. For the mass of boys and men, pupils as well as teachers, the distinction is practically impossible." But, in spite of such pessimist views, it may, on the whole, be safely asserted that since the appearance of a more philosophical spirit in philology, under the guidance of Hermann, Boeckh, and other master-minds among the Germans, the best grammarians have come to recognise the importance of this element of ancient Hellenic enunciation, while not a few carry out their principles into a consistent practice. The only circumstance, indeed, that prevents our English scholars from practically recognising the element of accent in classical teaching, is the apprehension that this would interfere seriously with the practical inculcation of quantity; an apprehension in which they are certainly justified by the practice of the modern Greeks, who have given such a predominance to accent, as altogether to subordinate, and in many cases completely overwhelm quantity; and who also, in public token of this departure from the classical habit of pronunciation, regularly compose their verses with a reference to the spoken accent only, leaving the quantity—as in modern language generally—altogether to the discretion of the poet. But, as experiment will teach any one that there is no necessity whatever in the nature of the human voice for this confusion of two essentially different elements, it is not unlikely that English scholars will soon follow the example of the Germans, and read Greek prose at least systematically according to the laws of classical speech, as handed down to us by the grammarians of Alexandria and Byzantium. In the recitation of classical verse, of course, as it was not constructed on accentual principles, the skilful reader will naturally allow the musical accent, or the emphasis of the rhythm to overbear, to a great extent, or altogether to overwhelm, the accent of the individual word; though with regard to the recitation of verse, it will always remain a problem how far the ancients themselves did not achieve an "*accentuum cum quantitate apta conciliatio*," such as that which Hermann (*De emendanda ratione, &c.*) describes as the perfection of a polished classical enunciation. A historic survey of the course of learned opinion on the subject of accent, from the age of Erasmus down to the present day, forms an interesting and important part of Professor Blackie's essay quoted above. See Pennington's work on Greek Pronunciation, Cambridge, 1844; the German work on Greek Accent by Göttling (English), London, 1831; and Blackie's essay on the *Place and Power of Accent*, in the *Transactions of the Royal Society of Edinburgh*, 1870–71.

If there is any perplexity regarding the nature or influence of classical accent, there is none about English. It does not conflict or combine with the modulations of quantity. It is the sole determining element in our metrical system. Almost the very earliest of our authors, the Venerable Bede, notices this. In defining rhythm he says—"It is a modulated composition of words, not according to the laws of metre, but adapted in the number of its syllables to the judgment of the ear, *as are the verses of our vulgar poets*" (*Bede*, *Op.* vol. i. p. 57, ed. 1553). We have, of course, long vowels and short, like the Greeks and the Romans, but we do not regulate our verse by them; and our mode of accentuation is sufficiently despotic to occasionally almost change their character, so that a long vowel shall seem short, and *vice versa*. In reality this is not so. The long vowel remains long, but then its length gives it no privilege of place in a verse. It may modify the enunciation, it may increase the roll of sound, but a short vowel could take its place without a violation of metre. Take the word *far*, for example; there the vowel *a* is long, yet in the line

"O Moon, far-spooming Ocean bows to thee,"

it is not necessary that the *a* in *far* should be long; a short vowel would do as well for metrical purposes, and would even bring out more distinctly the accentuation of the syllable *spoom*.

Originally English accent was upon the root, and not upon inflectional syllables. Göttling finds the same principle operating in Greek, but in that language it certainly never exercised the universal sway it does in the earlier forms of English. In the following passage from *Beowulf*, the oldest monument of English literature, belonging, in its first form, to a period even anterior to the invasion of Britain by the Angles and Saxons, we shall put the accented or emphatic syllables in italics:—

Strǽt waes *stán*-fah . .	The street was of variegated ston ,
stíg wísode	the path directed
*gum*um aet-*gaed*ere . .	the men together;
gúd-byrne scán	the war-corselet shone
heard, *hond*-locen . . .	hard, hand-locked;
hring-íren scír	the ring-iron bright
song in *sear*wum . . .	sang in their trappings,
þá híe tó *sel*e furdum .	when they to the hall forward
in hyra *grýre*-*geat*wum .	in their terrible armour
*gang*an cwomon . . .	came to go.

It will be observed that in these verses the accent (not to be confounded with the mark which is used in Anglo-Saxon to show that the vowel over which it is placed is long) is invariably on a monosyllable, or on the root part of a word of more than one syllable. The passage is also a good illustration of what has previously been stated, that the metre or rhythm in English is determined not by the vowel-quantity of a syllable, but by the stress of the voice on particular syllables, whether the vowels are long or short. In the older forms of English verse the accent is somewhat irregular; or, to put it more accurately, the number of syllables intervening between the recurrent accents is not definitely fixed. Sometimes two or more intervene, sometimes none at all. Take, for example, the opening lines of Langland's poem, entitled the *Vision of Piers the Plowman*:—

"In a *som*er *se*son
Whan soft was the *son*ne,
I *shope* me in *shroud*es,
As I a *shepe* were,
In *ha*bit as an *he*remite
Un*ho*ly of workes,
Went *wide* in this *world*
*Won*ders to here.
Ac on a *May morn*ynge
On *Mal*uerne hulles,
Me by*fel* a *fer*ly.
Of *fai*ry, me thoughte;
I was *we*ry for*wan*dred,
And *went* me to reste
Under a *brode bun*ke
By a *bor*nes side.
And as I *lay* and *len*ed,
And *lok*ed in the waters,
I *slom*bred in a *slep*yng,
It *swey*ued so merye."

But no matter how irregular the time elapsing between the

recurrence of the accents, they are always on the root-syllables.

The Norman Conquest, however, introduced a different system, which gradually modified the rigid uniformity of the native English accentuation. The change is visible as early as the end of the 12th century. By the middle of the 14th, that is to say, in the age of Chaucer, it is in full operation. Its origin is thus explained by Mr Marsh, in his *Origin and History of the English Language* (Lond., 1862):—"The vocabulary of the French language is derived, to a great extent, from Latin words deprived of their terminal inflections. The French adjectives *mortal* and *fatal* are formed from the Latin *mortalis* and *fatalis*, by dropping the inflected syllable; the French nouns *nation* and *condition* from the Latin accusatives *nationem*, *conditionem*, by rejecting the *em* final. In most cases, the last syllable retained in the French derivatives was prosodically long in the Latin original; and either because it was also accented, or because the slight accent which is perceivable in the French articulation represents temporal length, the stress of the voice was laid on the *final* syllable of all these words. When we borrowed such words from the French we took them with their native accentuation; and as accent is much stronger in English than in French, the *final* syllable was doubtless more forcibly enunciated in the former than in the latter language." The new mode of accentuation soon began to affect even words of pure English origin—*e.g.*, in *Robert of Gloucester* we find fals*hede* instead of *fals*hede, tid*inge* instead of *tid*inge, trewe*hede* instead of *trewe*hede, glad*dore* instead of *glad*dore, wis*liche* instead of *wis*liche, begynn*yng* instead of beg*ynn*yng, end*yng* instead of *end*yng. In the *Proverbs of Hendyng* we have no*thyng* for *noth*ing, hab*ben* for *hab*ben, fo*mon* for *fo*mon; in *Robert of Brunne*, haly*dom* for *haly*dom, cloth*yng* for *cloth*ing, gret*and* for *gret*and. Chaucer furnishes numerous instances of the same foreign influence revolutionising the native accent; fre*dom* for *fre*dom, hethen*esse* for *hethe*nesse, worthin*esse* for *worth*inesse, low*ly* for *low*ly, wynn*ynge* for *wynn*ynge, wedd*ynge* for *wedd*ynge, com*ynge* for *com*ynge; and it is traceable even in Spenser. On the other hand, a contrary tendency must not be overlooked. We see an effort, probably unconscious, to compel words of French origin to submit to the rule of English accentuation. It is noticeable in the century before Chaucer: in Chaucer himself it begins to work strongly; mor*tal* becomes *mor*tal; tem*pest*, *tem*pest; sub*stance*, *sub*stance; amy*able*, *amy*able; mor*sel*, *mor*sel; ser*vise*, *ser*vise; duch*esse*, *duch*esse; co*syn*, *co*syn, &c.; while a multitude of words oscillate between the rival modes of accentuation, now following the French and now the English. Before and during the Elizabethan period, the latter began to prove the stronger, and for the last 300 years it may be said to have, for the most part, Anglicised the accent and the nature of the foreign additions to our vocabulary. Nevertheless, many French words still retain their own accent. Morris (*Historical Outlines of English Accidence*, p. 75) thus classifies these:—

"(1.) Nouns in *-ade*, *-ier* (*-eer*), *-é*, *-ee*, or *-oon*, *-ine*, (*-in*), as *cascade'*, *crusade'*, &c.; *cavalier'*, *chandelier'*, &c.; *gazetteer'*, *pioneer'*, &c. (in conformity with these we say *harpooneer'*, *mountaineer'*,); *legatee'*, *payee'*, &c.; *balloon'*, *cartoon'*, &c.; *chagrin'*, *violin'*, &c.; *routine'*, *marine'*, &c.

"Also the following words:—*cadet'*, *brunette'*, *gazette'*, *cravat'*, *canal'*, *control'*, *gazelle'*, *amateur'*, *fatigue'*, *antique'*, *police'*, &c.

"(2.) Adjectives (*a*) from Lat. adj. in *us*, as *august'*, *benign'*, *robust*, &c.; (*b*) in *-ose*, as *morose'*, *verbose'*, &c.; (*c*) *-esque*, as *burlesque*, *grotesque'*, &c.

"(3.) Some verbs, as *baptize'*, *cajole'*, *caress'*, *carouse'*, *chastise'*, *escape'*, *esteem'*, &c."

To these may be added the Greek and Latin words which have been introduced into English for scientific and other learned purposes, and which, not having been altered in form, retain their original accentuation—as *auro'ra*, *coro'na*, *colos'sus*, *ide'a*, *hypoth'esis*, *cæsu'ra*, *diæ'resis*, *diagno'sis*, *dilu'vium*, *diplo'ma*, *efflu'vium*, *elys'ium*, &c.; besides the still larger number that have suffered a slight modification of form, but no change of accent, as *dialec'tic*, *diagnos'tic*, *efflores'cent*, *ellip'tic*, *emer'sion*, *emol'lient*, &c. The Italian contributions to our tongue retain their original accent when the form is untouched, as *mulat'to*, *sona'ta*, *volca'no*, but lose it when the form is shortened, as *ban'dit* (It. *bandi'to*).

A change in the position of the accent serves a variety of purposes in English. It distinguishes (1.) a *noun* from a *verb*, as ac'cent, accent'; aug'ment, augment'; tor'ment, torment'; com'ment, comment'; con'sort, consort'; con'test, contest'; con'trast, contrast'; di'gest, digest'; dis'count, discount'; in'sult, insult', &c.; (2.) an *adjective* from a *verb*, as ab'sent, absent'; fre'quent, frequent'; pre'sent, present'; com'pound, compound', &c.; (3.) an *adjective* from a *noun*, as ex'pert, expert'; com'pact, compact'. It also denotes a difference of meaning, *e.g.*, con'jure, conjure'; in'cense, incense'; au'gust, august'; su'pine, supine'.

Accent has exercised a powerful influence in changing the *forms* of words. The unaccented syllables in the course of time frequently dropped off. This process was necessarily more rapid and thorough in English than in many other languages which were not subjected to equal strain. The Norman Conquest made havoc of the English tongue for a time. It was expelled from the court, the schools, the church, and the tribunals of justice; it ceased to be spoken by priests, lawyers, and nobles; its only guardians were churls, ignorant, illiterate, indifferent to grammar, and careless of diction. Who can wonder if, in circumstances like these, it suffered disastrous eclipse? The latter part of the Anglo-Saxon *Chronicle* furnishes melancholy evidence of the chaos into which it had fallen, yet out of this chaos it rose again into newness of life, reforming and re-accenting its half-ruined vocabulary, and drawing from the very agent of its destruction the elements of a richer and more plastic expression. For it cannot be doubted that the irregularities now existing in English accent, though perplexing to a foreigner, copiously vary the modulation, and so increase the flexibility and power of the language. The older forms of English, those in use before the Conquest, and down to the period of Chaucer, are stiff, monotonous, and unmusical. A hard strength is in the verse, but no liquid sweetness or nimble grace. Now, it is possible, in spite of our deficiency in vowel endings, to produce the noblest melody in accent words known to the modern world. Almost every kind of metre, swift or slow, airy or majestic, has been successfully attempted since the age of the *Canterbury Tales*. When we compare the drone of Caedmon with the aerial melody of the *Skylark*, the *Cloud*, and the *Arethusa* of Shelley, we see what an infinite progress has been made by the development of accent in the rhythm of our native tongue.

See *Lectures on the English Language*, by G. P. Marsh (Lond. 1861); the *Origin and History of the English Language*, &c., by G. P. Marsh (Lond. 1862); *Historische Grammatik der Englische Sprache*, von. C. Friedrich Koch (1863–69); *The English Language*, by R. G. Latham (1855); *Philological Essays*, by the Rev. Richard Garnett (Lond. 1859); *On Early English Pronunciation, with especial reference to Shakspere and Chaucer*, by A. J. Ellis (Lond. 1867–71); *Historical Outlines of English Accidence*, by Dr R. Morris (Lond. 1872). (J. M. R.)

ACCEPTANCE is the act by which a person binds himself to comply with the request contained in a bill of exchange addressed to him by the drawer. In all cases it is understood to be a promise to pay the bill *in money*, the law not recognising an acceptance in which the promise is

to pay in some other way, as, for example, partly in money and partly by another bill. Acceptance may be absolute, conditional, or partial. *Absolute* acceptance is an engagement to pay the bill strictly according to its tenor, and is made by the drawee subscribing his name, with or without the word "accepted," at the bottom of the bill, or across the face of it. *Conditional* acceptance is a promise to pay on a contingency occurring, as, for example, on the sale of certain goods consigned by the drawer to the acceptor. No contingency is allowed to be mentioned in the body of the bill, but a contingent acceptance is quite legal, and equally binding with an absolute acceptance upon the acceptor when the contingency has occurred. *Partial* acceptance is where the promise is to pay only part of the sum mentioned in the bill, or to pay at a different time or place from those specified. In all cases acceptance involves the signature of the acceptor either by himself or by some person duly authorised on his behalf. A bill can be accepted in the first instance only by the person or persons to whom it is addressed; but if he or they fail to do so, it may, after being protested for non-acceptance, be accepted by another "*supra* protest," for the sake of the honour of one or more of the parties concerned in it.

ACCESSION is applied, in a historical or constitutional sense, to the coming to the throne of a dynasty or line of sovereigns, as the accession of the House of Hanover. The corresponding term, when a single sovereign is spoken of, is "succession." In law, accession is a method of acquiring property, by which, in things that have a close connection with or dependence on one another, the property of the principal draws after it the property of the accessory, according to the principle, *accessio cedet principali*, or *accessorium sequitur principale*. Thus, the owner of a cow becomes likewise the owner of the calf, and a landowner becomes proprietor of what is added to his estate by alluvion. Accession produced by the art or industry of man has been called industrial accession, and may be by specification, as when wine is made out of grapes, or by confusion or commixture. Accession sometimes likewise signifies consent or acquiescence. Thus, in the bankrupt law of Scotland, when there is a settlement by a trust-deed, it is accepted on the part of each creditor by a deed of accession.

ACCESSORY, a person guilty of a felonious offence, not as principal, but by participation; as by advice, command, aid, or concealment. In treason, accessories are excluded, every individual concerned being considered as a principal. In crimes under the degree of felony, also, all persons concerned, if guilty at all, are regarded as principals. (See 24 and 25 Vict. c. 94. s. 8.) There are two kinds of accessories—*before* the fact, and *after* it. The first is he who commands or procures another to commit felony, and is not present himself; for if he be present, he is a principal. The second is he who receives, assists, or comforts any man that has done murder or felony, whereof he has knowledge. An accessory before the fact is liable to the same punishment as the principal; and there is now indeed no practical difference between such an accessory and a principal in regard either to indictment, trial, or punishment (24 and 25 Vict. c. 94). Accessories after the fact are in general punishable with imprisonment for a period not exceeding two years (*ib.* s. 4). The law of Scotland makes no distinction between the accessory to any crime (called *art and part*) and the principal. Except in the case of treason, accession after the fact is not noticed by the law of Scotland, unless as an element of evidence to prove previous accession.

ACCIAJUOLI, DONATO, was born at Florence in 1428. He was famous for his learning, especially in Greek and mathematics, and for his services to his native state. Having previously been intrusted with several important embassies, he became Gonfalonier of Florence in 1473. He died at Milan in 1478, when on his way to Paris to ask the aid of Louis XI. on behalf of the Florentines against Pope Sixtus IV. His body was taken back to Florence, and buried in the church of the Carthusians at the public expense, and his daughters were portioned by his fellow-citizens, the fortune he left being, owing to his probity and disinterestedness, very small. He wrote a Latin translation of some of Plutarch's *Lives* (Florence, 1478); Commentaries on Aristotle's *Ethics* and *Politics;* and the lives of Hannibal, Scipio, and Charlemagne. In the work on Aristotle he had the co-operation of his master Argyropylus.

ACCIDENT. An attribute of a thing or class of things, which neither belongs to, nor is in any way deducible from, the essence of that thing or class, is termed its *accident.* An accident may be either inseparable or separable: the former, when we can conceive it to be absent from that with which it is found, although it is always, as far as we know, present, *i.e.*, when it is not necessarily but is universally present; the latter, when it is neither necessarily nor universally present. It is often difficult to determine whether a particular attribute is essential or accidental to the object we are investigating, subsequent research frequently proving that what we have described as accidental ought to be classed as essential, and *vice versa.* Practically, and for the time being, an attribute, which neither directly nor indirectly forms part of the signification of the term used to designate the object, may be considered an accident; and many philosophers look upon this as the only intelligible ground for the distinction. Propositions expressing the relation between a thing or class and an accident, and also between a thing or class and its property (*i.e.*, something deducible from, but not strictly forming part of, its essence), are variously styled "accidental," "synthetical," "real," "ampliative," in contradistinction to "essential," "analytical," "verbal," and "explicative" propositions. The former give us information that we could not have discovered from an analysis of the subject notion—*e.g.*, "man is found in New Zealand;" the latter merely state what we already know, if we understand the meaning of the language employed, *e.g.*, "man is rational."

ACCIUS, a poet of the 16th century, to whom is attributed *A Paraphrase of Æsop's Fables*, of which Julius Scaliger speaks with great praise.

ACCIUS (or ATTIUS), LUCIUS, a Latin tragic poet, was the son of a freedman, born, according to St Jerome, in the year of Rome 583, though this appears somewhat uncertain. He made himself known before the death of Pacuvius by a dramatic piece, which he exhibited the same year that Pacuvius brought one on the stage, the latter being then eighty years of age, and Accius only thirty. We do not know the name of this piece of Accius's, but the titles of several of his tragedies are mentioned by various authors. He wrote on the most celebrated stories which had been represented on the Athenian stage; but he did not always take his subject from Grecian story; for he composed at least one dramatic piece wholly Roman, entitled *Brutus*, and referring to the expulsion of the Tarquins. Only fragments of his tragedies remain. He did not confine himself to dramatic writing, having left other productions, particularly his *Annals*, mentioned by Macrobius, Priscian, Festus, and Nonnius Marcellus. He has been censured for the harshness of his style, but in other respects he has been esteemed a great poet. He died at an advanced age; and Cicero, who evidently attaches considerable weight to his opinions, speaks of having conversed with him in his youth.

ACCLAMATION, the expression of the opinion, favourable or unfavourable, of any assembly by means of the voice. *Applause* denotes strictly a similar expression by

clapping of hands, but this distinction in the usage of the words is by no means uniformly maintained. Among the Romans acclamation was varied both in form and purpose. At marriages it was usual for the spectators to shout *Io Hymen, Hymenæe*, or *Talassio;* a victorious army or general was greeted with *Io triumphe;* in the theatre acclamation was called for at the close of the play by the last actor, who said, *Plaudite;* in the senate opinions were expressed and votes passed by acclamation in such forms as *Omnes, omnes, Æquum est, Justum est*, &c; and the praises of the emperor were celebrated in certain pre-arranged sentences, which seem to have been chanted by the whole body of senators. The acclamations which authors and poets who recited their works in public received were at first spontaneous and genuine, but in time became very largely mercenary, it being customary for men of fortune who affected literary tastes to keep applauders in their service and lend them to their friends. When Nero performed in the theatre his praises were chanted, at a given signal, by five thousand soldiers, who were called *Augustals*. The whole was conducted by a music-master, *mesochorus* or *pausarius*. It was this case of Nero which, occurring to the recollection of the French poet Dorat, may be said to have originated the well-known Paris *claque*. Buying up a number of the tickets for a performance of one of his plays, he distributed them gratuitously to those who promised to express approbation. From that time the *claque*, or organised body of professional applauders, has been a recognised institution in connection with the theatres of Paris. In the early ages of the Christian church it was by no means uncommon for an audience to express their approbation of a favourite preacher during the course of his sermon. Chrysostom especially was very frequently interrupted both by applause and by acclamations. In ecclesiastical councils vote by acclamation is very common, the question being usually put in the form, *placet* or *non placet*. This differs from the acclamation with which in other assemblies a motion is said to be carried, when, no amendment being proposed, approval is expressed by shouting such words as *Aye* or *Agreed*.

ACCLIMATISATION is the process of adaptation by which animals and plants are gradually rendered capable of surviving and flourishing in countries remote from their original habitats, or under meteorological conditions different from those which they have usually to endure, and which are at first injurious to them.

The subject of acclimatisation is very little understood, and some writers have even denied that it can ever take place. It is often confounded with *domestication* or with *naturalisation;* but these are both very different phenomena. A *domesticated* animal or a cultivated plant need not necessarily be *acclimatised;* that is, it need not be capable of enduring the severity of the seasons without protection. The canary bird is *domesticated* but not *acclimatised*, and many of our most extensively cultivated plants are in the same category. A *naturalised* animal or plant, on the other hand, must be able to withstand all the vicissitudes of the seasons in its new home, and it may therefore be thought that it must have become acclimatised. But in many, perhaps most cases of *naturalisation*, there is no evidence of a gradual adaptation to new conditions which were at first injurious, and this is essential to the idea of *acclimatisation*. On the contrary, many species, in a new country and under somewhat different climatic conditions, seem to find a more congenial abode than in their native land, and at once flourish and increase in it to such an extent as often to exterminate the indigenous inhabitants. Thus Agassiz (in his work on Lake Superior) tells us that the road-side weeds of the north-eastern United States, to the number of 130 species, are all European, the native weeds having disappeared westwards; while in New Zealand there are, according to Mr T. Kirk (*Transactions of the New Zealand Institute*, vol. ii. p. 131), no less than 250 species of naturalised plants, more than 100 of which spread widely over the country, and often displace the native vegetation. Among animals, the European rat, goat, and pig, are naturalised in New Zealand, where they multiply to such an extent as to injure and probably exterminate many native productions. In neither of these cases is there any indication that *acclimatisation* was necessary or ever took place.

On the other hand, the fact that an animal or plant cannot be *naturalised* is no proof that it is not *acclimatised*. It has been shown by Mr Darwin that, in the case of most animals and plants in a state of nature, the competition of other organisms is a far more efficient agency in limiting their distribution than the mere influence of climate. We have a proof of this in the fact that so few, comparatively, of our perfectly hardy garden plants ever run wild; and even the most persevering attempts to naturalise them usually fail. Alphonse de Candolle (*Géographie Botanique*, p. 798) informs us that several botanists of Paris, Geneva, and especially of Montpellier, have sown the seeds of many hundreds of species of exotic hardy plants, in what appeared to be the most favourable situations, but that in hardly a single case has any one of them become naturalised. Attempts have also been made to naturalise continental insects in this country, in places where the proper food-plants abound and the conditions seem generally favourable, but in no case do they seem to have succeeded. Even a plant like the potato, so largely cultivated and so perfectly hardy, has not established itself in a wild state in any part of Europe.

Different Degrees of Climatal Adaptation in Animals and Plants.—Plants differ greatly from animals in the closeness of their adaptation to meteorological conditions. Not only will most tropical plants refuse to live in a temperate climate, but many species are seriously injured by removal a few degrees of latitude beyond their natural limits. This is probably due to the fact, established by the experiments of M. Becquerel, that plants possess no proper temperature, but are wholly dependent on that of the surrounding medium.

Animals, especially the higher forms, are much less sensitive to change of temperature, as shown by the extensive range from north to south of many species. Thus, the tiger ranges from the equator to northern Asia as far as the river Amour, and to the isothermal of 32° Fahr. The mountain sparrow (*Passer montana*) is abundant in Java and Singapore in a uniform equatorial climate, and also inhabits this country and a considerable portion of northern Europe. It is true that most terrestrial animals are restricted to countries not possessing a great range of temperature or very diversified climates, but there is reason to believe that this is due to quite a different set of causes, such as the presence of enemies or deficiency of appropriate food. When supplied with food and partially protected from enemies, they often show a wonderful capacity of enduring climates very different from that in which they originally flourished. Thus, the horse and the domestic fowl, both natives of very warm countries, flourish without special protection in almost every inhabited portion of the globe. The parrot tribe form one of the most pre-eminently tropical groups of birds, only a few species extending into the warmer temperate regions; yet even the most exclusively tropical genera are by no means delicate birds as regards climate. In the *Annals and Magazine of Natural History* for 1868 (p. 381) is a most interesting account, by Mr Charles Buxton, M.P., of the naturalisation of parrots at Northreps Hall, Norfolk. A considerable number of

African and Amazonian parrots, Pengal parroquets, four species of white and rose crested cockatoos, and two species of crimson lories, have been at large for many years. Several of these birds have bred, and they almost all live in the woods the whole year through, refusing to take shelter in a house constructed for their use. Even when the thermometer fell 6° below zero, all appeared in good spirits and vigorous health. Some of these birds have lived thus exposed for nearly twenty years, enduring our cold easterly winds, rain, hail, and snow, all through the winter,—a marvellous contrast to the equable equatorial temperature (hardly ever less than 70°) which many of them had been accustomed to for the first year or years of their existence.

Mr Jenner Weir records somewhat similar facts in the *Zoologist* for 1865 (p. 9411). He keeps many small birds in an open aviary in his garden at Blackheath, and among these are the Java rice bird (*Padda oryzivora*), two West African weaver birds (*Hyphantornis textor* and *Euplectes sanguinirostris*), and the blue bird of the southern United States (*Spiza cyanea*). These denizens of the tropics prove quite as hardy as our native birds, having lived during the severest winters without the slightest protection against the cold, even when their drinking water had to be repeatedly melted.

Hardly any group of Mammalia is more exclusively tropical than the Quadrumana, yet there is reason to believe that, if other conditions are favourable, some of them can withstand a considerable degree of cold. The *Semnopithecus schistaceus* was found by Captain Hutton at an elevation of 11,000 feet in the Himalayas, leaping actively among fir-trees whose branches were laden with snow-wreaths. In Abyssinia a troop of dog-faced baboons were observed by Mr Blandford at 9000 feet above the sea. We may therefore conclude that the restriction of the monkey tribe to warm latitudes is probably determined by other causes than temperature alone.

Similar indications are given by the fact of closely allied species inhabiting very extreme climates. The recently extinct Siberian mammoth and woolly rhinoceros were closely allied to species now inhabiting tropical regions exclusively. Wolves and foxes are found alike in the coldest and hottest parts of the earth, as are closely allied species of falcons, owls, sparrows, and numerous genera of waders and aquatic birds.

A consideration of these and many analogous facts might induce us to suppose that, among the higher animals at least, there is little constitutional adaptation to climate, and that in their case acclimatisation is not required. But there are numerous examples of domestic animals which show that such adaptation does exist in other cases. The yak of Thibet cannot long survive in the plains of India, or even on the hills below a certain altitude; and that this is due to climate, and not to the increased density of the atmosphere, is shown by the fact that the same animal appears to thrive well in Europe, and even breeds there readily. The Newfoundland dog will not live in India, and the Spanish breed of fowls in this country suffer more from frost than most others. When we get lower in the scale the adaptation is often more marked. Snakes, which are so abundant in warm countries, diminish rapidly as we go north, and wholly cease at lat. 62°. Most insects are also very susceptible to cold, and seem to be adapted to very narrow limits of temperature.

From the foregoing facts and observations we may conclude, firstly, that some plants and many animals are not constitutionally adapted to the climate of their native country only, but are capable of enduring and flourishing under a more or less extensive range of temperature and other climatic conditions; and, secondly, that most plants and some animals are, more or less closely, adapted to climates similar to those of their native habitats. In order to domesticate or naturalise the former class in countries not extremely differing from that from which the species was brought, it will not be necessary to *acclimatise*, in the strict sense of the word. In the case of the latter class, however, acclimatisation is a necessary preliminary to naturalisation, and in many cases to useful domestication, and we have therefore to inquire whether it is possible.

Acclimatisation by Individual Adaptation.—It is evident that acclimatisation may occur (if it occurs at all) in two ways, either by modifying the constitution of the individual submitted to the new conditions, or by the production of offspring which may be better adapted to those conditions than their parents. The alteration of the constitution of individuals in this direction is not easy to detect, and its possibility has been denied by many writers. Mr Darwin believes, however, that there are indications that it occasionally occurs in plants, where it can be best observed, owing to the circumstance that so many plants are propagated by cuttings or buds, which really continue the existence of the same individual almost indefinitely. He adduces the example of vines taken to the West Indies from Madeira, which have been found to succeed better than those taken directly from France. But in most cases habit, however prolonged, appears to have little effect on the constitution of the individual, and the fact has no doubt led to the opinion that acclimatisation is impossible. There is indeed little or no evidence to show that any animal to which a new climate is at first prejudicial can be so acclimatised by habit that, after subjection to it for a few or many seasons, it may live as healthily and with as little care as in its native country; yet we may, on general principles, believe that under proper conditions such acclimatisation would take place. In his *Principles of Biology* (chap. v.), Mr Herbert Spencer has shown that every organ and every function of living beings undergoes modification to a limited extent under the stimulus of any new conditions, and that the modification is almost always such as to produce an adaptation to those conditions. We may feel pretty sure, therefore, that if robust and healthy individuals are chosen for the experiment, and if the change they are subjected to is not too great, a real individual adaptation to the new conditions—that is, a more or less complete acclimatisation—will be brought about. If now animals thus modified are bred from, we know that their descendants will inherit the modification. They will thus start more favourably, and being subject to the influence of the same or a slightly more extreme climate during their whole lives, the acclimatisation will be carried a step further; and there seems no reason to doubt that, by this process alone, if cautiously and patiently carried out, most animals which breed freely in confinement could in time be acclimatised in almost any inhabited country. There is, however, a much more potent agent, which renders the process of adaptation almost a certainty.

Acclimatisation by Variation.—A mass of evidence exists showing that variations of every conceivable kind occur among the offspring of all plants and animals, and that, in particular, constitutional variations are by no means uncommon. Among cultivated plants, for example, hardier and more tender varieties often arise. The following cases are given by Mr Darwin:—Among the numerous fruit-trees raised in North America, some are well adapted to the climate of the Northern States and Canada, while others only succeed well in the Southern States. Adaptation of this kind is sometimes very close, so that, for example, few English varieties of wheat will thrive in Scotland. Seed-wheat from India produced a miserable crop when planted

by the Rev. M. J. Berkeley on land which would have produced a good crop of English wheat. Conversely, French wheat taken to the West Indies produced only barren spikes, while native wheat by its side yielded an enormous harvest. Tobacco in Sweden, raised from home-grown seed, ripens its seeds a month earlier than plants grown from foreign seed. In Italy, as long as orange trees were propagated by grafts, they were tender; but after many of the trees were destroyed by the severe frosts of 1709 and 1763, plants were raised from seed, and these were found to be hardier and more productive than the former kinds. Where plants are raised from seed in large quantities, varieties always occur differing in constitution, as well as others differing in form or colour; but the former cannot be perceived by us unless marked out by their behaviour under exceptional conditions, as in the following cases. After the severe winter of 1860–61, it was observed that in a large bed of araucarias some plants stood quite unhurt among numbers killed around them. In Mr Darwin's garden two rows of scarlet runners were entirely killed by frost, except three plants, which had not even the tips of their leaves browned. A very excellent example is to be found in Chinese history, according to M. Huc, who, in his *L'Empire Chinois* (tom. ii. p. 359), gives the following extract from the *Memoirs of the Emperor Khang*:—"On the 1st day of the 6th moon I was walking in some fields where rice had been sown to be ready for the harvest in the 9th moon. I observed by chance a stalk of rice which was already in ear. It was higher than all the rest, and was ripe enough to be gathered. I ordered it to be brought to me. The grain was very fine and well grown, which gave me the idea to keep it for a trial, and see if the following year it would preserve its precocity. It did so. All the stalks which came from it showed ear before the usual time, and were ripe in the 6th moon. Each year has multiplied the produce of the preceding, and for thirty years it is this rice which has been served at my table. The grain is elongate, and of a reddish colour, but it has a sweet smell and very pleasant taste. It is called *Yu-mi*, Imperial rice, because it was first cultivated in my gardens. It is the only sort which can ripen north of the great wall, where the winter ends late and begins very early; but in the southern provinces, where the climate is milder and the land more fertile, two harvests a year may be easily obtained, and it is for me a sweet reflection to have procured this advantage for my people." M. Huc adds his testimony that this kind of rice flourishes in Mandtchuria, where no other will grow. We have here, therefore, a perfect example of acclimatisation by means of a spontaneous constitutional variation.

That this kind of adaptation may be carried on step by step to more and more extreme climates is illustrated by the following examples. Sweet-peas raised in Calcutta from seed imported from England rarely blossom, and never yield seed; plants from French seed flower better, but are still sterile; but those raised from Darjeeling seed (originally imported from England) both flower and seed profusely. The peach is believed to have been tender, and to have ripened its fruit with difficulty, when first introduced into Greece; so that (as Darwin observes) in travelling northward during two thousand years it must have become much hardier. Dr Hooker ascertained the average vertical range of flowering plants in the Himalayas to be 4000 feet, while in some cases it extended to 8000 feet. The same species can thus endure a great difference of temperature; but the important fact is, that the individuals have become acclimatised to the altitude at which they grow, so that seeds gathered near the upper limit of the range of a species will be more hardy than those gathered near the lower limit. This was proved by Dr Hooker to be the case with Himalayan conifers and rhododendrons, raised in this country from seed gathered at different altitudes.

Among animals exactly analogous facts occur. M. Roulin states that when geese were first introduced into Bogota they laid few eggs at long intervals, and few of the young survived. By degrees the fecundity improved, and in about twenty years became equal to what it is in Europe. The same author tells us that, according to Garcilaso, when fowls were first introduced into Peru they were not fertile, whereas now they are as much so as in Europe. Mr Darwin adduces the following examples. Merino sheep bred at the Cape of Good Hope have been found far better adapted for India than those imported from England; and while the Chinese variety of the Ailanthus silk-moth is quite hardy, the variety found in Bengal will only flourish in warm latitudes. Mr Darwin also calls attention to the circumstance that writers of agricultural works generally recommend that animals should be removed from one district to another as little as possible. This advice occurs even in classical and Chinese agricultural books as well as in those of our own day, and proves that the close adaptation of each variety or breed to the country in which it originated has always been recognised.

Constitutional Adaptation often accompanied by External Modification.—Although in some cases no perceptible alteration of form or structure occurs when constitutional adaptation to climate has taken place, in others it is very marked. Mr Darwin has collected a large number of cases in his *Animals and Plants under Domestication* (vol. ii. p. 277), of which the following are a few of the most remarkable. Dr Falconer observed that several trees, natives of cooler climates, assumed a pyramidal or fastigiate form when grown in the plains of India; cabbages rarely produce heads in hot climates; the quality of the wood, the medicinal products, the odour and colour of the flowers, all change in many cases when plants of one country are grown in another. One of the most curious observations is that of Mr Meehan, who "compared twenty-nine kinds of American trees belonging to various orders, with their nearest European allies, all grown in close proximity in the same garden, and under as nearly as possible the same conditions. In the American species Mr Meehan finds, with the rarest exceptions, that the leaves fall earlier in the season, and assume before falling a brighter tint; that they are less deeply toothed or serrated; that the buds are smaller; that the trees are more diffuse in growth, and have fewer branchlets; and, lastly, that the seeds are smaller;—all in comparison with the European species." Mr Darwin concludes that there is no way of accounting for these uniform differences in the two series of trees than by the long-continued action of the different climates of the two continents.

In animals equally remarkable changes occur. In Angora, not only goats, but shepherd-dogs and cats, have fine fleecy hair; the wool of sheep changes its character in the West Indies in three generations; M. Costa states that young oysters, taken from the coast of England, and placed in the Mediterranean, at once altered their manner of growth and formed prominent diverging rays, like those on the shells of the proper Mediterranean oyster.

In his *Contributions to the Theory of Natural Selection* (p. 167), Mr Wallace has recorded cases of simultaneous variation among insects, apparently due to climate or other strictly local causes. He finds that the butterflies of the family *Papilionidæ*, and some others, become similarly modified in different islands and groups of islands. Thus, the species inhabiting Sumatra, Java, and Borneo, are almost always much smaller than the closely allied species of Celebes and the Moluccas; the species or varieties of the small island of Amboyna are larger than the same

species or closely allied forms inhabiting the surrounding islands; the species found in Celebes possess a peculiar form of wing, quite distinct from that of the same or closely allied species of adjacent islands; and, lastly, numerous species which have tailed wings in India and the western islands of the Archipelago, gradually lose the tail as we proceed eastward to New Guinea and the Pacific.

Many of these curious modifications may, it is true, be due to other causes than climate only, but they serve to show how powerfully and mysteriously local conditions affect the form and structure of both plants and animals; and they render it probable that changes of constitution are also continually produced, although we have, in the majority of cases, no means of detecting them. It is also impossible to determine how far the effects described are produced by spontaneous favourable variations or by the direct action of local conditions; but it is probable that in every case both causes are concerned, although in constantly varying proportions.

The Influence of Heredity.—Adaptation by variation would, however, be a slow and uncertain process, and might for considerable periods of time cease to act, did not heredity come into play. This is the tendency of every organism to produce its like, or more exactly, to produce a set of new forms varying slightly from it in many directions—a group of which the parent form is the centre. If now one of the most extreme of these variations is taken, it is found to become the centre of a new set of variations; and by continually taking the extreme in the same direction, an increasing variation in that direction can be effected, until checked by becoming so great that it interferes with the healthy action of the organism, or is in any other way prejudicial. It is also found that acquired constitutional peculiarities are equally hereditary; so that by a combination of those two modes of variation any desired adaptation may be effected with greater rapidity. The manner in which the form or constitution of an organism can be made to change continuously in *one* direction, by means of variations which are indefinite and in *all* directions, is often misunderstood. It may perhaps be illustrated by showing how a tree or grove of trees might, by natural causes, be caused to travel during successive generations in a definite course. The tree has branches radiating out from its stem to perhaps twenty feet on every side. Seeds are produced on the extremities of all these branches, drop to the ground, and produce seedlings, which, if untouched, would form a ring of young trees around the parent. But cattle crop off every seedling as soon as it rises above the ground, and none can ever arrive at maturity. If, however, one side is protected from the cattle, young trees will grow up on that side only. This protection may exist in the case of a grove of trees which we may suppose to occupy the whole space between two deep ravines, the cattle existing on the lower side of the wood only. In this case young trees would reach maturity on the upper side of the wood, while on the lower side the trees would successively die, fall, and rot away, no young ones taking their place. If this state of things continued unchanged for some centuries, the wood might march regularly up the side of the mountain till it occupied a position many miles away from where it once stood; and this would have taken place, not because more seed was produced on one side than the other (there might even be very much less), nor because soil or climate were better on the upper side (they might be worse), nor because any intelligent being chose which trees should be allowed to live and which should be destroyed;—but simply because, for a series of generations, the conditions permitted the existence of young trees on one side, and wholly prevented it on the other. Just in an analogous way animals or plants are caused to vary in definite directions, either by the influence of natural agencies, which render existence impossible for those that vary in any other direction, or by the action of the judicious breeder, who carefully selects favourable variations to be the parents of his future stock; and in either case the rejected variations may far outnumber those which are preserved.

Evidence has been adduced by Mr Darwin to show that the tendency to vary is itself hereditary; so that, so far from variations coming to an end, as some persons imagine, the more extensively variation has occurred in any species in the past, the more likely it is to occur in the future. There is also reason to believe that individuals which have varied largely from their parents in a special direction will have a greater tendency to produce offspring varying in that direction than in any other; so that the facilities for adaptation, that is, for the production and increase of favourable variations in certain definite directions, are far greater than the facilities for locomotion in one direction in the hypothetical illustration just given.

Selection and Survival of the Fittest as Agents in Naturalisation.—We may now take it as an established fact, that varieties of animals and plants occur, both in domesticity and in a state of nature, which are better or worse adapted to special climates. There is no positive evidence that the influence of new climatal conditions on the parents has any tendency to produce variations in the offspring better adapted to such conditions, although some of the facts mentioned in the preceding sections render it probable that such may be the case. Neither does it appear that this class of variations are very frequent. It is, however, certain that whenever any animal or plant is largely propagated constitutional variations will arise, and some of these will be better adapted than others to the climatal and other conditions of the locality. In a state of nature, every recurring severe winter or otherwise unfavourable season, weeds out those individuals of tender constitution or imperfect structure which may have got on very well during favourable years, and it is thus that the adaptation of the species to the climate in which it has to exist is kept up. Under domestication the same thing occurs by what Mr Darwin has termed "unconscious selection." Each cultivator seeks out the kinds of plants best suited to his soil and climate, and rejects those which are tender or otherwise unsuitable. The farmer breeds from such of his stock as he finds to thrive best with him, and gets rid of those which suffer from cold, damp, or disease. A more or less close adaptation to local conditions is thus brought about, and breeds or races are produced which are sometimes liable to deterioration on removal even to a short distance in the same country, as in numerous cases quoted by Mr Darwin (*Animals and Plants under Domestication*, vol. ii. p. 273).

The Method of Acclimatisation.—Taking into consideration the foregoing facts and illustrations, it may be considered as proved—1*st*, That habit has little (though it appears to have some) definite effect in adapting the constitution of animals to a new climate; but that it has a decided, though still slight, influence in plants when, by the process of propagation by buds, shoots, or grafts, the individual can be kept under its influence for long periods; 2*d*, That the offspring of both plants and animals vary in their constitutional adaptation to climate, and that this adaptation may be kept up and increased by means of heredity; and, 3*d*, That great and sudden changes of climate often check reproduction even when the health of the individuals does not appear to suffer. In order, therefore, to have the best chance of acclimatising any animal or plant in a climate very dissimilar from that of its native country, and in which it has been proved that the species in question cannot live and maintain itself

without acclimatisation, we must adopt some such plan as the following :—

1. We must transport as large a number as possible of adult healthy individuals to some intermediate station, and increase them as much as possible for some years. Favourable variations of constitution will soon show themselves, and these should be carefully selected to breed from, the tender and unhealthy individuals being rigidly eliminated.

2. As soon as the stock has been kept a sufficient time to pass through all the ordinary extremes of climate, a number of the hardiest may be removed to the more remote station, and the same process gone through, giving protection if necessary while the stock is being increased, but as soon as a large number of healthy individuals are produced, subjecting them to all the vicissitudes of the climate.

It can hardly be doubted that in most cases this plan would succeed. It has been recommended by Mr Darwin, and at one of the early meetings of the Société Zoologique d'Acclimatisation, at Paris, M. Geoffroy St Hilaire insisted that it was the only method by which acclimatisation was possible. But in looking through the long series of volumes of Reports published by this Society, there is no sign that any systematic attempt at acclimatisation has even once been made. A number of foreign animals have been introduced, and more or less domesticated, and some useful exotics have been cultivated for the purpose of testing their applicability to French agriculture or horticulture; but neither in the case of animals nor of plants has there been any systematic effort to modify the constitution of the species, *by breeding largely and selecting the favourable variations that appeared.*

Take the case of the *Eucalyptus globulus* as an example. This is a Tasmanian gum-tree of very rapid growth and great beauty, which will thrive in the extreme south of France. In the *Bulletin* of the Society a large number of attempts to introduce this tree into general cultivation in other parts of France are recorded in detail, with the failure of almost all of them. But no precautions such as those above indicated appear to have been taken in any of these experiments; and we have no intimation that either the Society or any of its members are making systematic efforts to acclimatise the tree. The first step would be, to obtain seed from healthy trees growing in the coldest climate and at the greatest altitude in its native country, sowing these very largely, and in a variety of soils and situations, in a part of France where the climate is somewhat but not much more extreme. It is almost a certainty that a number of trees would be found to be quite hardy. As soon as these produced seed, it should be sown in the same district and farther north in a climate a little more severe. After an exceptionally cold season, seed should be collected from the trees that suffered least, and should be sown in various districts all over France. By such a process there can be hardly any doubt that the tree would be thoroughly acclimatised in any part of France, and in many other countries of central Europe; and more good would be effected by one well-directed effort of this kind than by hundreds of experiments with individual animals and plants, which only serve to show us which are the species that *do not require to be acclimatised.*

Acclimatisation of Man.—On this subject we have, unfortunately, very little direct or accurate information. The general laws of heredity and variation have been proved to apply to man as well as to animals and plants; and numerous facts in the distribution of races show that man must, in remote ages at least, have been capable of constitutional adaptation to climate. If the human race constitutes a single species, then the mere fact that man now inhabits every region, and is in each case constitutionally adapted to the climate, proves that acclimatisation has occurred. But we have the same phenomenon in single varieties of man, such as the American, which inhabits alike the frozen wastes of Hudson's Bay and Terra del Fuego, and the hottest regions of the tropics,—the low equatorial valleys and the lofty plateaux of the Andes. No doubt a sudden transference to an extreme climate is often prejudicial to man, as it is to most animals and plants; but there is every reason to believe that, if the migration occurs step by step, man can be acclimatised to almost any part of the earth's surface in comparatively few generations. Some eminent writers have denied this. Sir Ranald Martin, from a consideration of the effects of the climate of India on Europeans and their offspring, believes that there is no such thing as acclimatisation. Dr Hunt, in a report to the British Association in 1861, argues that "time is no agent," and —"if there is no sign of acclimatisation in one generation, there is no such process." But he entirely ignores the effect of favourable variations, as well as the direct influence of climate acting on the organisation from infancy.

Professor Waitz, in his *Introduction to Anthropology*, adduces many examples of the comparatively rapid constitutional adaptation of man to new climatic conditions. Negroes, for example, who have been for three or four generations acclimatised in North America, on returning to Africa become subject to the same local diseases as other unacclimatised individuals. He well remarks, that the debility and sickening of Europeans in many tropical countries are wrongly ascribed to the climate, but are rather the consequences of indolence, sensual gratification, and an irregular mode of life. Thus the English, who cannot give up animal food and spirituous liquors, are less able to sustain the heat of the tropics than the more sober Spaniards and Portuguese. The excessive mortality of European troops in India, and the delicacy of the children of European parents, do not affect the real question of acclimatisation under proper conditions. They only show that acclimatisation is in most cases necessary, not that it cannot take place. The best examples of partial or complete acclimatisation are to be found where European races have permanently settled in the tropics, and have maintained themselves for several generations. There are, however, two sources of inaccuracy to be guarded against, and these are made the most of by the writers above referred to, and are supposed altogether to invalidate results which are otherwise opposed to their views. In the first place, we have the possibility of a mixture of native blood having occurred; in the second, there have almost always been a succession of immigrants from the parent country, who continually intermingle with the families of the early settlers. It is maintained that one or other of these mixtures is absolutely necessary to enable Europeans to continue long to flourish in the tropics.

There are, however, certain cases in which the sources of error above mentioned are reduced to a minimum, and cannot seriously affect the results; such as those of the Jews, the Dutch at the Cape of Good Hope and in the Moluccas, and the Spaniards in South America.

The Jews are a good example of acclimatisation, because they have been established for many centuries in climates very different from that of their native land; they keep themselves almost wholly free from intermixture with the people around them; and they are often so populous in a country that the intermixture with Jewish immigrants from other lands cannot seriously affect the local purity of the race. They have, for instance, attained a population of near two millions in such severe climates as Poland and Russia; and according to Mr Brace (*Races of the Old World*, p. 185), "their increase in Sweden is said to be greater than that of the Christian population; in the towns of Algeria they are the only race able to maintain its numbers: and in

Cochin China and Aden they succeed in rearing children and forming permanent communities."

In some of the hottest parts of South America Europeans are perfectly acclimatised, and where the race is kept pure it seems to be even improved. Some very valuable notes on this subject have been furnished to the present writer by the well-known botanist Dr Richard Spruce, who resided many years in South America, but who has hitherto been prevented by ill health from giving to the world the results of his researches. As a careful, judicious, and accurate observer, both of man and nature, he has few superiors. He says—

"The white inhabitants of Guayaquil (lat. 2° 13′ S.) are kept pure by careful selection. The slightest tincture of red or black blood bars entry into any of the old families who are descendants of Spaniards from the Provincias Vascongadas, or those bordering the Bay of Biscay, where the morals are perhaps the purest (as regards the intercourse of the sexes) of any in Europe, and where for a girl, even of the poorest class, to have a child before marriage is the rarest thing possible. The consequence of this careful breeding is, that the women of Guayaquil are considered (and justly) the finest along the whole Pacific coast. They are often tall, sometimes very handsome, decidedly healthy, although pale, and assuredly prolific enough. Their sons are big, stout men, but when they lead inactive lives are apt to become fat and sluggish. Those of them, however, who have farms in the savannahs, and are accustomed to take long rides in all weathers, and those whose trade obliges them to take frequent journeys in the mountainous interior, or even to Europe and North America, are often as active and as little burdened with superfluous flesh as a Scotch farmer.

"The oldest Christian town in Peru is Piura (lat. 5° S.), which was founded by Pizarro himself. The climate is very hot, especially in the three or four months following the southern solstice. In March 1843 the temperature only once fell as low as 83°, during the whole month, the usual lowest night temperature being 85°. Yet people of all colours find it very healthy, and the whites are very prolific. I resided in the town itself nine months, and in the neighbourhood seven months more. The population (in 1863–4) was about 10,000, of which not only a considerable proportion was white, but was mostly descended from the first emigrants after the conquest. Purity of descent was not, however, quite so strictly maintained as at Guayaquil. The military adventurers, who have often risen to high or even supreme rank in Peru, have not seldom been of mixed race, and fear or favour has often availed to procure them an alliance with the oldest and purest-blooded families."

These instances, so well stated by Dr Spruce, seem to demonstrate the complete acclimatisation of Spaniards in some of the hottest parts of South America. Although we have here nothing to do with mixed races, yet the want of fertility in these has been often taken to be a fact inherent in the mongrel race, and has been also sometimes held to prove that neither the European nor his half-bred offspring can maintain themselves in the tropics. The following observation is therefore of interest:—

"At Guayaquil for a lady of good family—married or unmarried—to be of loose morals is so uncommon, that when it does happen it is felt as a calamity by the whole community. But here, and perhaps in most other towns in South America, a poor girl of mixed race—especially if good-looking—rarely thinks of marrying one of her own class until she has—as the Brazilians say—'approveitada de sua mocidade' (made the most of her youth) in *receiving presents from gentlemen.* If she thus bring a good dowry to her husband, he does not care to inquire, or is not sensitive, about the mode in which it was acquired. The consequences of this indiscriminate sexual intercourse, especially if much prolonged, is to diminish, in some cases to paralyse, the fertility of the female. And as among people of mixed race it is almost universal, the population of these must fall off both in numbers and quality."

The following example of divergent acclimatisation of the same race to hot and cold zones is very interesting, and will conclude our extracts from Dr Spruce's valuable notes:—

"One of the most singular cases connected with this subject that have fallen under my own observation, is the difficulty, or apparent impossibility, of acclimatising the Red Indian in a certain zone of the Andes. Any person who has compared the physical characters of the native races of South America must be convinced that these have all originated in a common stirps. Many local differences exist, but none capable of invalidating this conclusion. The warmth yet shade-loving Indian of the Amazon; the Indian of the hot, dry, and treeless coasts of Peru and Guayaquil, who exposes his bare head to the sun with as much zest as an African negro; the Indian of the Andes, for whom no cold seems too great, who goes constantly bare-legged and often bare-headed, through whose rude straw hut the piercing wind of the paramos sweeps, and chills the white man to the very bones;—all these, in the colour and texture of the skin, the hair, and other important features, are plainly of one and the same race.

"Now there is a zone of the equatorial Andes, ranging between about 4000 and 6000 feet altitude, where the very best flavoured coffee is grown, where cane is less luxuriant but more saccharine than in the plains, and which is therefore very desirable to cultivate, but where the red man sickens and dies. Indians taken down from the sierra get ague and dysentery. Those of the plains find the temperature chilly, and are stricken down with influenza and pains in the limbs. I have seen the difficulty experienced in getting farms cultivated in this zone, on both sides of the Cordillera. The permanent residents are generally limited to the major domo and his family; and in the dry season labourers are hired, of any colour that can be obtained—some from the low country, others from the highlands—for three, four, or five months, who gather in and grind the cane, and plant for the harvest of the following year; but a staff of resident Indian labourers, such as exists in the farms of the sierra, cannot be kept up in the *Yungas*, as these half-warm valleys are called. White men, who take proper precautions, and are not chronically soaked with cane-spirit, stand the climate perfectly, but the creole whites are still too much *caballeros* to devote themselves to agricultural work.

"In what is now the republic of Ecuador, the only peopled portions are the central valley, between the two ridges of the Andes—height 7000 to 12,000 feet—and the hot plain at their western base; nor do the wooded slopes appear to have been inhabited, except by scattered savage hordes, even in the time of the Incas. The Indians of the highlands are the descendants of others who have inhabited that region exclusively for untold ages; and a similar affirmation may be made of the Indians of the plain. Now, there is little doubt that the progenitors of both these sections came from a temperate region (in North America); so that here we have one moiety acclimatised to endure extreme heat, and the other extreme cold; and at this day exposure of either to the opposite extreme (or even, as we have seen, to the climate of an intermediate zone) is always pernicious and often fatal. But if this great difference has been brought about in the red man, might not the same have happened to the white man? Plainly it might, time being given; for one cannot doubt that the inherent adapta-

bility is the same in both, or (if not) that the white man possesses it in a higher degree."

The observations of Dr Spruce are of themselves almost conclusive as to the possibility of Europeans becoming acclimatised in the tropics; and if it is objected that this evidence applies only to the dark-haired southern races, we are fortunately able to point to facts, almost equally well authenticated and conclusive, in the case of one of the typical Germanic races. At the Cape of Good Hope the Dutch have been settled and nearly isolated for about 200 years, and have kept themselves almost or quite free from native intermixture. They are described as being still perfectly fair in complexion, while physically they are the finest body of men in the colony, being very tall and strong. They marry young, and have large families. The population, according to a census taken in 1798, was under 22,000. In 1865 it was near 182,000, the majority being (according to the *Statesman's Year Book* for 1873) of "Dutch, German, or French origin, mostly descendants of original settlers." We have here a population which has doubled itself every twenty-two years; and the greater part of this rapid increase must certainly be due to the old European immigrants. In the Moluccas, where the Dutch have had settlements for nearly 250 years, some of the inhabitants trace their descent to early immigrants; and these, as well as most of the people of Dutch descent in the East, are quite as fair as their European ancestors, enjoy excellent health, and are very prolific. But the Dutch accommodate themselves admirably to a tropical climate, doing much of their work early in the morning, dressing very lightly, and living a quiet, temperate, and cheerful life. They also pay great attention to drainage and general cleanliness. In addition to these examples, it may be maintained that the rapid increase of English-speaking populations in the United States and in Australia, only a comparatively small portion of which can be due to direct immigration, is far from supporting the view of Dr Knox, that Europeans cannot permanently maintain themselves in those countries. Mr Brace expressly denies that the American physique has degenerated from the English type. He asserts that manufacturers and others find that "for labours requiring the utmost physical endurance and muscular power, such as iron-puddling and lumbering in the forests and on the streams, and pioneer work, foreigners are never so suitable as native Americans. The reports of the examining surgeons for volunteers—such as that of Dr W. H. Thomson to the Surgeon-General in 1862, who examined 9000 men—show a far higher average of physique in the Americans examined than in the English, Germans, or Irish. It is a fact well known to our life insurance companies, that the average length of life here is greater than that of the English tables."—*The Races of the Old World*, p. 375. Although the comparisons here instituted may not be quite fair or conclusive, they furnish good arguments against those who maintain that the Americans are physically deteriorating.

On the whole, we seem justified in concluding that, under favourable conditions, and with a proper adaptation of means to the end in view, man may become acclimatised with at least as much certainty and rapidity (counting by generations rather than by years) as any of the lower animals. (A. R. W.)

ACCOLADE (from *collum*, the neck), a ceremony anciently used in conferring knighthood; but whether it was an embrace (according to the use of the modern French word, *accolade*), or a slight blow on the neck or cheek, is not agreed. Both these customs appear to be of great antiquity. Gregory of Tours writes that the early kings of France, in conferring the gilt shoulder-belt, kissed the knights on the left cheek; and William the Conqueror is said to have made use of the blow in conferring the honour of knighthood on his son Henry. At first it was given with the naked fist, a veritable box on the ear, but for this was substituted a gentle stroke on the shoulder with the flat of the sword. A custom of a similar kind is still followed in bestowing the honour of knighthood.

ACCOLTI, Benedict, was born in 1415 at Arezzo, in Tuscany, of a noble family, several members of which were distinguished like himself for their attainments in law. He was for some time professor of jurisprudence in the University of Florence, and on the death of the celebrated Poggio in 1459 became chancellor of the Florentine republic. He died in 1466. In conjunction with his brother Leonard, he wrote in Latin a history of the first crusade, entitled *De Bello a Christianis contra Barbaros, pro Christi Sepulchro et Judæa recuperandis, libri tres*, which, though itself of little interest, furnished Tasso with the historic basis for his *Jerusalem Delivered*. This work appeared at Venice in 1432, and was translated into Italian in 1543, and into French in 1620. Another work of Accolti's—*De Præstantia Virorum sui Ævi*—was published at Parma in 1689.

ACCOLTI, Bernard (1465-1535), son of the preceding, known in his own day as *l'Unico Aretino*, acquired great fame as a reciter of impromptu verse. He was listened to by large crowds, composed of the most learned men and the most distinguished prelates of the age. Among others, Cardinal Bembo has left on record a testimony to his extraordinary talent. His high reputation with his contemporaries seems scarcely justified by the poems he published, though they give evidence of brilliant fancy. It is probable that he succeeded better in his extemporary productions than in those which were the fruit of deliberation. His works, under the title *Virginia, Comedia, Capitoli e Strambotti di Messer Bernardo Accolti Aretino*, were published at Florence in 1513, and have been several times reprinted.

ACCOLTI, Pietro, brother of the preceding, was born at Florence in 1455, and died there in 1549. He was abbreviator under Leo X., and in that capacity drew up in 1520 the famous bull against Luther. In 1527 he was made a cardinal by Clement VII., who had employed him as his secretary.

ACCOMMODATION, a term used in Biblical interpretation to denote the presentation of a truth not absolutely as it is in itself, but relatively or under some modification, with the view of suiting it either to some other truth or to the persons addressed. It is generally distinguished into *formal* and *material*,—the accommodation in the one case being confined to the *method* of teaching, and in the other being extended to the *matter* taught. To the former head may be referred teaching by symbols or parables, by progressive stages graduated according to the capacity of the learner, by the application of prophecy to secondary fulfilments, &c. To the latter head are to be referred the allegations of the anti-supranaturalistic school, that Christ and the writers of Scripture modified or perverted the truth itself in order to secure wider acceptance and speedier success, by speaking in accordance with contemporary ideas rather than with absolute and eternal truth.

ACCOMMODATION, in commerce, denotes generally temporary pecuniary aid given by one trader to another, or by a banker to his customers, but it is used more particularly to describe that class of bills of exchange which represents no actual exchange of real value between the parties.

ACCORAMBONI, Vittoria, an Italian lady remarkable for her extraordinary beauty and her tragic history. Her contemporaries regarded her as the most captivating woman that had ever been seen in Italy. She was sought in marriage by Paolo Giordano Orsini, Duke of Bracciano, who, it was generally believed, had murdered his wife,

Isabella de Medici, with his own hand; but her father gave her in preference to Francesco Peretti, nephew of Cardinal Montalto. Peretti was assassinated (1581), and a few days afterwards Vittoria fled from the house of the Cardinal, where she had resided, to that of the Duke of Bracciano. The opposition of Pope Gregory XIII., who even went so far as to confine Vittoria to Fort St Angelo for nearly a year, did not prevent her marriage with the duke. On the accession of Montalto to the papal throne as Sixtus V. (1585), the duke thought it prudent to take refuge with his wife in the territory of the Venetian republic. After a few months' residence at Salò, on the Lake of Garda, he died, bequeathing nearly the whole of his large fortune to his widow. This excited the anger of Ludovico Orsini, a relative, who caused Vittoria to be murdered in her residence at Padau (Dec. 22, 1585). The history of this beautiful and accomplished but unfortunate woman has been written by Adry (1800), and recently by Count Gnoli, and forms the basis of Webster's tragedy, *The White Devil*, and of Tieck's romance, *Vittoria Accoramboni*.

ACCORDION (from the French *accord*), a small musical instrument in the shape of a bellows, which produces sounds by the action of wind on metallic reeds of various sizes. It is played by being held in both hands and pulled backwards and forwards, the fingers being left free to touch the keys, which are ranged along each side. The instrument is akin to the concertina, but differs from it in having the chords *fixed* by a mechanical arrangement. It is manufactured chiefly in Paris.

ACCORSO (in Latin *Accursius*), FRANCIS, an eminent lawyer, born at Florence about 1182. After practising for some time in his native city, he was appointed professor at Bologna, where he had great success as a teacher. He undertook the great work of arranging into one body the almost innumerable comments and remarks upon the Code, the Institutes, and Digests, the confused dispersion of which among the works of different writers caused much obscurity and contradiction. When he was employed in this work, it is said that, hearing of a similar one proposed and begun by Odofred, another lawyer of Bologna, he feigned indisposition, interrupted his public lectures, and shut himself up, till he had, with the utmost expedition, accomplished his design. His work has the vague title of the *Great Gloss*, and, though written in barbarous Latin, has more method than that of any preceding writer on the subject. The best edition of it is that of Godefroi, published at Lyons in 1589, in 6 vols. folio. Accursius was greatly extolled by the lawyers of his own and the immediately succeeding age, and he was even called the *Idol of Jurisconsults*, but those of later times formed a much lower estimate of his merits. There can be no doubt that he has disentangled with much skill the sense of many laws; but it is equally undeniable that his ignorance of history and antiquities has often led him into absurdities, and been the cause of many defects in his explanations and commentaries. He died at Bologna in 1260. His eldest son Francis, who filled the chair of law at Bologna with great reputation, was invited to Oxford by King Edward I., and in 1275 or 1276 read lectures on law in that university. In 1280 he returned to Bologna, where he died in 1293.

ACCORSO (or ACCURSIUS), MARIANGELO, a learned and ingenious critic, was born at Aquila, in the kingdom of Naples, about 1490. He was a great favourite with Charles V., at whose court he resided for thirty-three years, and by whom he was employed on various foreign missions. To a perfect knowledge of Greek and Latin he added an intimate acquaintance with several modern languages. In discovering and collating ancient manuscripts, for which his travels abroad gave him special opportunities, he displayed uncommon diligence. His work entitled *Diatribæ in Ausonium, Solinum, et Ovidium*, printed at Rome, in folio, in 1524, is a singular monument of erudition and critical skill. He bestowed, it is said, unusual pains on Claudian, and made, from different manuscripts, above seven hundred corrections on the works of that poet. Unfortunately these criticisms were never published. He was the first editor of the *Letters of Cassiodorus*, with his *Treatise on the Soul;* and his edition of *Ammianus Marcellinus* (1533) contains five books more than any former one. The affected use of antiquated terms, introduced by some of the Latin writers of that age, is humorously ridiculed by him, in a dialogue published in 1531 (republished, with his name, in 1574), entitled *Osco, Volsco, Romanaque Eloquentia Interlocutoribus, Dialogus Ludis Romanis actus.* Accorso was accused of plagiarism in his notes on Ausonius; and the determined manner in which he repelled, by a most solemn oath, this charge of literary theft, presents us with a singular instance of anxiety and care to preserve a literary reputation unstained.

ACCOUNT, a Stock Exchange term: *e.g.*, "*To Buy or Sell for the Account*," &c. The word has different, though kindred, significations, all derived from the making up and settling of accounts on particular days, in which stricter sense the word "Settlement" is more specially used.

The financial importance of *the Account* may be gathered from the Clearing House returns. Confining ourselves to the six years, from the 30th of April 1867 to the 30th of April 1873, we have the following figures, furnished by the Clearing House to Sir John Lubbock, and communicated by him to the *Times*:—

April to April	On fourths of the Month.	On Stock Exchange Account Days.	On Consols Settling Days.
1867 to 1868	£147,113,000	£444,443,000	£132,293,000
1868 to 1869	161,861,000	550,622,000	142,270,000
1869 to 1870	168,523,000	594,763,000	148,822,000
1870 to 1871	186,517,000	635,946,000	169,141,000
1871 to 1872	229,629,000	942,446,000	233,843,000
1872 to 1873	265,965,000	1,032,474,000	243,561,000

During the year ending April 30, 1873, the *total* amount of bills, checks, &c., paid at the Clearing House showed an increase of £643,613,000 during the same period ending April 1872, and of £2,745,924,000 over 1868. The amounts passing through on the *4ths of the month* amounted to £265,965,000, showing an increase of £36,336,000 over 1872. The payments on *Stock Exchange Account Days* formed a sum of £1,032,474,600, being an increase of £90,028,000 over 1872. The payments on *Consols Account Days* for the same period amounted to £243,561,000, giving an increase of £9,718,000 over 1872.

In English and Indian Government Securities, the settlements are monthly, and for foreign, railway, and other securities, generally speaking, they are fortnightly. It follows therefore that in 1867–1868, an ordinary Stock Exchange Account Day involved payments, on Stock Exchange accounts only, averaging about £10,000,000 sterling, and in 1872–3 something like £25,000,000 sterling; and these sums again, enormous as they are, represent for the most part only the balance of much larger transactions. The London Account is, in fact, probably the greatest and most important periodical event in the financial world. The great European centres have their own Account Days and methods of settlement, but the amounts dealt in are very much less than on the London market. The leading cities in the United Kingdom have also their Stock Exchanges, but their practice follows more or less that of London, where the bulk of their business is transacted by means of post and telegraph.

The Account in Consols or other English Government Securities, or in the securities of the Government of India, or in Bank of England Stock, or other Stocks transferable at the Bank of England, extends over a month, the settlements being monthly, and in them the committee of the Stock Exchange does not take cognisance of any bargain for a future account, if it shall have been effected more

than eight days previously to the close of the existing account.

The Account in Securities to Bearer, and, with the above exceptions, in Registered Securities also, extends over a period of from twelve to nineteen days. This period is in each case terminated by the "settlement," which occurs twice in each month (generally about the middle and end), on days fixed by the committee for general purposes of the Stock Exchange in the preceding month.

This "settlement" occupies three continuous days, which are all termed Account days, but the third day is the true Account, Settling, or Pay Day.

Continuation or Carrying-over is the operation by which the settlement of a bargain transacted for money, or for a given account, may for a consideration (called either a "Contango" or a "Backwardation") be deferred for the period of another account. Such a continuation is equivalent to a sale "for the day," and a repurchase for the succeeding account, or to a purchase "for the day," and a re-sale for the succeeding account. The price at which such transactions are adjusted is the "Making-Up" price of the day.

Contango is a technical term which expresses the rate of interest charged for the loan of money upon the security of stock transferred for the period of an account or otherwise, or the rate of interest paid by the buyer to the seller to be allowed to defer paying for the stock purchased, until the next settlement day.

Backwardation, or, as it is more often called, *Back* (for brevity), in contradistinction to contango, is the amount charged for the loan of stock from one account to the other, and it is paid to the purchaser by the seller in order to allow the seller to defer the delivery of the stock.

A *Bull Account* is one in which either the purchases have predominated over the sales, or the disposition to purchase has been more marked than the disposition to sell.

A *Bear Account* is one in which either the sales have preponderated over the purchases, or in which the disposition to sell has been more strongly displayed than the disposition to buy.

Sometimes the Bull or the Bear disposition extends to the great majority of securities, as when there are general falls or general rises. Sometimes a Bull Account in one set of securities is contemporaneous with a Bear Account in another.—*Vide* Cracroft's *Stock Exchange Manual.*

ACCOUNTANT, earlier form ACCOMPTANT, in the most general sense, is a person skilled in accounts. It is applied to the person who has the charge of the accounts in a public office or in the counting-house of a large private business. It is also the designation of a distinct profession, which deals in any required way with mercantile accounts.

ACCOUNTANT-GENERAL, an officer in the English Court of Chancery, who receives all monies lodged in court, and by whom they are deposited in bank and disbursed.

ACCRA or ACRA, a town, or rather a collection of forts, in a territory of the same name, on the Gold Coast of Africa, about 75 miles east of Cape Coast Castle. Of the forts, Fort St James is a British settlement, Crèvecœur was established by the Dutch, and Christianborg by the Danes; but the two last have since been ceded to Britain—Christianborg in 1850, and Crèvecœur in 1871. Accra is considered to be one of the healthiest stations on the west coast of Africa, and has some trade in the productions of the interior,—ivory, gold dust, and palm-oil; while cotton goods, tobacco, rum, and beads are imported in exchange. It is the residence of a British civil commandant.

ACCRINGTON, an important manufacturing town of England, in Lancashire, lies on the banks of a stream called the Hindburn, in a deep valley, 19 miles N. from Manchester and 5 miles E. of Blackburn. It has increased rapidly in recent years, and is the centre of the Manchester cotton-printing trade. There are large cotton factories and print-works, besides bleach-fields, &c., employing many hands. Coal is extensively wrought in the neighbourhood. The town has a good appearance, and among the more handsome buildings are a fine church, in the Gothic style, erected in 1838, and the Peel Institution, an Italian structure, containing an assembly room, a lecture room, &c., The sanitary arrangements generally are good, and a reservoir capable of containing 140,000,000 gallons has been constructed for the water supply of the town. Accrington is a station on the Lancashire and Yorkshire Railway. The population of the two townships of Old and New Accrington was in 1861, 17,688; and in 1871, 21,788.

ACCUM, FREDERICK, chemist, born at Bückeburg in 1769, came to London in 1793, and was appointed teacher of chemistry and mineralogy at the Surrey Institution in 1801. While occupying this position he published several scientific manuals (*Chemistry*, 1803; *Mineralogy*, 1808; *Crystallography*, 1813), but his name will be chiefly remembered in connection with gas-lighting, the introduction of which was mainly due to him and to the enterprising printseller, Ackermann. His excellent *Practical Treatise on Gaslight* appeared in 1815; and he rendered another valuable service to society by his *Treatise on Adulterations of Food and Culinary Poisons* (1820), which attracted much notice at the time it appeared. Both works, as well as a number of his smaller publications, were translated into German. In consequence of charges affecting his honesty, Accum left London for Germany, and in 1822 was appointed professor in the Industrial Institute and Academy of Architecture at Berlin. He died there in 1838.

ACCUMULATOR, a term applied frequently to a powerful electrical machine, which generates or accumulates, by means of friction, electric currents of high tension,—manifested by sparks of considerable length. Accumulators have been employed in many places for exploding torpedoes and mines, for blasting, &c. An exceedingly powerful apparatus of this kind was employed by the Confederate authorities during the civil war in America for discharging submarine and river torpedoes. Whatever the nature of the materials employed in the construction of the accumulator, or the form which it may assume mechanically, it is simply a modification of, or an improvement upon, the ordinary cylindrical or the plate-glass frictional electrical machine, — the fundamental scientific principles being the same in nearly every case. The exciting body consists generally of a large disc or circular plate of vulcanite,—more frequently termed by electricians "ebonite," in consequence of its resemblance, in point of hardness and of polish, to polished ebony,—the vulcanite disc taking the place of the ordinary circular plate of thick glass.

ACE, the received name for the single point on cards or dice—the unit. Mr Fox Talbot has a speculation (*English Etymologies*, p. 262) that the Latins invented, if not the game of dice, at least the name for the single point, which they called *unus*. The Greeks corrupted this into ὄνος, and at length the Germanic races, learning the game from the Greeks, translated the word into *ass*, which has now become *ace*. The fact, however, is, that the root of the word lies in the Latin *as*, the monetary unit, which is to be identified with the Greek εἷς; Doric, αἷς or ἅς.

ACEPHALA, a name sometimes given to a section of the molluscous animals, which are divided into *encephala* and *acephala*, according as they have or want a distinctly differentiated head. The Acephala, or *Lamellibranchiata*, as they are also called, are commonly known as bivalve shell-fish.

ACEPHALI (from ἀ privative, and κεφαλή, a head), a term applied to several sects as having no head or leader; and in particular to a sect that separated itself, in the end of the 5th century, from the rule of the patriarchs of Alexandria, and remained without king or bishop for more than 300 years (*Gibbon*, c. xlvii.)

ACEPHALI was also the name given to the levellers in the reign of Henry I., who are said to have been so poor as to have no tenements, in virtue of which they might acknowledge a superior lord.

ACEPHALI, or *Acephalous Persons*, fabulous monsters, described by some ancient naturalists and geographers as having no heads.

ACER. See MAPLE.

ACERBI, GIUSEPPE (JOSEPH), an Italian traveller, born at Castel-Goffredo, near Mantua, on the 3d May 1773, studied at Mantua, and devoted himself specially to natural science. In 1798 he undertook a journey through Denmark, Sweden, Finland, and Lapland; and in the following year he reached the North Cape, which no Italian had previously visited. He was accompanied in the latter part of the journey by the Swedish colonel Skiöldebrand, an excellent landscape-painter. On his return Acerbi stayed for some time in England, and published his *Travels through Sweden*, &c. (London, 1802), which was translated into German (Weimar, 1803), and, under the author's personal superintendence, into French (Paris, 1804). The French translation received numerous corrections, but even in this amended form the work contains many mistakes. Acerbi rendered a great service to Italian literature by starting the *Biblioteca Italiana* (1816), in which he opposed the pretensions of the Academy della Crusca. Being appointed Austrian consul-general to Egypt in 1826, he entrusted the management of the *Biblioteca* to Gironi, contributing to it afterwards a series of valuable articles on Egypt. While in the East he obtained for the museums of Vienna, Padua, Milan, and Pavia many objects of interest. He returned from Egypt in 1836, and took up his residence in his native place, where he occupied himself with his favourite study till his death in August 1846.

ACERNUS, the Latinised name by which SEBASTIAN FABIAN KLONOWICZ, a celebrated Polish poet, is generally known, was born at Sulmierzyce in 1551, and died at Lublin in 1608. He was for some time burgomaster and president of the Jews' civil tribunal in the latter town, where he had taken up his residence after studying at Cracow. Though himself of an amiable disposition, his domestic life was very unhappy, the extravagance and misconduct of his wife driving him at last to the public hospital of Lublin, where he ended his days. He wrote both Latin and Polish poems, and the genius they displayed won for him the name of the *Sarmatian Ovid.* The titles of fourteen of his works are known; but a number of these were totally destroyed by the Jesuits and a section of the Polish nobility, and copies of the others are for the same reason exceedingly rare. The *Victoria Deorum ubi continetur Veri Herois Educatio*, a poem in forty-four cantos, cost the poet ten years' labour.

ACERRA, in *Antiquity*, a little box or pot, wherein were put the incense and perfumes to be burned on the altars of the gods, and before the dead. It appears to have been the same with what was otherwise called *thuribulum* and *pyxis*. The *censers* of the Jews were *acerræ;* and the Romanists still retain the use of *acerræ*, under the name of *incense pots*.

The name *acerra* was also applied to an altar erected among the Romans, near the bed of a person recently deceased, on which his friends offered incense daily till his burial. The real intention probably was to fumigate the apartment. The Chinese have still a somewhat similar custom.

ACERRA, a town of Italy, in the province of Terra di Lavoro, situated on the river Agno, 7 miles N.E. of Naples, with which it is connected by rail. It is the ancient *Acerrae*, the inhabitants of which were admitted to the privileges of Roman citizenship so early as 332 B.C., and which was plundered and burnt by Hannibal during the second Punic war. A few inscriptions are the only traces time has left of the ancient city. The town stands in a fertile district, but is rendered very unhealthy by the malaria rising from the artificial water-courses of the surrounding Campagna. It is the seat of a bishop, and has a cathedral and seminary. Flax is grown in the neighbourhood. Population, 11,717.

ACETIC ACID, one of the most important organic acids. It occurs naturally in the juice of many plants, and in certain animal secretions; but is generally obtained, on the large scale, from the oxidation of spoiled wines, or from the destructive distillation of wood. In the former process it is obtained in the form of a dilute aqueous solution, in which also the colouring matters of the wine, salts, &c., are dissolved; and this impure acetic acid is what we ordinarily term vinegar. The strongest vinegar sold in commerce contains 5 per cent. of real acetic acid. It is used as a mordant in calico-printing, as a local irritant in medicine, as a condiment, and in the preparation of various acetates, varnishes, &c. Pure acetic acid is got from the distillation of wood, by neutralising with lime, separating the tarry matters from the solution of acetate of lime, evaporating off the water, and treating the dry residue with sulphuric acid. On applying heat, pure acetic acid distills over as a clear liquid, which, after a short time, if the weather is cold, becomes a crystalline mass known by the name of Glacial Acetic Acid. For synthesis, properties, &c., see CHEMISTRY.

ACHAIA, in *Ancient Geography*, a name differently applied at different periods. In the earliest times the name was borne by a small district in the south of Thessaly, and was the first residence of the Achæans. At a later period *Achaia Propria* was a narrow tract of country in the north of the Peloponnesus, running 65 miles along the Gulf of Corinth, and bounded by the Ionian Sea on the W., by Elis and Arcadia on the S., and by Sicyonia on the E. On the south it is separated from Arcadia by lofty mountains, but the plains between the mountains and the sea are very fertile. Its chief town was Patræ. The name of Achaia was afterwards employed to denote collectively the states that joined the Achæan League. When Greece was subdued by the Romans, *Achaia* was the name given to the most southerly of the provinces into which they divided the country, and included the *Peloponnesus*, the greater part of Greece Proper, and the islands.

Achæans and the Achæan League.—The early inhabitants of Achaia were called *Achæans*. The name was given also in those times to some of the tribes occupying the eastern portions of the Peloponnesus, particularly *Argos* and *Sparta.* Afterwards the inhabitants of Achaia Propria appropriated the name. This republic was not considerable, in early times, as regards either the number of its troops, its wealth, or the extent of its territory, but was famed for its heroic virtues. The Crotonians and Sybarites, to re-establish order in their towns, adopted the laws and customs of the Achæans. After the famous battle of Leuctra, a difference arose betwixt the Lacedæmonians and Thebans, who held the virtue of this people in such veneration, that they terminated the dispute by their decision. The government of the Achæans was democratical. They preserved their liberty till the time of Philip and Alexander; but in the reign of these princes, and afterwards, they were either subjected to the Macedonians, who had made themselves masters of Greece, or oppressed by domestic tyrants. The Achæan commonwealth consisted of twelve inconsiderable towns in Peloponnesus. About 280 years before Christ the republic of the Achæans recovered its old institutions and unanimity. This was the renewal of the ancient confederation, which subsequently became so famous under the name of the ACHÆAN LEAGUE—having for its object, not as formerly a common worship, but a substantial political union. Though dating from the year B.C. 280, its import-

ance may be referred to its connection with Aratus of Sicyon, about 30 years later, as it was further augmented by the splendid abilities of Philopœmen. Thus did this people, so celebrated in the heroic age, once more emerge from comparative obscurity, and become the greatest among the states of Greece in the last days of its national independence. The inhabitants of Patræ and of Dyme were the first assertors of ancient liberty. The tyrants were banished, and the towns again made one commonwealth. A public council was then held, in which affairs of importance were discussed and determined; and a register was provided for recording the transactions of the council. This assembly had two presidents, who were nominated alternately by the different towns. But instead of two presidents, they soon elected but one. Many neighbouring towns, which admired the constitution of this republic, founded on equality, liberty, the love of justice, and of the public good, were incorporated with the Achæans, and admitted to the full enjoyment of their laws and privileges. The Achæan League affords the most perfect example in antiquity of the federal form of government; and, allowing for difference of time and place, its resemblance to that of the United States government is very remarkable. (See Arts. AMPHICTYONY and FEDERAL GOVERNMENT; also Freeman's *Federal Government*, 2 vols. 8vo. 1863, and *Comparative Politics*, 8vo. 1873; Droysen, *Geschichte des Hellenismus*, 2 vols.; Helwing, *Geschichte des Achäischen Bundes*.)

ACHAN, the son of Carmi, of the tribe of Judah, at the taking of Jericho concealed two hundred shekels of silver, a Babylonish garment, and a wedge of gold, contrary to the express command of God. This sin proved fatal to the Israelites, who were repulsed at the siege of Ai. In this emergency Joshua prostrated himself before the Lord, and begged that he would have mercy upon his people. Achan was discovered by casting lots, and he and his children were stoned to death. This expiation being made, Ai was taken by stratagem. (Josh. vii. viii.)

ACHARD, FRANZ CARL, a Prussian chemist, born at Berlin on the 28th April 1753, was the first to turn Marggraf's discovery of the presence of sugar in beet-root to commercial account. He erected a factory on an estate in Silesia, granted to him about 1800 by the king of Prussia, and produced there large quantities of sugar to meet the scarcity occasioned by the closing of the West Indian ports to continental traders. In 1812 a similar establishment was erected by Napoleon at Rambouillet, although the Institute of France in 1800, while honouring Achard for his researches, had declared his process to have little practical value. At the close of the war the manufacture of beet-root sugar was protected by duties on other sugars that were almost prohibitive, so that the real worth of Achard's discoveries could not be tested. Achard was a frequent contributor to the *Memoirs of the Academy of Berlin*, and published in 1780 *Chymisch-Physische Schriften*, containing descriptions and results of his very numerous and carefully conducted experiments on the adhesion of bodies. He died in 1821.

ACHARIUS, ERIK, a Swedish physician and botanist, born at Gefle in 1757. The son of a comptroller of customs, he studied first in his native town, and then in 1773 at the University of Upsal, where Linnæus was one of his teachers. In 1782 he took the degree of M.D. at the University of Lund, and practised thereafter in various districts of Sweden. But the direction of his studies had been determined by his contact with Linnæus, and he found his appropriate sphere when he was appointed Professor of Botany at the Wadstena Academy in 1801. Five years before he had been admitted a member of the Academy at Stockholm. He devoted himself to the study of the cryptogamic orders of plants, and especially of the family of lichens. All his publications were connected with this subject, the *Lichenographia Universalis* (Göttingen, 1804) being the most important. Acharius died of apoplexy in 1819. His name has been given by botanists to more than one species of plants.

ACHATES, the faithful friend and companion of Æneas, celebrated in Virgil's *Æneid* as *fidus Achates*.

ACHEEN. See ACHÍN.

ACHELOUS, the largest river in Greece, rises in Mount Pindus, and dividing Ætolia from Acarnania, falls into the Ionian Sea. In the lower part of its course the river winds in an extraordinary manner through very fertile but marshy plains. Its water descends from the mountains, heavily charged with fine mud, which is deposited along its banks and in the sea at its mouth, where a number of small islands have gradually been formed. It was formerly called *Thoas*, from its impetuosity in its upper portion, and Homer gave it the name of *king of rivers*. It has a course of 130 miles. The epithet *Acheloius* is used for *aqueus* (Virgil), the ancients calling all water *Achelous*, according to Ephorus. The river is now called *Aspro Potamo*.

ACHENWALL, GOTTFRIED, a German writer, celebrated as having formulated and developed the science (*Wissenschaft der Staaten*) to which he was the first to apply the name *scientia statistica*, or *statistics*. Born at Elbing, in East Prussia, in October 1719, he studied at Jena, Halle, and Leipsic, and took a degree at the last-named university. He removed to Marburg in 1746, where for two years he read lectures on history, and on the law of nature and of nations. Here, too, he commenced those inquiries in statistics by which his name became known. In 1748, having been invited by Münchhausen, the Hanoverian minister, to occupy a chair at the university, he removed to Göttingen, where he resided till his death in 1772. His chief works were connected with statistics. The *Staatsverfassungen der europäischen Reiche* appeared first in 1752, and revised editions—corrected from information which he travelled through England, France, and other countries to collect—were published in 1762 and 1768. He was married in 1752 to a lady named Walther, who obtained some celebrity by a volume of poems published in 1750, and by other writings.

ACHERON, in *Classical Mythology*, the son of Ceres, who, for supplying the Titans with drink when they were in contest with Jupiter, was turned into a river of Hades, over which departed souls were ferried on their way to Elysium. The name eventually was used to designate the whole of the lower world.

ACHILL, or "Eagle" Island, off the west coast of Ireland, forms part of the county of Mayo. It is of triangular shape, and extends 15 miles from east to west, and 12 from north to south, its total area being 51,521 acres. The island is very mountainous; its extreme western point, Achill Head, is a bold and rugged promontory rising to a height of 2222 feet above the sea. Large bogs, incapable of cultivation, alternate with the hills of this desolate isle, of whose extensive surface not more than 500 acres have been reclaimed. The inhabitants earn a scanty subsistence by fishing and tillage; their dwellings are miserable hovels. There is a mission-station on the island, and remains of ancient churches are still extant.

ACHILLES (Ἀχιλλεύς). When first taken up by the legendary history of Greece, the ancestors of Achilles were settled in Phthia and in Ægina. That their original seat, however, was in the neighbourhood of Dodona and the Achelous is made out from a combination of the following facts: That in the *Iliad* (xvi. 233) Achilles prays to Zeus of Dodona; that this district was the first to bear the name of Hellas; that the followers of Achilles at Troy were the only persons named Hellenes in the time of Homer

(Thucyd. i .3; cf. *Iliad*, ii. 684, where the more usual name of Myrmidones also occurs); that in Ægina Zeus was styled "Hellanios;" and that the name of Selloi, applied to the priesthood at Dodona, is apparently identical with the name Hellenes. Whether from this local connection the derivation of the name of Achilles from the same root as Ἀχελῷος should be preferred to the other derivations, such as Ἀχι-λεύς = Ἐχέλαος, "ruler," or Ἀχ-ιλεύς, = "the bane of the Ilians," remains undecided. But this is gained, that we see in what manner the legend of Achilles had its root in the earlier Pelasgic religion, his adherence to which in the prayer just cited would otherwise appear very strange on the part of a hero who, through the influence of Homer and his successors, is completely identified with the Olympian system of gods. According to the genealogy, Æacus had two sons, Peleus and Telamon, of whom the former became the father of Achilles—the latter, of Ajax; but of this relationship between Achilles and Ajax there is no sign in the *Iliad*. Peleus ruled in Phthia; and the gods remarking his piety, rewarded him with, among other presents, a wife in the person of the beautiful nereid Thetis. After her son was born, Thetis appears to have returned to her life in the sea. The boy was placed under his father's friend, the centaur Cheiron. When six years old he slew lions and boars, and could run down a stag. When nine, he was removed from his instructor to the island of Scyrus, where, dressed as a girl, he was to be brought up among the daughters of Lycomedes, his mother preferring for him a long inglorious life to a brief but splendid career. The same desire for his safety is apparent in other legends, which describe her as trying to make him invulnerable when a child by placing him in boiling water or in a fire, and then salving him with ambrosia; or again, in later story, by dipping him in the river Styx, from which he came out, all but the heel which she held, proof against wounds. When the aid of Achilles was found indispensable to the expedition against Troy, Odysseus set out for Scyrus as a pedlar, spread his wares, including a shield and spear, before the king's daughters, among whom was Achilles in disguise. Then he caused an alarm of danger to be sounded, upon which, while the girls fled, Achilles seized the arms, and thus revealed himself. Provided with a contingent of 50 ships, and accompanied by the aged Phœnix and Patroclus, he joined the expedition, which after occupying nine years in raids upon the towns in the neighbourhood of Troy and in Mysia, as detailed in the epic poem entitled the *Cypria*, culminated in the regular siege of Troy, as described in the *Iliad*, the grand object of which is the glorification of our hero. Estranged from his comrades, because his captive Briseïs had been taken from him, Achilles remained inexorable in his tent, while defeat attended the Greeks. At length, at their greatest need, he yielded so far as to allow Patroclus to take his chariot and to assume his armour. Patroclus fell, and the news of his death roused Achilles, who, now equipped with new armour fashioned by Hephæstus, drove back the Trojans, slew Hector, and after dragging his body thrice round the Trojan walls, restored it to Priam. With the funeral rites of Patroclus the *Iliad* concludes, and the story is taken up by the *Æthiopis*, a poem by Arctinus of Miletus, in which is described the combat of Achilles first with the amazon Penthesilea, and next with Memnon. When the latter fell, Achilles drove back the Trojans, and, impelled by fate, himself advanced to the Scæan gate, where an arrow from the bow of Paris struck his vulnerable heel, and he fell, bewailed through the whole camp. (A. S. M.)

ACHILLES TATIUS, a Greek writer, born at Alexandria. The precise time when he flourished is uncertain, but it cannot have been earlier than the 5th century, as in his principal work he evidently imitates Heliodorus. Suidas, who calls him Achilles Statius, says that he was converted from heathenism and became a Christian bishop, but this is doubtful, the more so that Suidas also attributes to him a work on the sphere (περὶ σφαίρας) which is referred to by Firmicus (330–50), and must, therefore, have been written by another person. The erotic romance of Achilles Tatius, entitled *The Loves of Clitophon and Leucippe*, is almost certainly the work of a heathen writer. The style of the work is ornate and rhetorical, while the story is often unnatural, and sometimes coarse, and the development of the plot irregular and frequently interrupted. Its popularity at the time it appeared is proved by the many manuscripts of it which still exist, and the value attached to it by modern scholars and critics is seen in the frequency with which it has been reprinted and translated. A Latin translation by Annibal Crucceius was published, first in part at Leyden in 1544, and then complete at Basel in 1554. The Greek text was first printed by Commelin, at Heidelberg, in 1601. Other editions by Salmasius (Leyden, 1640), Mitscherlich (Biponti, 1792), and Jacobs (Leipsic, 1821), have been superseded by the editions of Hirschig (Paris, 1856), and Hercher (Leipsic, 1857). An English translation by A. H. (Anthony Hodges) appeared at Oxford in 1638.

ACHILLINI, ALEXANDER (1463–1512), a native of Bologna, was celebrated as a lecturer both in medicine and in philosophy, and was styled the second Aristotle. He and Mundinus were the first at Bologna to avail themselves of the permission given by Frederick II. to dissect dead bodies. His philosophical works were printed in one volume folio, at Venice, in 1508, and reprinted with considerable additions in 1545, 1551, and 1568. He also wrote several medical works, chiefly on anatomy.

ÁCHÍN (pronounced *Atcheen*), a town and also a state of Northern Sumatra; the one state of that island which has been powerful at any time since the discovery of the Cape route to the East, and the only one that still remains independent of the Dutch, though that independence is now menaced.

De Barros names Áchín among the twenty-nine states that divided the sea-board of Sumatra when the Portuguese took Malacca. Northern Sumatra had been visited by several European travellers in the Middle Ages, such as Marco Polo, Friar Odorico, and Nicolo Conti. Some of these as well as Asiatic writers mention Lambri, a state which must have nearly occupied the position of Áchín. But the first voyager to visit Áchín, by that name, was Alvaro Tellez, a captain of Tristan d'Acunha's fleet, in 1506. It was then a mere dependency of the adjoining state of Pedir; and the latter, with Pasei, formed the only states on the coast whose chiefs claimed the title of Sultan. Yet before twenty years had passed Áchín had not only gained independence, but had swallowed up all other states of Northern Sumatra. It attained its climax of power in the time of Sultan Iskandar Muda (1607–1636), under whom the subject coast extended from Aru opposite Malacca round by the north to Padang on the west coast, a sea-board of not less than 1100 miles; and besides this, the king's supremacy was owned by the large island of Nyás, and by the continental Malay states of Johōr, Páháng, Quedah, and Perák.

The present limits of Áchín supremacy in Sumatra are reckoned to be, on the east coast the River Tamiang, in about 4° 25′ N. lat., which forms the frontier of territories tributary to Siák; and on the west coast a line in about 2° 48′ N., the frontier of Trumon, a small modern state lying between Áchín and the Dutch government of Padang. Even within these limits the actual power of Áchín is precarious, and the interior boundary can be laid down only from conjecture. This interior country is totally unexplored. It is believed to be inhabited by tribes kindred

to the Battas, that remarkable race of anthropophagi who adjoin on the south. The whole area of Áchín territory, defined to the best of our ability, will contain about 16,400 English square miles. A rate of 20 per square mile, perhaps somewhat too large an average, gives a probable population of 328,000.

The production of rice and pepper forms the chief industry of the Áchín territory. From Pedir and other ports on the north coast large quantities of betel-nut are exported to continental India, to Burmah, and to Penang for China. Some pepper is got from Pedir, but the chief export is from a number of small ports and anchorages on the west coast, where vessels go from port to port making up a cargo. Áchín ponies are of good repute, and are exported. Minor articles of export are sulphur, iron, sappan-wood, gutta-percha, *dammer*, rattans, bamboos, benzoin, and camphor from the interior forests. The camphor is that from the *Dryabalanops camphora*, for which so high a price is paid in China, and the whole goes thither, the bulk of that whole being, however, extremely small. Very little silk is now produced, but in the 16th century the quantity seems to have been considerable. What is now wanted for the local textures, which are in some esteem, is imported from China.

The chief attraction to the considerable trade that existed at Áchín two centuries ago must have been gold. No place in the East, unless Japan, was so abundantly supplied with gold. We can form no estimate of the annual export, for it is impossible to accept Valentyn's statement that it sometimes reached 80 bahars (512,000 ounces !). Crawford (1820), who always reckoned low, calculated the whole export of Sumatra at 35,530 ounces, and that of Áchín at 10,450; whilst Anderson (1826), who tends to put figures too high, reckoned the whole Áchín export alone at 32,000 ounces. The chief imports to Áchín are opium (largely consumed), rice (the indigenous supply being inadequate), salt, iron ware, piece-goods, arms and ammunition, vessels of copper and pottery, China goods of sorts, and a certain kind of dried fish.

The great repute of Áchín at one time as a place of trade is shown by the fact, that to this port the first Dutch (1599) and first English (1602) commercial ventures to the Indies were directed. Lancaster, the English commodore, carried letters from Queen Elizabeth to the king of Áchín, and was well received by the prince then reigning, Aláuddín Sháh. Another exchange of letters took place between King James I. and Iskandar Muda in 1613. But native caprice and natural jealousy at the growing force of the European nations in those seas, the reckless rivalries of the latter and their fierce desire for monopoly, were alike destructive of sound trade; and the English factory, though several times set up, was never long maintained. The French made one great effort under Beaulieu (1621) to establish relations with Áchín, but nothing came of it.

Still the foreign trade of Áchín, though subject to spasmodic interruptions, was important. Dampier and others speak of the number of foreign merchants settled there,—English, Dutch, Danes, Portuguese, Chinese, Banyans from Guzerat, &c. Dampier says the roads were rarely without ten or fifteen sail of different nations, bringing vast quantities of rice, as well as silks, chintzes, muslins, and opium. Besides the Chinese merchants settled at Áchín, others used to come annually with the junks, ten or twelve in number, which arrived in June. A regular fair was then established, which lasted two months, and was known as the China camp,—a lively scene, and great resort of foreigners.

The Áchínese are not identical with the Malays proper either in aspect or language. They are said to be taller, handsomer, and darker, as if with a mixture of blood from India proper. Their language is little known; but though it has now absorbed much Malay, the original part of it is said to have characteristics connecting it both with the Batta and with the Indo-Chinese tongues. The Áchín literature, however, is entirely Malay; it embraces poetry, a good deal of theology, and several chronicles.

The name of the state is properly *Acheh*. This the Portuguese made into *Achem;* whilst we, with the Dutch, learned to call it *Áchín*. The last appears to have been a Persian or Indian form, suggested by jingling analogy with Máchín (China).

The town itself lies very near the north-west extremity of Sumatra, known in charts as Áchín Head. Here a girdle of ten or twelve small islands affords protection to the anchorage. This fails in N.W. winds, but it is said that vessels may find safe riding at all seasons by shifting their berths. The town lies between two and three miles from the sea, chiefly on the left bank of a river of no great size. This forms a swampy delta, and discharges by three mouths. The central and chief mouth is about 100 yards wide, and has a depth of 20 to 30 feet within the bar. But the latter has barely 4 feet at low tide; at high tide it admits native craft of 20 or 30 tons, and larger craft in the rainy season. The town, like most Malay towns, consists of detached houses of timber and thatch, clustered in enclosed groups called *kampongs*, and buried in a forest of fruit-trees. The chief feature is the palace of the Sultan, which communicates with the river by a canal, and is enclosed, at least partially, by a wall of cut stone.

The valley or alluvial plain in which Áchín lies is low, and subject to partial inundation; but it is shut in at a short distance from the town, on the three landward sides, by hills. It is highly cultivated, and abounds in small villages and kampongs, with white mosques interspersed. The hills to the eastward are the spurs of a great volcanic mountain, upwards of 6000 feet in height, called by natives Yamuria, by mariners "the Golden Mountain." [1] Of the town population we find no modern estimate.

The real original territory of the Áchínese, called by them Great Áchín (in the sense of Áchín proper), consists of three districts immediately round the city, distinguished respectively as the 26, the 25, and the 22 múkims[2] (or hundreds, to use the nearest English term).

Each of these three districts has two heads, called *panglimas;* and these, according to some modern accounts, constitute the council of state, who are the chief administrators, and in whose hands it lies to depose the sovereign or to sanction his choice of a successor. Late notices speak of a chief minister, apparently distinct from these; and another important member of the government is the Shábandar, who is over all matters of customs, shipping, and commerce.

The court of Áchín, in the 17th century, maintained a good deal of pomp; and, according to Beaulieu, the king had always 900 elephants. These animals, though found throughout Sumatra, are now no longer tamed or kept.

Hostilities with the Portuguese began from the time of the first independent king of Áchín; and they had little remission till the power of Portugal fell with the loss of Malacca (1641). Not less than ten times before that event were armaments despatched from Áchín to reduce Malacca, and more than once its garrison was very hard pressed. One of these armadas, equipped by Iskandar Muda in 1615, gives an idea of the king's resources. It consisted of 500 sail, of which 250 were galleys, and

[1] Several other great volcanic cones exist in the Áchín territory, and two visible from seaward rise to a height of 11,000 feet or more in the unexplored interior.

[2] A múkim is said properly to embrace 44 households.

among these a hundred were greater than any then used in Europe. 60,000 men were embarked, with the king and his women.

On the death of Iskandar's successor in 1641, the widow was placed on the throne; and as a female reign favoured the oligarchical tendencies of the Malay chiefs, three more queens were allowed to reign successively. Though this series of female sovereigns lasted only fifty-eight years altogether, so dense is apt to be the ignorance of recent history, that long before the end of that period it had become an accepted belief among foreign residents at Áchín that there never had been any sovereigns in Áchín except females; and hence, by an easy inference, that the Queen of Sheba had been Queen of Áchín!

In 1699 the Arab or fanatical party suppressed female government, and put a chief of Arab blood on the throne. The remaining history of Áchín is one of rapid decay. Thirty sovereigns in all have reigned from the beginning of the 16th century to the present day.

After the restoration of Java to the Netherlands in 1816, a good deal of weight was attached by the neighbouring English colonies to the maintenance of our influence in Áchín; and in 1819 a treaty of friendship was concluded with the Calcutta Government, which excluded other European nationalities from fixed residence in Áchín. When the home Government, in 1824, made a treaty with the Netherlands, surrendering our remaining settlements in Sumatra in exchange for certain possessions on the continent of Asia, no reference was made in the articles to the Indian treaty of 1819; but an understanding was exchanged that it should be modified by us, whilst no proceedings hostile to Áchín should be attempted by the Dutch.

This reservation was formally abandoned by our Government in a convention signed at the Hague, November 2, 1871; and little more than a year elapsed before the government of Batavia declared war upon Áchín. Doubtless there was provocation, as there always will be between such neighbours; but the necessity for war has been greatly doubted, even in Holland. A Dutch force landed at Áchín in April 1873, and attacked the palace. It was defeated with considerable loss, including that of the general (Köhler). The approach of the south-west monsoon was considered to preclude the immediate renewal of the attempt; but hostilities were resumed, and Áchín fell in January 1874.

(De Barros; Faria y Souza; Valentyn, vol. v.; Beaulieu (in Thévenot's Collection); Dampier; Marsden; Crawfurd's *Hist. and Decl. of the Ind. Archip.; J. of Ind. Archip.;* Dulaurier in *J. Asiatique*, 3d s. vol. viii.; Anderson's *Acheen*, 1840; Veth, *Atchin*, &c. Leyden, 1873, &c.) (H. Y.)

ACHMET, or AHMED, the name of three emperors or sultans of Turkey, the first of the name reigning from 1603 to 1617, the second from 1691 to 1695. Achmet III. succeeded his brother Mustapha II., whom the Janissaries deposed in 1703. After the battle of Pultowa in 1709, Charles XII. of Sweden took refuge with him, and incited him to war with Peter the Great, Czar of Russia. Achmet recovered the Morea from the Venetians (1715); but his expedition into Hungary was less fortunate, his army being defeated at Peterwardein by Prince Eugene in 1716, and again near Belgrade the year after. The empire was distracted during his reign by political disturbances, which were occasioned, in part at least, by his misgovernment; and the discontent of his soldiers at last (1730) drove him from the throne. He died in prison in 1736.

ACHRAY, a small picturesque lake in Perthshire, near Loch Katrine, 20 miles W. of Stirling, which has obtained notoriety from Scott's allusion to it in the *Lady of the Lake.*

ACHROMATIC GLASSES are so named from being specially constructed with a view to prevent the confusion of colours and distortion of images that result from the use of lenses in optical instruments. When white light passes through a lens, the different-coloured rays that constitute it are refracted or bent aside at different angles, and so converge at different foci, producing a blurred and coloured image. To remedy this compound lenses have been devised, which present a well-defined image, unsurrounded by coloured bands of light. To instruments fitted with lenses of this kind has been given the name *achromatic*, from ἀ privative, and χρῶμα, colour. The celebrated optician, John Dollond, was the first to surmount this practical difficulty, about the year 1757, by the use of a combination of crown and flint glass. See OPTICS, MICROSCOPE, &c.

ACI REALE, a city and seaport of Sicily, in the Italian province of Catania, near the base of Mount Etna. It stands on solidified lava, which has here been deposited by different streams to a depth of 560 feet. The town, which has been almost entirely re-erected since the earthquake of 1693, is built of lava, contains many handsome edifices, and is defended by a fortress. Linen, silks, and cutlery are manufactured, and the trade in cotton, flax, grain, and wines is considerable. The place is celebrated for its cold sulphurous mineral waters. Near Aci Reale is the reputed scene of the mythical adventures of Acis and Galatea; and on this account several small towns in the neighbourhood also bear the name of Aci, such as Aci Castello, Aci Terra, &c. Aci Reale has a population of 24,151.

ACID, a general term in chemistry, applied to a group of compound substances, possessing certain very distinctive characteristics. All acids have one essential property, viz., that of combining chemically with an alkali or base, forming a new compound that has neither acid nor alkaline characters. The new bodies formed in this way are termed *salts*. Every acid is therefore capable of producing as many salts as there are basic substances to be neutralised; and this salt-forming power is the best definition of an acid substance.

The majority of acids possess the following *contingent* properties:—

1. When applied to the tongue, they excite that sensation which is called *sour* or *acid*.

2. They change the blue colours of vegetables to a red. The vegetable blues employed for this purpose are generally tincture of litmus and syrup of violets or of radishes, which have obtained the name of *re-agents* or *tests*. If these colours have been previously converted to a *green* by alkalies, the acids restore them.

All these secondary properties are variable; and if we attempted to base a definition on any one of them, many important acids would be excluded. Take the case of a body like silica, so widely diffused in nature. Is pure silicious sand or flint an acid or a neutral substance? When it is examined, it is found to be insoluble in water, to be devoid of taste, and to possess no action on vegetable colouring matters; yet this substance is a true acid, because when it is heated along with soda or lime, it forms the new body commonly called glass, which is chemically a salt of silicic acid. Many other acids resemble silica in properties, and would be mistaken for neutral bodies if the salt-forming power was overlooked.

Another method of regarding an acid, which is found of great importance in discussing chemical reactions, is to say an acid is a *salt* whose base is *water*. This definition is very apparent if we regard what takes place in separating the acid from a salt. In this decomposition the acid would appear to be left without having any substitute for the removed alkali. This is not however the case, as *water* is found to enter into union instead of the base. Thus every true acid must contain *hydrogen;* and if this is displaced

by a metal, salts are formed directly. An acid is therefore a salt, whose metal is *hydrogen*. The full importance of the definition of an acid will be learned under the heading CHEMISTRY.

ACIDALIUS, VALENS, a very distinguished scholar and critic, born in 1567 at Wittstock, in Brandenburg. After studying at Rostock and Helmstaedt, and residing about three years in Italy, he took up his residence at Breslau, where he professed the Roman Catholic religion. His excessive application to study was supposed to have caused his untimely death, which occurred in 1595, when he had just completed his twenty-eighth year. He wrote notes on Tacitus and Curtius, a commentary on Plautus, and a number of poems, which are inserted in the *Deliciæ* of the German poets. Baillet gave him a place among his *Enfans Célèbres*, and tells that he wrote the commentary on Plautus and several of the Latin poems when he was only seventeen or eighteen years of age.

ACINACES, an ancient Persian sword, short and straight, and worn, contrary to the Roman fashion, on the right side, or sometimes in front of the body, as shown in the bas-reliefs found at Persepolis. Among the Persian nobility they were frequently made of gold, being worn as a badge of distinction. The acinaces was an object of religious worship with the Scythians and others (*Herod.* iv. 62).

ACIS, in *Mythology*, the son of Faunus and the nymph Symæthis, was a beautiful shepherd of Sicily, who being beloved by Galatea, Polyphemus the giant was so enraged that he crushed his rival with a rock, and his blood gushing forth from under the rock, was metamorphosed into the river bearing his name (Ovid, *Met.* xiii. 750; Sil. Ital. xiv. 221). This river, now *Fiume di Jaci*, or *Acque Grandi*, rises under a bed of lava on the eastern base of Etna, and passing Aci Reale, after a rapid course of one mile, falls into the sea. The waters of the stream, once celebrated for their purity, are now sulphureous.

ACKERMANN, JOHN CHRISTIAN GOTTLIEB, a learned physician and professor of medicine, born at Zeulenroda, in Upper Saxony, in 1756. At the early age of fifteen he became a student of medicine at Jena, where he soon attracted the favourable notice of Baldinger, who undertook the direction of his studies. When Baldinger was transferred to Göttingen in 1773, Ackermann went with him, and afterwards studied for two years at Halle. A few years' practice at Stendal (1778–99), where there were numerous factories, enabled him to add many valuable original observations to his translation of Ramazzini's *Treatise of the Diseases of Artificers* (1780–83). In 1786 he became professor of medicine at the university of Altorf, in Franconia, occupying first the chair of chemistry, and then, from 1794 till his death in 1801, that of pathology and therapeutics. Dr Ackermann's knowledge of the history of medicine may be estimated by his valuable contributions to Harless's edition of Fabricius' *Bibliotheca Græca*. He wrote numerous original works, besides translations.

ACŒMETÆ (ἀκοίμητος, sleepless), an order of monks instituted by Alexander, a Syrian, about the middle of the 5th century. Founding on the precept, *Pray without ceasing*, they celebrated divine service uninterruptedly night and day, for which purpose they divided themselves into three sections, that relieved each other in turn. The chief seat of the Acœmetæ was the cloister *Studium* at Constantinople, whence they were sometimes called *Studites*. Having adopted the monophysite heresy, they were put under the Papal ban about the year 536.

ACOLYTE (from ἀκόλουθος, an attendant), one of a minor order of clergy in the ancient church, ranking next to the sub-deacon. We learn from the canons of the fourth Council of Carthage that the archdeacon, at their ordination, put into their hands a candlestick with a taper and an empty pitcher, to imply that they were appointed to light the candles of the church and to furnish wine for the eucharist. Their dress was the cassock and surplice. The name and office still exist in the church.

ACONCAGUA, a province of Chile, South America, is about 100 miles long by 40 miles wide, and lies between 31° 30′ and 33° 20′ S. lat., and 70° and 71° 30′ W. long., between the provinces of Valparaiso and Santiago on the N. and Coquimbo on the S. A large part of the province is mountainous, but it contains several rich and fertile valleys, which yield wheat, maize, sugar-cane, fruits, and garden produce in abundance. In the agricultural districts there are raised from 50 to 60 fanegas of wheat for every quadra, equal to about 35 bushels per English acre. The province has also mineral resources, but not to such extent as Coquimbo or Atacama. Its chief town is San Felipe. The mountain Aconcagua, one of the loftiest peaks of the Andes, rises to the height of 23,910 feet above the sea on the frontier between this province and Mendoza, a department of the Argentine Republic. A river of the same name rises on the south side of the mountain, and after a course of 230 miles falls into the Pacific 12 miles N. of Valparaiso. Population (1870), 134,178.

ACONITE, ACONITUM, a genus of plants commonly known as Aconite, Monkshood, Friar's Cap, or Helmet flower, and embracing about 18 species, chiefly natives of the mountainous parts of the northern hemisphere. They are distinguished by having one of the five blue or yellow coloured sepals in the form of a helmet; hence the English name. Two of the petals placed under the hood of the calyx are supported on long stalks, and have a hollow spur at their apex. The genus belongs to the natural order Ranunculaceæ, or the Buttercup family. *Aconitum Napellus*, common monkshood, is a doubtful native of Britain. It is an energetic irritant and narcotic poison. It causes death by a depressing effect on the nervous system, by producing palsy of the muscles concerned in breathing, and by fainting. A tincture prepared by the action of spirit on the roots is used medicinally to allay pain, especially in cases of tic. Its roots have occasionally been mistaken for horse-radish. The Aconite has a short underground stem, from which dark-coloured tapering roots descend. The crown or upper portion of the root gives rise to new plants. When put to the lip, the juice of the Aconite root produces a feeling of numbness and tingling. The horse-radish root, which belongs to the natural order Cruciferæ, is much longer than that of the Aconite, and it is not tapering; its colour is yellowish, and the top of the root has the remains of the leaves on it. It has a pungent taste. Many species of Aconite are cultivated in gardens, some having blue and others yellow flowers. *Aconitum Lycoctonum*, Wolfsbane, is a yellow-flowered species common on the Alps of Switzerland. One species, *Aconitum heterophyllum*, found in the East Indies, and called Butees, has tonic properties in its roots. The roots of *Aconitum ferox* supply the famous Indian (Nipal) poison called Bikh, Bish, or Nabee. This species is considered by Hooker and Thomson as a variety of *Aconitum Napellus*. *Aconitum palmatum* yields another of the celebrated Bikh poisons. *Aconitum luridum*, of the Himalayas, also furnishes a poison.

ACONTIUS, the Latinised form of the name of GIACOMO ACONCIO, a philosopher, jurisconsult, engineer, and theologian, born at Trent on the 7th September 1492. He embraced the reformed religion; and after having taken refuge for a time in Switzerland and Strasburg, he came to England about 1558. He was very favourably received by

Queen Elizabeth, at whose court, it is said, though on doubtful authority, that he resided for a considerable period. With the sanction of Parliament, he carried on for several years extensive works for the embankment of the Thames, and so reclaimed a large quantity of waste land, part of which was bestowed upon him by way of recompense. His gratitude to Queen Elizabeth was expressed in the dedication to her of his celebrated *Collection of the Stratagems of Satan*, which has been often translated, and has passed through many editions. Various opinions have been given of this work, which advocated toleration to an extent that many considered indifference. The nature of its doctrine may perhaps be best gathered from the fact that it gained for the author the praise of Arminius, and the strong condemnation of the Calvinists. Acontius also wrote a treatise, *De Methodo*, which was published at Basel in 1558. He died in London about the year 1566.

ACORUS, a genus of monocotyledonous plants belonging to the natural order Aroideæ, and the sub-order Orontiaceæ. *Acorus Calamus*, sweet-sedge or sweet-flag, is a native of Britain. It has an agreeable odour, and has been used as a strengthening remedy, as well as to allay spasms. The starchy matter contained in its running stem or rhizome is associated with a fragrant oil, and it is used as hair-powder. Confectioners form a candy from the rhizomes of the plant, and it is also used by perfumers in preparing aromatic vinegar.

ACOSTA, Christoval d', a Portuguese naturalist, born at Mozambique in the early part of the 16th century. On a voyage to Asia he was taken captive by pirates, who exacted from him a very large ransom. After spending some years in India, chiefly at Goa, a Portuguese colony, he returned home, and settled as a surgeon at Burgos. Here he published his *Tratado de las drogas y medecinas de las Indias orientales* (1578). This work was translated into Latin, Italian, and French, became well known throughout Europe, and is still consulted as an authority. Acosta also wrote an account of his travels, a book in praise of women, and other works. He died in 1580.

ACOSTA, Joseph d', a celebrated Spanish author, was born at Medina del Campo about the year 1539. In 1571 he went to Peru as a provincial of the Jesuits; and, after remaining there for seventeen years, he returned to his native country, where he became in succession visitor for his order of Aragon and Andalusia, superior of Valladolid, and rector of the university of Salamanca, in which city he died in February 1600. About ten years before his death he published at Seville his valuable *Historia Natural y Moral de las Indias*, part of which had previously appeared in Latin, with the title *De Natura Novi Orbis, libri duo.* This work, which has been translated into all the principal languages of Europe, gives exceedingly valuable information regarding the condition of South America at the time. On the subject of climate Acosta was the first to propound the theory, afterwards advocated by Buffon, which attributed the different degrees of heat in the old and new continents to the agency of the winds. He also contradicted, from his own experience, the statement of Aristotle, that the middle zone of the earth was so scorched by the sun as to be destitute of moisture, and totally uninhabitable. Even after the discovery of America this Aristotelian dogma was an article of faith, and its denial was one ground of the charge of scepticism and atheism brought against Sir Walter Raleigh. Acosta, however, boldly declared that what he had seen was so different from what he had expected, that he could not but "laugh at Aristotle's meteors and his philosophy." In speaking of the conduct of his countrymen, and the means they employed for the propagation of their faith, Acosta is in no respect superior to the other prejudiced writers of his country and age. Though he acknowledges that the career of Spanish conquest was marked by the most savage cruelty and oppression, he yet represents this people as chosen by God to spread the gospel among the nations of America, and recounts a variety of miracles as a proof of the constant interposition of Heaven in favour of the merciless and rapacious invaders. Besides his History, Acosta wrote the following works:—1. *De Promulgatione Evangelii apud Barbaros*; 2. *De Christo Revelato*; 3. *De Temporibus Novissimis*, lib. vi.; 4. *Concionum tomi iii.*

ACOSTA, Uriel d', a Portuguese of noble family, was born at Oporto towards the close of the 16th century. His father being a Jewish convert to Christianity, he was brought up in the Roman Catholic faith, and strictly observed the rites of the church till the course of his inquiries led him, after much painful doubt, to abandon the religion of his youth for Judaism. Passing over to Amsterdam, he was received into the synagogue, having his name changed from Gabriel to Uriel. He soon discovered, however, that those who sat in Moses' seat were shameful perverters of the law; and his bold protests served only to exasperate the rabbis, who finally punished his contumacy with the greater excommunication. Persecution seemed only to stimulate his temerity, and he soon after published a defence, *Examen das tradiçoens Phariseas*, &c., in which he not merely exposed the departures of the Jewish teachers from the law, but combated the doctrine of a future life, holding himself supported in this position by the silence of the Mosaic Books. For this he was imprisoned and fined, besides incurring public odium as a blasphemer and atheist. Nothing deterred, he pursued his speculations, which ended in his repudiating the divine authority of the law of Moses. Wearied, however, by his melancholy isolation, and longing for the benefits of society, he was driven, in the inconsistency of despairing scepticism, to seek a return to the Jewish communion. Having recanted his heresies, he was readmitted after an excommunication of fifteen years, but was soon excommunicated a second time. After seven years of miserable exclusion, he once more sought admission, and, on passing through a humiliating penance, was again received. These notices of his singular and unhappy life are taken from his autobiography, *Exemplar Humanæ Vitæ*, published, with a "refutation," by Limborch, and republished in 1847. It has been said that he died by his own hand, but this is, to say the least, doubtful. His eventful history forms the subject of a tale and of a tragedy by Gutzkow.

ACOTYLEDONES, the name given to one of the Classes of the Natural System of Botany, embracing flowerless plants, such as ferns, lycopods, horse-tails, mosses, liverworts, lichens, sea-weeds, and mushrooms. The name is derived from the character of the embryo, which has no cotyledon. Flowering plants have usually one or two cotyledons, that is, seed-leaves or seed-lobes connected with their embryo; while in flowerless plants the body representing the embryo consists of a cell, called a spore, without any leaves. The plants have no flowers, and their organs of reproduction are inconspicuous, hence they are called by Linnæus cryptogamous. Some flowering plants, such as dodders, have no cotyledons; and some have the cotyledons divided into more than two, as in conifers. Some acotyledonous spores, when sprouting, produce a leaf-like expansion called a prothallus, on which the organs of reproduction, consisting of antheridia and archegonia, are produced. This is well seen in the case of ferns. In the interior of the antheridian cells, moving filamentous bodies, called spermatozoids, have been observed. These fertilise the archegonial cells, whence new plants are produced. In the article Botany these plants will be noticed under Class III. of the Natural System.

ACOUSTICS

Definition. 1. ACOUSTICS (from ἀκούω, to hear) is that branch of Natural Philosophy which treats of the nature of sound, and the laws of its production and propagation, in so far as these depend on physical principles. The description of the mechanism of the organ of voice and of the ear, and the difficult questions connected with the processes by which, when sound reaches the drum of the ear, it is transmitted to the brain, must be dealt with in separate articles of this work. It is to the physical part of the science of acoustics that the present article is restricted.

Part I.

General notions as to Vibrations, Waves, &c.

Sound is due to vibration. 2. We may easily satisfy ourselves that, in every instance in which the sensation of sound is excited, the body, whence the sound proceeds, must have been thrown, by a blow or other means, into a state of agitation or tremor, implying the existence of a vibratory motion, or motion to and fro, of the particles of which it consists.

Thus, if a common glass-jar be struck so as to yield an audible sound, the existence of a motion of this kind may be felt by the finger lightly applied to the edge of the glass; and, on increasing the pressure so as to destroy this motion, the sound forthwith ceases. Small pieces of cork put in the jar will be found to dance about during the continuance of the sound; water or spirits of wine poured into the glass will, under the same circumstances, exhibit a ruffled surface. The experiment is usually performed, in a more striking manner, with a bell-jar and a number of small light wooden balls suspended by silk strings to a fixed frame above the jar, so as to be just in contact with the widest part of the glass. On drawing a violin bow across the edge, the pendulums are thrown off to a considerable distance, and falling back are again repelled, &c.

It is also in many cases possible to follow with the eye the motions of the particles of the sounding body, as, for instance, in the case of a violin string or any string fixed at both ends, when the string will appear, by a law of optics, to occupy at once all the positions which it successively assumes during its vibratory motion.

Sound is propagated to the ear by vibrations of air, &c. 3. It is, moreover, essential, in order that the ear may be affected by a sounding body, that there be interposed between it and the ear one or more intermediate bodies (*media*), themselves capable of molecular vibration, which shall receive such motion from the source of sound, and transmit it to the external parts of the ear, and especially to the *membrana tympani* or *drum* of the ear. This statement is confirmed by the well-known effect of stopping the ear with soft cotton, or other substance possessing little elasticity.

The air around us forms the most important medium of communication of sound to our organs of hearing; in fact, were air devoid of this property, we should practically be without the sense of hearing. In illustration of the part thus assigned to the atmosphere in acoustics, an apparatus has been constructed, consisting of a glass receiver, in which is a bell and a hammer connected with clock-work, by which it can be made to strike the bell when required. The receiver is closed air-tight by a metal plate, through which passes, also air-tight, into the interior, a brass rod. By properly moving this rod with the hand, a detent is released, which checks the motion of the wheel-work, and the hammer strikes the bell continuously, till the detent is pushed into its original position. As long as the air in the receiver is of the usual atmospheric density, the sound is perfectly audible. But on rarefying the air by means of an air-pump (the clock-work apparatus having been separated from the plate of the pump by means of a padding of soft cotton), the sound grows gradually fainter, and at last becomes inaudible when the rarefaction of the air has reached a very low point. If, however, at this stage of the experiment, the metal rod be brought into contact with the bell, the sound will again be heard clearly, because now there is the necessary communication with the ear. On readmitting the air, the sound recovers its original intensity. This experiment was first performed by Hawksbee in 1705.

Laws of vibratory motion. 4. Inasmuch, then, as sound necessarily implies the existence in the sounding body, in the air, &c., and (we may add) in the ear itself, of vibratory motion of the particles of the various media concerned in the phenomenon, a general reference to the laws of such motion is essential to a right understanding of the principles of acoustics.

The most familiar instance of this kind of motion is afforded by the pendulum, a small heavy ball, for instance, attached to a fine string, which is fixed at its other end. There is but one position in which the ball will remain at rest, viz., when the string is vertical, there being then equilibrium between the two forces acting on the body, the tension of the string and the earth's attractive force or gravity. Thus, in the adjoining fig., if C is the point of suspension, and CA the vertical through that point of length l, equal to the string, A is the equilibrium position of the particle.

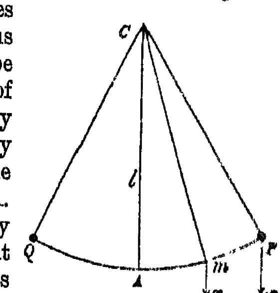


Fig. 1.

Let now the ball be removed from A to P, the string being kept tight, so that P describes the arc AP of a circle of radius equal to l, and let the ball be there dropped. The tension of the string not being now directly opposite in direction to gravity (g), motion will ensue, and the body will retrace the arc PA. In doing so, it will continually increase its velocity until it reaches the point A, where its velocity will be a maximum, and will consequently pass to the other side of A towards Q. But now gravity tends to draw it back towards A, and hence the motion becomes a retarded one; the velocity continually diminishes, and is ultimately destroyed at some point Q, which would be at a distance from A equal to that of P, but for the existence of friction, resistance of the air, &c., which make that distance less. From Q it will next move down with accelerated motion towards A, where it will have its greatest velocity in the direction from left to right, and whence it will pass onwards towards P, and so on. Thus the body will vibrate to and fro on either side of A, its *amplitude* of vibration or distance between its extreme positions gradually diminishing in consequence of the resistances before mentioned, and at last being sensibly reduced to nothing, the body then resuming its equilibrium-position A.

If the amplitude of vibration is restricted within inconsiderable limits, it is easy to prove that the motion takes place just as if the string were removed, the ball deprived altogether of weight and urged by a force directed to the point A, and proportional to the distance from that point. For then, if m be any position of the ball, the chord mA may be regarded as coincident with the tangent to the

circle at m, and therefore as being perpendicular to Cm. Hence g, acting parallel to CA, being resolved along Cm and mA, the former component is counteracted by the tension of the string, and there remains as the only effective acceleration, the tangential component along mA, which, by the triangle of forces, is equal to $g \cdot \frac{\mathrm{A}m}{\mathrm{C}m}$ or $\frac{g}{l} \cdot \mathrm{A}m$, and is therefore proportional to Am.

On this supposition of indefinitely small vibrations, the pendulum is isochronous; that is, the time occupied in passing from one extreme position to the other is the same, for a given length l of the pendulum, whatever the extent of vibration.

We conclude from this that, whatever may be the nature of the forces by which a particle is urged, if the resultant of those forces is directed towards a fixed point, and is proportional to the distance from that point, the particle will oscillate to and fro about that point in times which are independent of the amplitudes of the vibrations, provided these are very small.

Acoustic vibrations.

5. The particle, whose vibratory motion we have been considering, is a solitary particle acted on by external forces. But, in acoustics, we have to do with the motion of particles forming a connected system or medium, in which the forces to be considered arise from the mutual actions of the particles. These forces are in equilibrium with each other when the particles occupy certain relative positions. But, if any new or disturbing force act for a short time on any one or more of the particles, so as to cause a mutual approach or a mutual recession, on the removal of the disturbing force, the disturbed particles will, if the body be *elastic*, forthwith move towards their respective positions of equilibrium. Hence arises a vibratory motion to and fro of each about a given point, analogous to that of a pendulum, the velocity at that point being always a maximum, alternately in opposite directions. Thus, for example, if to one extremity of a pipe containing air were applied a piston, of section equal to that of the pipe, by pushing in the piston slightly and then removing it, we should cause particles of air, forming a thin section at the extremity of the pipe, to vibrate in directions parallel to its axis.

In order that a medium may be capable of molecular vibrations, it must, as we have mentioned, possess *elasticity*, that is, a tendency always to return to its original condition when slightly disturbed out of it.

Transmission of vibrations.

6. We now proceed to show how the disturbance whereby certain particles of an elastic medium are displaced from their equilibrium-positions, is successively transmitted to the remaining particles of the medium, so as to cause these also to vibrate to and fro.

Let us consider a line of such particles y, x, a, b, &c.

$$y \quad x \, a_1 \, a \, a_2 \, b \quad c \quad d \quad e \quad f \quad g \quad h \quad i \quad k \quad l \quad m \quad n \quad o \quad p$$

equidistant from each other, as above; and suppose one of them, say a, to be displaced, by any means, to a_1. As we have seen, this particle will swing from a_1 to a_2 and back again, occupying a certain time T, to complete its double vibration. But it is obvious that, the distance between a and the next particle b to the right being diminished by the displacement of the former to a_1, a tendency is generated in b to move towards a_1, the mutual forces being no longer in equilibrium, but having a resultant in the direction ba_1. The particle b will therefore also suffer displacement, and be compelled to swing to and fro about the point b. For similar reasons the particles c, d . . . will all likewise be thrown into vibration. Thus it is, then, that the disturbance propagates itself in the direction under consideration. There is evidently also, in the case supposed, a transmission from a to x, y, &c., *i.e.*, in the opposite direction.

Confining our attention to propagation in the direction abc . . ., we have next to remark that each particle in that line will be affected by the disturbance always later than the particle immediately preceding it, so as to be found in the same stage of vibration a certain interval of time after the preceding particle.

7. Two particles which are in the same stage of vibration, that is, are equally displaced from their equilibrium-positions, and are moving in the same direction and with equal velocities, are said to be in the same *phase*. Hence we may express the preceding statement more briefly thus: Two particles of a disturbed medium at different distances from the centre of disturbance, are in the same phase at different times, the one whose distance from that centre is the greater being later than the other. Phase.

8. Let us in the meantime assume that, the intervals ab, bc, cd . . . . being equal, the intervals of time which elapse between the like phases of b and a, of c and b . . . . are also equal to each other, and let us consider what at any given instant are the appearances presented by the different particles in the row.

T being the time of a *complete* vibration of each particle, let $\frac{\mathrm{T}}{p}$ be the interval of time requisite for any phase of a to pass on to b. If then at a certain instant a is displaced to its greatest extent to the right, b will be somewhat short of, but moving towards, *its* corresponding position, c still further short, and so on. Proceeding in this way, we shall come at length to a particle p, for which the distance $ap = p \, . \, ab$, which therefore lags in its vibrations behind a by a time $= p \times \frac{\mathrm{T}}{p} = \mathrm{T}$, and is consequently precisely in the same phase as a. And between these two particles a, p, we shall evidently have particles in all the possible phases of the vibratory motion. At h, which is at distance from $a = \frac{1}{2}ap$, the difference of phase, compared with a, will be $\frac{1}{2}$T, that is, h will, at the given instant, be displaced to the greatest extent on the opposite side of its equilibrium-position from that in which a is displaced; in other words, h is in the exactly opposite phase to a.

9. In the case we have just been considering, the vibrations of the particles have been supposed to take place in a direction coincident with that in which the disturbance passes from one particle to another. The vibrations are then termed *longitudinal*. Longitudinal and transversal vibrations

But it need scarcely be observed that the vibrations may take place in any direction whatever, and may even be curvilinear. If they take place in directions at right angles to the line of progress of the disturbance, they are said to be *transversal*.

10. Now the reasoning employed in the preceding case will evidently admit of general application, and will, in particular, hold for transversal vibrations. Hence if we mark (as is done in fig. 2) the positions $a_1 \, b_1 \, c_1$ . . ., occupied by the various particles, when swinging transversely, at the instant at which a has its maximum displacement *above* its equilibrium-position, and trace a continuous line running through the points so found, that line will by its ordinates indicate to the eye the state of motion at the given instant. Wave of transversal displacements.

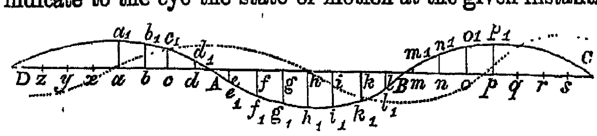


Fig. 2.

Thus a and p are in the *same* phase, as are also b and q, c and r, &c. a and h are in *opposite* phases, as are also b and i, c and k, &c.

Distances ap, bq, &c., separating particles in the same phase, and each of which, as we have seen, is passed over by the disturbance in the time T of a complete vibration, include within them *all* the possible phases of the motion.

Beyond this distance, the curve repeats itself exactly, that is, the phases recur in the same order as before.

Now the figure so traced offers an obvious resemblance to the undulating surface of a lake or other body of water, after it has been disturbed by wind, exhibiting a wave with its trough Ah_1B, and its crest Bp_1C. Hence have been introduced into Acoustics, as also into Optics, the terms *wave* and *undulation.* The distance ap, or bq... or A C, which separates two particles in same phase, or which includes both a wave-crest and a wave-trough, is termed the *length of the wave*, and is usually denoted by λ.

As the curve repeats itself at intervals each $=\lambda$, it follows that particles are in the same phase at any given moment, when the distances between them in the direction of transmission of the disturbance $=\lambda, 2\lambda, 3\lambda$... and generally $=n\lambda$, where n is any whole number.

Particles such as a and h, b and i, &c., which are at distances $=\frac{1}{2}\lambda$, being in *opposite* phases, so will also be particles separated by distance, $\frac{1}{2}\lambda+\lambda=\frac{3}{2}\lambda$, or, in general, by $\frac{1}{2}\lambda+m\lambda=(2m+1)\frac{\lambda}{2}$, that is, by any *odd* multiple of $\frac{\lambda}{2}$.

Wave of velocities.

11. A like construction to the one just adopted for the displacements of the particles at any given instant, may be also applied for exhibiting graphically their velocities at the same instant. Erect at the various points a, b, c, &c., perpendiculars to the line joining them, of lengths proportional to and in the direction of their velocities, and draw a line through the extreme points of these perpendiculars; this line will answer the purpose required. It is indicated by dots in the previous figure, and manifestly forms a wave of the same length as the wave of displacements, but the highest and lowest points of the one wave correspond to the points in which the other wave crosses the line of equilibrium.

Waves for longitudinal vibrations.

12. In order to a graphic representation of the displacements and velocities of particles vibrating *longitudinally*, it is convenient to draw the lines which represent those quantities, not in the actual direction in which the motion takes place and which coincides with the line $a\,b\,c$..., but at right angles to it, ordinates drawn upwards indicating displacements or velocities to the right (*i.e.*, in the direction of transmission of the disturbance), and ordinates drawn downwards indicating displacements or velocities in the opposite direction. When this is done, waves of displacement and velocity are figured identically with those for transversal vibrations, and are therefore subject to the same resulting laws.

Propagation of waves.

13. But not only will the above waves enable us to see at a glance the circumstances of the vibratory motion at the instant of time for which it has been constructed, but also for any subsequent moment. Thus, if we desire to consider what is going on after an interval $\frac{T}{p}$, we have simply to conceive the whole wave (whether of displacement or velocity) to be moved to the right through a distance $=ab$. Then the state of motion in which a was before will have been transferred to b, that of b will have been transferred to c, and so on. At the end of another such interval, the state of the particles will in like manner be represented by the wave, if pushed onward through another equal space. In short, the whole circumstances may be pictured to the eye by two waves (of displacement and of velocity) advancing continuously in the line $a\,b\,c$... with a velocity V which will take it over the distance ab in the time $\frac{T}{p}$, V being therefore $=\frac{ab}{\frac{T}{p}}=\frac{p.ab}{T}=\frac{AC}{T}$ or $V=\frac{\lambda}{T}$.

This is termed the velocity of propagation of the wave, and, as we see, is equal to the length of the wave divided by the time of a complete vibration of each particle.

If, as is usually more convenient, we express T in terms of the number n of complete vibrations performed in a given time, say in the unit of time, we shall have $\frac{1}{T}=n$, and hence

$$V=n\lambda.$$

Variations of density due to longitudinal vibrations.

14. There is one very important distinction between the two cases of longitudinal and of transversal vibrations which now claims our attention, viz., that whereas vibrations of the latter kind, when propagated from particle to particle in an elastic medium, do not alter the relative distances of the particles, or, in other words, cause no change of density throughout the medium; longitudinal vibrations, on the other hand, by bringing the particles nearer to or further from one another than they are when undisturbed, are necessarily accompanied by alternate condensations and rarefactions.

Thus, in fig. 2, we see that at the instant to which that fig. refers, the displacements of the particles immediately adjoining a are equal and in the same direction; hence at that moment the density of the medium at a is equal to that of the undisturbed medium. The same applies to the points h, p, &c., in which the displacements are at their maxima and the velocities of vibration $=0$.

At any point, such as c, between a and A, the displacements of the two adjoining particles on either side are both to the right, but that of the *preceding* particle is now the greater of the two, and hence the density of the medium throughout aA exceeds the undisturbed density. So at any point, such as f, between A and h, the same result holds good, because now the displacements are to the left, but are in excess on the right side of the point f. From a to h, therefore, the medium is condensed.

From h to B, as at k, the displacements of the two particles on either side are both to the *left*, that of the preceding particle being, however, the greater. The medium, therefore, is here in a state of rarefaction. And in like manner it may be shown that there is rarefaction from B to p; so that the medium is rarefied from h to p.

At A the condensation is a maximum, because the displacements on the two sides of that point are equal and both directed towards A. At B, on the other hand, it is the rarefaction which is a maximum, the displacements on the right and left of that point being again equal, but directed outwards from B.

It clearly follows from all this that, if we trace a curve of which any ordinate shall be proportional to the difference between the density of the corresponding point of the disturbed medium and the density of the undisturbed medium—ordinates drawn upwards indicating condensation, and ordinates drawn downwards rarefaction—that curve will cross the line of rest of the particles $a\,b\,c$... in the same points as does the curve of velocities, and will therefore be of the same length λ, and will also rise above that line and dip below it at the same parts. But the connection between the *wave* of condensation and rarefaction and the wave of velocity, is still more intimate, when the extent to which the particles are displaced is very small, as is always the case in acoustics. For it may be shown that then the degree of condensation or rarefaction at any point of the medium is proportional to the velocity of vibration at that point. The same ordinates, therefore, will repre-

sent the degrees of condensation, which represent the velocities, or, in other words, the wave of condensation and rarefaction may be regarded as coincident with the velocity wave.

Part II.

Velocity of propagation of waves of longitudinal disturbance through any elastic medium.

Velocity of a wave.

15. Sir Isaac Newton was the first who attempted to determine, on theoretical grounds, the velocity of sound in air and other fluids. The formula obtained by him gives, however, a numerical value, as regards air, falling far short of the result derived from actual experiment; and it was not till long afterwards, when Laplace took up the question, that complete coincidence was arrived at between theory and observation. We are indebted to the late Professor Rankine, of Glasgow (*Phil. Trans.* 1870, p. 277)[1], for a very simple and elegant investigation of the question, which we will here reproduce in an abridged form.

Let us conceive the longitudinal disturbance to be propagated through a medium contained in a straight tube having a transverse section equal to unity, but of indefinite length.

Let two transverse planes A_1 A_2 (fig. 3) be conceived as moving along the interior of the tube in the same direction and with the same velocity V as the disturbance-wave itself.

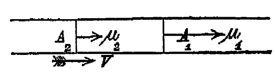


Fig. 3.

Let u_1 u_2 be the velocities of displacement of the particles of the medium at A_1 A_2 respectively, at any given instant, estimated in the same direction as V; and ρ_1 ρ_2 the corresponding densities of the medium.

The disturbances under consideration, being such as preserve a permanent type throughout their propagation, it follows that the quantity of matter between A_1 and A_2 remains constant during the motion of these planes, or that as much must pass into the intervening space through one of them as issues from it through the other. Now at A_1 the velocity of the particles relatively to A_1 itself is $V-u_1$ *inwards*, and consequently there flows into the space A_1 A_2 through A_1 a mass $(V-u_1)\rho_1$ in the unit of time.

Forming a similar expression as regards A_2, putting m for the invariable mass through which the disturbance is propagated in the unit of time, and considering that if ρ denote the density of the undisturbed medium, m is evidently equal to $V\rho$, we have—

$$V-u_1)\rho_1=(V-u_2)\rho_2=V\rho=m\,. \qquad (1.)$$

Now, $p_1 p_2$ being the pressures at A_1, A_2 respectively, and therefore p_2-p_1 the force generating the acceleration u_2-u_1, in unit of time, on the mass m of the medium, by the second law of motion,

$$p_2-p_1=m(u_2-u_1) \qquad (2.)$$

Eliminating u_1, u_2 from these equations, and putting for $\frac{1}{\rho_1}$, $\frac{1}{\rho_2}$, $\frac{1}{\rho}$ the symbols s_1, s_2, s (which therefore denote the volumes of the unit of mass of the disturbed medium at A_1, A_2, and of the undisturbed medium), we get:

$$m^2=\frac{p_2-p_1}{s_1-s_2} \text{ and } V^2=s^2\ \frac{p_2-p_1}{s_1-s_2}$$

Now, if (as is generally the case in sound) the changes of pressure and volume occurring during the disturbance of the medium are very small, we may assume that these changes are proportional one to the other. Hence, denoting the ratio which any increase of pressure bears to the diminution of the unit of volume of the substance, and which is termed the *elasticity* of the substance, by e, we shall obtain for the velocity of a wave of longitudinal displacements, supposed small, the equation:

$$\left.\begin{array}{l} V=\sqrt{es} \\ \text{or } V=\sqrt{\dfrac{e}{\rho}} \end{array}\right\} \qquad (I.)$$

Laplace's correction.

16. In applying this formula to the determination of the velocity of sound in any particular medium, it is requisite, as was shown by Laplace, to take into account the thermic effects produced by the condensations and rarefactions which, as we have seen, take place in the substance. The heat generated during the sudden compression, not being conveyed away, raises the value of the elasticity above that which otherwise it would have, and which was assigned to it by Sir Isaac Newton.

Thus, in a *perfect* gas, it is demonstrable by the principles of Thermodynamics, that the elasticity e, which, in the undisturbed state of the medium, would be simply equal to the pressure p, is to be made equal to γp, where γ is a number exceeding unity and represents the ratio of the specific heat of the gas under constant pressure to its specific heat at constant volume.

Hence, as air and most other gases may be practically regarded as perfect gases, we have for them:

$$V=\sqrt{\gamma p s}=\sqrt{\frac{\gamma p}{\rho}} \qquad (II.)$$

Velocity of sound in air is independent of the pressure.

17. From this the following inference may be drawn:—The velocity of sound in a given gas is unaffected by change of pressure if unattended by change of temperature. For, by Boyle's law, the ratio $\frac{p}{\rho}$ is constant at a given temperature. The accuracy of this inference has been confirmed by recent experiments of Regnault.

Effect of change of temperature.

18. To ascertain the influence of change of temperature on the velocity of sound in a gas, we remark that, by Gay Lussac's law, the pressure of a gas at different temperatures varies proportionally both to its density ρ and to $1+\alpha t$, where t is the number of degrees of temperature above freezing point of water (32° Fahr.), and α is the expansion of unit of volume of the gas for every degree above 32°.

If, therefore, p, p_0, ρ, ρ_0 denote the pressures and densities corresponding to temperatures $32°+t°$ and 32°, we have:

$$\frac{p}{p_0}=\frac{\rho}{\rho_0}\ (1+\alpha t)$$

and hence, denoting the corresponding velocities of sound by V, V_0, we get:

$$\frac{V}{V_0}=\sqrt{(1+\alpha t)}$$

whence, α being always a very small fraction, is obtained very nearly:

$$\frac{V}{V_0}=1+\frac{\alpha}{2}t \text{ and } V-V_0=\frac{\alpha}{2}.t.V_0.$$

The velocity increases, therefore, by $\frac{\alpha}{2}V_0$ for every degree of rise of temperature above 32°.

Another expression for V.

19. The general expression for V given in (II.) may be put in a different form: if we introduce a height H of the gas, regarded as having the same density ρ throughout and exerting the pressure p, then $p=g\rho H$, where g is the acceleration of gravity, and there results:

$$V=\sqrt{\gamma g H} \qquad (III.)$$

Now $\sqrt{gH}$ or $\sqrt{2g.\frac{H}{2}}$ is the velocity U which would be acquired by a body falling *in vacuo* from a height $\frac{H}{2}$. Hence $V=U\sqrt{\gamma}$.

[1] See also Maxwell, *Theory of Heat*, p. 203

If γ were equal to 1, $V = U$, which is the result obtained by Newton, and would indicate that the velocity of sound in a gas equals the velocity of a body falling from a height equal to half of that of a homogeneous atmosphere of the gas.

Numerical value of V in air.

20. In common dry air at 32° Fahr., g being 32·2 ft., and the mercurial barometer 30 ins. or 2·5 ft., the density of air is to that of mercury as 1 : 10,485·6; hence $H = 10,458 \cdot 6 \times 2 \cdot 5$ ft. $= 26,214$ ft.

$$\text{Also} \qquad \gamma = 1 \cdot 408$$
$$\text{Hence } V_0 = \sqrt{1,408 \times 32,2 \times 26,214} = 1090 \text{ ft.}$$

and, by § 18, the increase of velocity for each degree of rise of temperature $\left(\alpha \text{ being } \frac{1}{491}\right)$ is $\frac{1090}{982}$ or $\frac{545}{491} = 1 \cdot 110$ ft. $1\frac{1}{9}$ ft. very nearly.

V in different gases.

21. If the value of γ were the same for different gases, it is obvious from formula $V = \sqrt{\gamma \frac{p}{\rho}}$ that, at a given temperature, the velocities of sound in those gases would be to each other inversely as the square roots of their densities. Regnault has found that this is so for common air, carbonic acid, nitrous oxide, hydrogen and ammoniacal gas (though less so as regards the two last).

Experiments for determining V in air.

22. The experimental determination of the velocity of sound in air has been carried out by ascertaining accurately the time intervening between the flash and report of a gun as observed at a given distance, and dividing the distance by the time. A discussion of the many experiments conducted on this principle in various countries and at various periods, by Van Der Kolk (*Lond. and Edin. Phil. Mag.*, July 1865), assigns to the velocity of sound in dry air at 32° Fahr., 1091 ft. 8 in. per second, with a probable error of ± 3·7 ft.; and still more recently (in 1871) Mr Stone, the Astronomer Royal at the Cape of Good Hope, has found 1090·6 as the result of careful experiments by himself there. The coincidence of these numbers with that we have already obtained theoretically sufficiently establishes the general accuracy of the theory.

23. Still it cannot be overlooked that the formula for V is founded on assumptions which, though approximately, are not strictly correct. Thus, the air is not a perfect gas, nor is the variation of elastic force, caused by the passage through it of a wave of disturbance always very small in comparison with the elastic force of the undisturbed air. Earnshaw (1858) first drew attention to these points, and came to the conclusion that the velocity of sound increases with its loudness, that is, with the violence of the disturbance. In confirmation of this statement, he appeals to a singular fact, viz., that, during experiments made by Captain Parry, in the North Polar Regions, for determining the velocity of sound, it was invariably found that the report of the discharge of cannon was heard, at a distance of $2\frac{1}{2}$ miles, perceptibly earlier than the sound of the word *fire*, which, of course, preceded the discharge.

As, in the course of propagation in unlimited air, there is a gradual decay in the intensity of sound, it would follow that the velocity must also gradually decrease as the sound proceeds onwards. This curious inference has been verified experimentally by Regnault, who found the velocity of sound to have decreased by 2·2 ft. per second in passing from a distance of 4000 to one of 7500 feet.

V depends on the pitch of sound.

24. Among other interesting results, derived by the accurate methods adopted by Regnault, but which want of space forbids us to describe, may be mentioned the dependence of the velocity of sound on its pitch, lower notes being, *cæt. par.*, transmitted at a more rapid rate than higher ones. Thus, the fundamental note of a trumpet travels faster than its harmonies.

V in liquids and solids.

25. The velocity of sound in liquids and solids (the displacements being longitudinal), may be obtained by formula (I.), neglecting the thermic effects of the compressions and expansions as being comparatively inconsiderable, and may be put in other forms:

Thus, if we denote by ϵ the change in length of one foot of a column of the substance produced by its own weight w, then e being $= \frac{w}{\epsilon}$ or $\frac{g\rho}{\epsilon}$, we have $\frac{e}{\rho} = \frac{g}{\epsilon}$ and hence:

$$V = \sqrt{\frac{g}{\epsilon}} \quad . \qquad . \qquad . \qquad . \quad \text{(IV.)}$$

or, replacing $\frac{1}{\epsilon}$ (which is the length in feet of a column that would be increased 1 foot by the weight of 1 cubic foot) by l,

$$V = \sqrt{gl} \quad . \qquad . \quad \text{(V.)}$$

which shows that the velocity is that due to a fall through $\frac{l}{2}$.

Or, again, in the case of a liquid, if η denote the change of volume, which would be produced by an increase of pressure equal to one atmosphere, or to that of a column H of the liquid, since ϵ is the change of volume due to weight of a column 1 of the liquid, and $\therefore \frac{\eta}{\epsilon} = \frac{H}{1}$ and $\frac{1}{\epsilon} = \frac{H}{\eta}$, we get

$$V = \sqrt{\frac{gH}{\eta}} \quad . \qquad . \qquad . \quad \text{(VI.)}$$

V in water.

Ex. 1. For water, $\frac{1}{\eta} = 20,000$ very nearly; $H = 34$ ft. and hence $V = 4680$ feet.

This number coincides very closely with the value obtained, whether by direct experiment, as by Colladon and Sturm on the Lake of Geneva in 1826, who found 4708, or by indirect means which assign to the velocity in the water of the River Seine at 59° Fahr. a velocity of 4714 ft. (Wertheim).

V in iron.

Ex. 2. For iron. Let the weight necessary to double the length of an iron bar be 4260 millions of lbs. on the square foot. Then a length l will be extended to $l + 1$ by a force of $\frac{4260 \text{ millions lbs.}}{l}$ on the sq. ft. This, therefore, by our definition of l, must be the weight of a cubic foot of the iron. Assuming the density of iron to be 7·8, and 62·32 lbs. as the weight of a cubic foot of water, we get $7 \cdot 8 \times 62 \cdot 32$ or 486 lbs. as the weight of an equal bulk of iron. Hence $\frac{4260 \text{ millions}}{l} = 486$ and $l = \frac{4260}{486}$ millions,

$$\text{which gives } V = \sqrt{gl} = \sqrt{\frac{32 \cdot 2 \times 4260}{486}} \text{ millions}$$
$$= \sqrt{\frac{4260}{15}} \times 1000 = 1000 \sqrt{284}$$

or $V = 17,000$ feet per second nearly.

As in the case of water and iron, so, in general, it may be stated that sound travels faster in liquids than in air, and still faster in solids, the ratio $\frac{e}{\rho}$ being least in gases and greatest in solids.

Experimental determination of V in solids.

26. Biot, about 50 years ago, availed himself of the great difference in the velocity of the propagation of sound through metals and through air, to determine the ratio of the one velocity to the other. A bell placed near one extremity of a train of iron pipes forming a joint length of upwards of 3000 feet, being struck at the same instant as the same extremity of the pipe, a person placed at the other extremity heard first the sound of the blow on the pipe, conveyed through the iron, and then, after an interval

of time, which was noted as accurately as possible, the sound of the bell transmitted through the air. The result was a velocity for the iron of 10·5 times that in air. Similar experiments on iron telegraph wire, made more recently near Paris by Wertheim and Brequet, have led to an almost identical number. Unfortunately, owing to the metal in those experiments not forming a continuous whole, and to other causes, the results obtained, which fall short of those otherwise found, cannot be accepted as correct.

Other means therefore, of an indirect character, to which we will refer hereafter, have been resorted to for determining the velocity of sound in solids. Thus Wertheim, from the pitch of the lowest notes produced by longitudinal friction of wires or rods, has been led to assign to that velocity values ranging, in different metals, from 16,822 feet for iron, to 4030 for lead, at temperature 68° Fahr., and which agree most remarkably with those calculated by means of the formula $V=\sqrt{\frac{e}{\rho}}$. He points out, however, that these values refer only to solids whose cross dimensions are small in comparison with their length, and that in order to obtain the velocity of sound in an unlimited solid mass, it is requisite to multiply the value as above found by $\sqrt{\frac{3}{2}}$ or $\frac{5}{4}$ nearly. For while, in a solid bar, the extensions and contractions due to any disturbance take place laterally as well as longitudinally; in an extended solid, they can only occur in the latter direction, thus increasing the value of e.

27. To complete the discussion of the velocity of the propagation of sound, we have still to consider the case of transversal vibrations, such as are executed by the points of a stretched wire or cord when drawn out of its position of rest by a blow, or by the friction of a violin-bow.

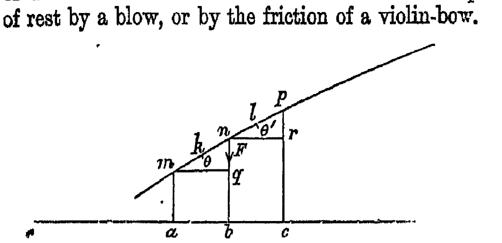


Fig. 4.

Velocity of propagation of transversal vibrations.

Let ox (fig. 4) be the position of the string when undisturbed, mnp when displaced. We will suppose the amount of displacement to be very small, so that we may regard the distance between any two given points of it as remaining the same, and also that the tension P of the string is not changed in its amount, but only in its direction, which is that of the string.

Take any origin o in ox, and $ab=bc=\delta x$ (a very small quantity), then the perpendiculars am, bn, cp, are the displacements of abc. Let k, l be the middle points of mn, np; then kl (which $=mn$ or ab very nearly) may be regarded as a very small part of the string acted on by two forces each $=$ P, and acting at n in the directions np, nm. These give a component parallel to ac, which on our supposition is negligible, and another F along nb, such that

$$F=P\,(\sin\theta-\sin\theta')=P.\left(\frac{nq}{mn}-\frac{pr}{nq}\right)=P.\,\frac{nq-pr}{\delta x}\,.$$

Now if $c=$ a length of string of weight equal to P, and the string be supposed of uniform thickness and density, the weight of $kl=\frac{P}{c}.\,kl=\frac{P}{c}.\,\delta x$, and the mass m of $kl=\frac{P}{gc}.\,\delta x$.

Hence the acceleration f in direction nb is—

$$f=\frac{F}{m}=gc\frac{nq-pr}{\delta x^2}.$$

If we denote ma by y, oa by x, and the time by t, we shall readily see that this equation becomes ultimately,

$$\frac{d^2y}{dt^2}=gc\frac{d^2y}{dx^2}$$

which is satisfied by putting

$$y=\phi\,(x+\sqrt{gc}.\,t)+\psi\,(x-\sqrt{gc}.\,t)$$

where ϕ and ψ indicate any functions.

Now we know that if for a given value of t, x be increased by the length λ of the wave, the value of y remains unchanged; hence,

$$\phi\,(x+\sqrt{gc}.\,t)+\&c.=\phi\,(x+\lambda+\sqrt{gc}.\,t)\ \&c.$$

But this condition is equally satisfied for a given value of x, by increasing $\sqrt{gc}.\,t.$ by λ, *i.e.*, increasing t by $\frac{\lambda}{\sqrt{gc}}$. This therefore must $=$ T (the time of a complete vibration of any point of the string). But $V=\frac{\lambda}{T}$. Hence,

$$V=\sqrt{gc}\quad.\ .\ .\ .\ .\quad(\text{VII.})$$

is the expression for the velocity of sound when due to very small transversal vibrations of a thin wire or chord, which velocity is consequently the same as would be acquired by a body falling through a height equal to one half of a length of the chord such as to have a weight equal to the tension.

The above may also be put in the form—

$$V=\sqrt{\frac{gP}{w}}\,,$$

where P is the tension, and w the weight of the unit of length of the chord.

Comparison of V for transversal and for longitudinal vibrations.

28. It appears then that while sound is propagated by longitudinal vibrations through a given substance with the same velocity under all circumstances, the rate of its transmission by transversal vibrations through the same substance depends on the tension and on the thickness. The former velocity bears to the latter the ratio of $\sqrt{l}:\sqrt{c}$, (where l is the length of the substance, which would be lengthened *one* foot by the weight of *one* foot, if we take the foot as our unit) or of $\sqrt{\frac{l}{c}}:1$, that is, of the square root of the length which would be extended *one* foot by the weight of c feet, or by the tension, to 1. This, for ordinary tensions, results in the velocity for longitudinal vibrations being very much in excess of that for transversal vibrations.

Law of decay of intensity of sounds with increased distance.

29. It is a well known fact that, in all but very exceptional cases, the loudness of any sound is less as the distance increases between the source of sound and the ear. The law according to which this decay takes place is the same as obtains in other natural phenomena, viz., that in an unlimited and uniform medium the loudness or intensity of the sound proceeding from a very small sounding body (strictly speaking, a point) varies inversely as the square of the distance. This follows from considering that the ear AC receives only the conical portion OAC of the whole volume of sound emanating from O, and that in order that an ear BD, placed at a greater distance from O, may admit the same quantity, its area must be to that of AC : as OB^2 : OA^2. But if A′ = AC be situated at same distance as BD, the amount of sound received by it and by BD (and therefore by AC) will be as the area of A[1] or AC to that of BD. Hence, the intensities of the sound as

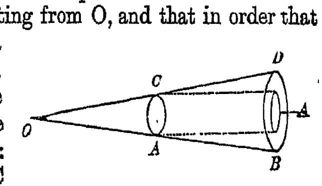


Fig. 5.

heard by the same ear at the distances OA and OB are to each other as OB^2 to OA^2.

Influence of diminished density of the air on intensity of sound.

30. In order to verify the above law when the atmosphere forms the intervening medium, it would be necessary to test it at a considerable elevation above the earth's surface, the ear and the source of sound being separated by air of constant density. As the density of the air diminishes, we should then find that the loudness of the sound at a given distance would decrease, as is the case in the air-pump experiment previously described. This arises from the decrease of the quantity of matter impinging on the ear, and the consequent diminution of its *vis-viva.* The decay of sound due to this cause is observable in the rarefied air of high mountainous regions. De Saussure, the celebrated Alpine traveller, mentions that the report of a pistol at a great elevation appeared no louder than would a small cracker at a lower level.

But it is to be remarked that, according to Poisson, when air-strata of different densities are interposed between the source of sound and the ear placed at a given distance, the intensity depends only on the density of the air at the source itself; whence it follows that sounds proceeding from the surface of the earth may be heard at equal distances as distinctly by a person in a floating balloon as by one situated on the surface itself; whereas any noise originating in the balloon would be heard at the surface as faintly as if the ear were placed in the rarefied air on a level with the balloon. This was exemplified during a balloon ascent by Glaisher and Coxwell, who, when at an elevation of 20,000 feet, heard with great distinctness the whistle of a locomotive passing beneath them.

Part III.

Reflexion and Refraction of Sound.

Laws of refraction.

31. When a wave of sound travelling through one medium meets a second medium of a different kind, the vibrations of its own particles are communicated to the particles of the new medium, so that a wave is excited in the latter, and is propagated through it with a velocity dependent on the density and elasticity of the second medium, and therefore differing in general from the previous velocity. The direction, too, in which the new wave travels is different from the previous one. This change of direction is termed *refraction,* and takes place according to the same laws as does the refraction of light, viz., (1.) The new direction or *refracted ray* lies always in the *plane of incidence,* or plane which contains the incident ray (*i.e.,* the direction of the wave in the first medium), and the normal to the surface separating the two media, at the point in which the incident ray meets it; (2.) The *sine* of the angle between the normal and the incident ray bears to the *sine* of the angle between the normal and the refracted ray, a ratio which is constant for the same pair of media.

For a theoretical demonstration of these laws, we must refer to the art. Optics, where it will be shown that the ratio involved in the second law is always equal to the ratio of the velocity of the wave in the first medium to the velocity in the second; in other words, the *sines* of the angles in question are *directly* proportional to the velocities.

Refraction is to or from the normal according to relative values of the velocities.

32. Hence sonorous rays, in passing from one medium into another, are bent in towards the normal, or the reverse, according as the velocity of propagation in the former exceeds or falls short of that in the latter. Thus, for instance, sound is refracted *towards* the perpendicular when passing into air from water, or into carbonic acid gas from air; the converse is the case when the passage takes place the opposite way.

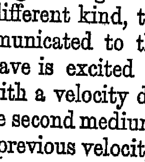


Fig. 6.

Limiting angle and total reflexion.

33. It further follows, as in the analogous case of light, that there is a certain angle termed the *limiting angle,* whose *sine* is found by dividing the less by the greater velocity, such that all rays of sound meeting the surface separating two different bodies will not pass onward, but suffer total reflexion back into the first body, if the velocity in that body is less than that in the other body, and if the angle of incidence exceeds the limiting angle.

The velocities in air and water being respectively 1090 and 4700 feet, the limiting angle for these media may be easily shown to be slightly above $15\frac{1}{2}°$. Hence, rays of sound proceeding from a distant source, and therefore nearly parallel to each other, and to PO (fig. 6), the angle POM being greater than $15\frac{1}{2}°$, will not pass into the water at all, but suffer total reflexion. Under such circumstances, the report of a gun, however powerful, would be inaudible by an ear placed in the water.

Acoustic lenses.

34. As light is concentrated into a focus by a convex glass lens (for which the velocity of light is less than for the air), so sound ought to be made to converge by passing through a convex lens formed of *carbonic acid* gas. On the other hand, to produce convergence with water or hydrogen gas, in both which the velocity of sound exceeds its rate in air, the lens ought to be *concave.* These results have been confirmed experimentally by Sondhaus and Hajech, who also succeeded in verifying the law of the equality of the index of refraction to the ratio of the velocities of sound.

Laws of reflexion.

35. When a wave of sound falls on a surface separating two media, in addition to the refracted wave transmitted into the new medium, which we have just been considering, there is also a fresh wave formed in the new medium, and travelling in it in a different direction, but, of course, with the same velocity. This *reflected* wave is subject to the same laws as regulate the reflexion of light, viz., (1.) the coincidence of the planes of incidence and of reflexion, and (2.) the equality of the angles of incidence and reflexion, that is, of the angles made by the incident and reflected rays with the normal.

Reflexion by a spheroid.

36. As in an ellipse (fig. 7), the normal PG at any point bisects the angle SPH (S, H being the foci), rays of sound diverging from S, and falling on the spheroidal surface formed by the revolution of the ellipse about the longest diameter AB, will be reflected to H. Also, since SP + PH is always = AB, the times in which the different rays will reach H will all be equal to each other, and hence a crash at S will be heard as a crash at H.

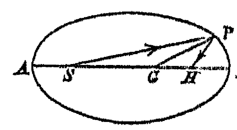


Fig. 7.

Reflexion by parabolic surfaces

37. At any point P of a parabola (fig. 8) of which S is the focus, and AX the axis, the normal PG bisects the angle SPX, PX being drawn parallel to AX.

Hence rays of sound diverging from S, and falling on the paraboloid formed by the revolution of the parabola about its axis, will all be reflected in directions parallel to the axis. And *vice versa* rays of sound XP, XQ, &c., from a very distant source, and parallel to the axis of a paraboloid, will be reflected into the focus. Consequently, if two reflecting paraboloids be placed at a considerable distance from and opposite to each other, with their axis coincident in direction (fig. 9), the tick of a watch placed at the focus S of one will be heard distinctly by an ear at S', the focus of the other.

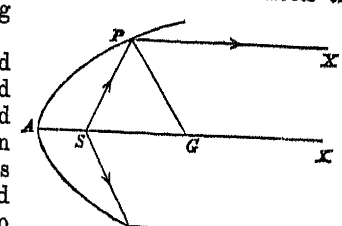


Fig. 8.

Echoes. 38. As a luminous object may give a succession of images when placed between two or more reflecting surfaces, so also in like circumstances may a sound suffer repetition.

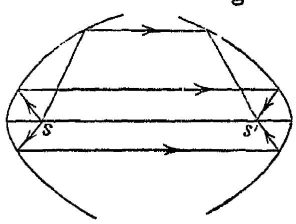


Fig. 9.

To these principles are easily traceable all the peculiarities of echoes. A wall or steep cliff may thus send back, somewhat reduced in intensity, a shout, the report of a pistol, &c. The time which elapses between the sound and its echo may be easily deduced from the known velocity of sound in air, if the distance of the wall be given. Thus, for a distance of 37 yards, the interval will be found by dividing the double of that or 74 yards by 370 yards, the velocity of sound at 50° Fahr., to amount to $\frac{1}{5}$ of a second. Hence, if we assume that the rate at which syllables can be distinctly uttered is five per second, the wall must be at a distance exceeding 37 yards to allow of the echo of a word of one syllable reaching the ear *after* the word has been uttered, 74 yards for a word of *two* syllables, and so on.

If the reflecting surface consists of one or more walls, cliffs, &c., forming together a near approach in shape to that of a prolate spheroid or of a double parabolic surface, then two points may be found, at one of which if a source of sound be placed, there will be produced, by convergence, a distinct echo at the other. As examples of this may be mentioned the whispering gallery in St Paul's, London, and the still more remarkable case of the Cathedral of Girgenti in Sicily mentioned by Sir John Herschel.

Sound conveyed over water, &c. 39. On similar principles of repeated reflexion may be explained the well-known fact that sounds may be conveyed to great distances with remarkably slight loss of intensity, on a level piece of ground or smooth sheet of water or ice, and still more so in pipes, chimneys, tunnels, &c. Thus, in one of Captain Parry's Polar expeditions, a conversation was on one occasion carried on, at a distance of $1\frac{1}{4}$ mile, between two individuals separated by a frozen sheet of water. M. Biot heard distinctly from one end of the train of pipes $\frac{5}{8}$ of a mile long, previously referred to, a low whisper proceeding from the opposite end.

Practical illustrations are afforded by the system of communication by means of tubing now so extensively adopted in public and private buildings, and by the *speaking trumpet* and the *ear trumpet*.

Thunder. 40. The prolonged roll of thunder, with its manifold varieties, is partly to be ascribed to reflexion by mountains, clouds, &c.; but is mainly accounted for on a different acoustic principle, viz., the comparatively low rate of transmission of sound through air, as was first shown by Dr Hooke at the close of the 17th century. The explanation will be more easily understood by adverting to the case of a volley fired by a long line of troops. A person situated at a point in that line produced, will first it is evident hear the report of the nearest musket, followed by that of the one following, and so down to the last one in the line, which will close the prolonged roll thus reaching his ear; and as each single report will appear to him less intense according as it proceeds from a greater distance, the roll of musketry thus heard will be one of gradually decreasing loudness. But if he were to place himself at a relatively great distance right opposite to the centre of the line, the separate reports from each of the two wings would reach him nearly at the same moment, and hence the sound of the volley would now approach more nearly to that of a single loud crash. If the line of soldiers formed an arc of a circle having its centre in his position, then the distances gone over by the separate reports being equal, they would reach his ear at the same absolute instant of time, and with exactly equal intensities; and the effect produced would be strictly the same as that of a single explosion, equal in violence to the sum of all the separate discharges, occurring at the same distance. It is easy to see that, by varying the form of the line of troops and the position of the observer, the sonorous effect will be diversified to any extent desired. If then we keep in view the great diversity of form exhibited by lightning-flashes, which may be regarded as being lines, at the points of which are generated explosions at the same instant of time, and the variety of distance and relative position at which the observer may be placed, we shall feel no difficulty in accounting for all those acoustic phenomena of thunder to which Hooke's theory is applicable.

Part IV.

The Principles of Musical Harmony.

41. A few words on the subject of *musical harmony* must be introduced here for the immediate purposes of this article, further details being reserved for the special article on that subject.

Sounds in general exhibit three different qualities, so far as their effect on the ear is concerned, viz., *loudness*, *pitch*, and *timbre*.

Loudness depends, *cæt. par.*, on the violence with which the vibrating portions of the ear are excited; and therefore on the *extent* or *amplitude* of the vibrations of the body whence the sound proceeds. Hence, after a bell has been struck, its effect on the ear gradually diminishes as its vibration becomes less and less extensive. By the theory of vibrations, loudness or intensity is measured by the *vis-viva* of the vibrating particles, and is consequently proportional to the square of their maximum velocity or to the square of their maximum displacement. Helmholtz, however, in his remarkable work on the perception of tone, observes that notes differing in pitch differ also in loudness, where their *vis viva* is the same, the higher note always exhibiting the greater intensity. Loudness depends on extent of vibration.

42. Difference of *pitch* is that which finds expression in the common terms applied to notes: *Acute, shrill, high, sharp, grave, deep, low, flat.* We will point out presently in what manner it is established that this quality of sound depends on the rapidity of vibration of the particles of air in contact with the external parts of the ear. The pitch of a note is higher in proportion to the number of vibrations of the air corresponding to it, in a given time, such as one second. If n denote this number, then, by § 13, $n = \frac{V}{\lambda}$, and hence, V being constant, the pitch is higher the less the length λ of the wave. Pitch depends on rapidity of vibration.

43. *Timbre*, or, as it is termed by German authors, *klang-farbe*, rendered by Tyndall into *clang-colour* or *clang-tint*, but for which we would substitute the expression *acoustic colour*, denotes that peculiarity of impression produced on the ear by sounds otherwise, in pitch, loudness, &c., alike, whereby they are recognisable as different from each other. Thus human voices are readily interdistinguishable; so are notes of the same pitch and intensity, produced by different instruments. The question whence arises this distinction must be deferred for the present. Timbre.

44. Besides the three qualities above mentioned, there exists another point in which sounds may be distinguished among each other, and which, though perhaps reducible to difference of timbre, requires some special remarks, viz., that by which sounds are characterised, either as *noises* or as *musical notes*. A musical note is the result of regular, Distinction between noises and musical notes.

periodic vibrations of the air-particles acting on the ear, and therefore also of the body whence they proceed, each particle passing through the same phase at stated intervals of time. On the other hand, the motion to which *noise* is due is irregular and flitting, alternately fast and slow, and creating in the mind a bewildering and confusing effect of a more or less unpleasant character. Noise may also be produced by combining in an arbitrary manner several musical notes, as when one leans with the fore-arm against the keys of a piano. In fact, the composition of regular periodic motions, thus effected, is equivalent to an irregular motion.

Laws of musical harmony. 45. We now proceed to state the laws of musical harmony, and to describe certain instruments by means of which they admit of being experimentally established. The chief of these laws are as follow :—

Ratios of vibrations. (1.) The notes employed in music always correspond to certain definite and invariable ratios between the numbers of vibrations performed in a given time by the air when conveying these notes to the ear, and these ratios are of a very simple kind, being restricted to the various permutations of the first four prime numbers 1, 2, 3, 5, and their powers.

Unison. (2.) Two notes are in *unison* whose corresponding vibrations are executed exactly at the same rate, or for which (denoting by n, n_1 the numbers per second) $\frac{n_1}{n} = 1$. This ratio or *interval* (as it is termed) is the simplest possible.

Octave. (3.) The next *interval* is that in which $\frac{n_1}{n} = 2$, and is termed the *octave*.

Twelfth and Fifth. (4.) The interval $\frac{n_1}{n} = 3$ is termed the *twelfth*, and if we reduce the higher note of the pair by an 8^{ve}, *i.e.*, divide its number of vibrations by 2, we obtain the interval $\frac{n_2}{n} = \frac{3}{2}$, designated as the interval of the *fifth*.

Major third. (5.) The interval $\frac{n_1}{n} = 5$ has no particular name attached to it, but if we lower the higher note by two 8^{ves} or divide n_1 by 4, we get the interval $\frac{n_3}{n} = \frac{5}{4}$, or the interval of the *major third*.

Major sixth. (6.) The interval $\frac{n_1}{n} = \frac{5}{3}$ is termed the *major sixth*.

Minor third. (7.) The interval $\frac{n_1}{n} = \frac{2 \times 3}{5} = \frac{6}{5}$ is termed the *minor third*.

Fourth. (8.) The interval $\frac{n_1}{n} = \frac{2 \times 2}{3} = \frac{4}{3}$ is termed the *fourth*.

Second. (9.) The interval $\frac{9}{8}$ which, being $= \frac{\frac{3}{2} \times \frac{3}{2}}{2}$, may be regarded as formed by taking in the first place a note one-fifth higher than the key-note or fundamental, *i.e.*, higher than the latter by the interval $\frac{3}{2}$, thence ascending by another fifth, which gives us $\frac{3}{2} \times \frac{3}{2}$ and lowering this by an octave, which results in $\frac{9}{8}$, which is called the *second*.

Seventh. (10.) The interval $\frac{15}{8}$ or $\frac{3}{2} \times \frac{5}{4}$ may be regarded as the major third $\left(\frac{5}{4}\right)$ of the fifth $\left(\frac{3}{2}\right)$, and is called the interval of the *seventh*.

Diatonic scale. 46. If the key-note or fundamental be denoted by C, and the notes, whose intervals above C are those just enumerated, by D, E, F, G, A, B, C, we form what is known in music as the natural or *diatonic* scale, in which therefore the intervals reckoned from C are successively

$$\frac{9}{8}, \frac{5}{4}, \frac{4}{3}, \frac{3}{2}, \frac{5}{3}, \frac{15}{8}, 2,$$

and therefore the intervals between each note and the one following are

$$\frac{9}{8}, \frac{10}{9}, \frac{16}{15}, \frac{9}{8}, \frac{10}{9}, \frac{9}{8}, \frac{16}{15}.$$

Major tone. Of these last intervals the *first*, *fourth*, and *sixth* are each $= \frac{9}{8}$, which is termed a *major tone*. Minor tone. The *second* and *fifth* are each $= \frac{10}{9}$, which is a ratio slightly less than the former, and hence is called a *minor tone*. Semitone. The *third* and *seventh* are each $= \frac{16}{15}$, to which is given the name of *semi-tone*.

Chromatic scale. By interposing an additional note between each pair of notes whose interval is a major or a minor tone, the resulting series of notes may be made to exhibit a nearer approach to equality in the intervals successively separating them, which will be very nearly *semi-tones*. This sequence of twelve notes forms the *chromatic* scale. The note interposed between C and D is either C sharp (C♯) or D flat (D♭), according as it is formed by *raising* C a semi-tone or *lowering* D by the same amount.

47. Various kinds of apparatus have been contrived with a view of confirming experimentally the truth of the laws of musical harmony as above stated.

Savart's toothed wheel apparatus. Savart's toothed wheel apparatus consists of a brass wheel, whose edge is divided into a number of equal projecting teeth distributed uniformly over the circumference, and which is capable of rapid rotation about an axis perpendicular to its plane and passing through its centre, by means of a series of multiplying wheels, the last of which is turned round by the hand. The toothed wheel being set in motion, the edge of a card or of a funnel-shaped piece of common note paper is held against the teeth, when a note will be heard arising from the rapidly succeeding displacements of the air in its vicinity. The pitch of this note will, agreeably to the theory, rise as the rate of rotation increases, and becomes steady when that rotation is maintained uniform. It may thus be brought into unison with any sound of which it may be required to determine the corresponding number of vibrations per second, as for instance the note A_3, three 8^{ves} higher than the A which is indicated musically by a small circle placed between the second and third lines of the G clef, which A is the note of the tuning-fork usually employed for regulating concert-pitch. A_3 may be given by a piano. Now, suppose that the note produced with Savart's apparatus is in unison with A_3, when the experimenter turns round the first wheel at the rate of 60 turns per minute or one per second, and that the circumferences of the various multiplying wheels are such that the rate of revolution of the toothed wheel is thereby increased 44 times, then the latter wheel will perform 44 revolutions in a second, and hence, if the number of its teeth be 80, the number of taps imparted to the card every second will amount to 44 × 80 or 3520. This, therefore, is the number of vibrations corresponding to the note A_3. If we divide this by 2^3 or 8, we obtain 440 as the number of vibrations answering to the note A. This, however, tacitly assumes that the bands by which motion is transmitted from wheel to wheel do not *slip* during the experiment. If, as is always more or less the case, slipping occurs, a different mode for determining the rate at which the toothed wheel revolves, such as is employed in the syren of De la Tour (*vide* below), must be adopted.

If, for the single toothed wheel, be substituted a set of four with a common axis, in which the teeth are in the ratios 4 : 5 : 6 : 8, and if the card be rapidly passed along their edges, we shall hear distinctly produced the fundamental chord C, E, G, C_1 and shall thus satisfy ourselves that the intervals C, E; C_1 G, and C C_1 are (as they ought to be) $\frac{5}{4}$, $\frac{3}{2}$, and 2 respectively.

Seebeck's syren.

48. The *syren* of Seebeck is the simplest form of apparatus thus designated, and consists of a large circular disc of pasteboard mounted on a central axis, about which it may be made to revolve with moderate rapidity. This disc is perforated with small round holes arranged in circles about the centre of the disc. In the first series of circles, reckoning from the centre, the openings are so made as to divide the respective circumferences, on which they are found, in aliquot parts bearing to each other the ratios of the numbers 2, 4, 5, 6, 8, 10, 12, 16, 20, 24, 32, 40, 48, 64. The second series consists of circles each of which is formed of two sets of perforations, in the first circle arranged as 4 : 5, in the next as 3 : 4, then as 2 : 3, 3 : 5, 4 : 7. In the outer series is a circle divided by perforations into four sets, the numbers of aliquot parts being as 3 : 4 : 5 : 6, followed by others which we need not further refer to.

The disc being started, then by means of a tube held at one end between the lips, and applied near to the disc at the other, or more easily with a common bellows, a blast of air is made to fall on the part of the disc which contains any one of the above circles. The current being alternately transmitted and shut off, as a hole passes on and off the aperture of the tube or bellows, causes a vibratory motion of the air, whose rapidity depends on the number of times per second that a perforation passes the mouth of the tube. Hence the note produced with any given circle of holes rises in pitch as the disc revolves more rapidly; and if, the revolution of the disc being kept as steady as possible, the tube be passed rapidly across the circles of the first series, the notes heard are found to produce on the ear, as required by theory, the exact impression corresponding to the ratios 2 : 4 : &c., *i.e.*, of a series of notes, which, if the lowest be denoted by C, form the sequence C C_1 E_1 G_1 C_2 &c., &c. In like manner, the first circle in which we have two sets of holes dividing the circumference, the one into say 8 parts, and the other into 10, or in ratio 4 : 5, the note produced is a compound one, such as would be obtained by striking on the piano two notes separated by the interval of a major third $\left(\frac{5}{4}\right)$. Similar results, all agreeing with the theory, are obtainable by means of the remaining perforations.

A still simpler form of syren may be constituted with a good spinning top, a perforated card disc, and a tube for blowing with.

ren of de la ur.

49. The syren of Cagnard de la Tour is founded on the same principle as the preceding. It consists of a cylindrical chest of brass, the base of which is pierced at its centre with an opening in which is fixed a brass tube projecting outwards, and intended for supplying the cavity of the cylinder with compressed air or other gas, or even liquid. The top of the cylinder is formed of a plate perforated near its edge by holes distributed uniformly in a circle concentric with the plate, and which are cut obliquely through the thickness of the plate. Immediately above this fixed plate, and almost in contact with it, is another of the same dimensions, and furnished with the same number, n, of openings similarly placed, but passing obliquely through in an opposite direction from those in the fixed plate, the one set being inclined to the left, the other to the right.

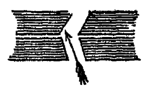


Fig. 10.

This second plate is capable of rotation about a steel axis perpendicular to its plane and passing through its centre. Now, let the movable plate be at any time in a position such that its holes are immediately above those in the fixed plate, and let the bellows by which air is forced into the cylinder (air, for simplicity, being supposed to be the fluid employed) be put in action; then the air in its passage will strike the side of each opening in the movable plate in an oblique direction (as shown in fig. 10), and will therefore urge the latter to rotation round its centre. After $\frac{1}{n}$th of a revolution, the two sets of perforations will again coincide, the lateral impulse of the air repeated, and hence the rapidity of rotation increased. This will go on continually as long as air is supplied to the cylinder, and the velocity of rotation of the upper plate will be accelerated up to a certain maximum, at which it may be maintained by keeping the force of the current constant.

Now, it is evident that each coincidence of the perforations in the two plates is followed by a non-coincidence, during which the air-current is shut off, and that consequently, during each revolution of the upper plate, there occur n alternate passages and interceptions of the current. Hence arises the same number of successive impulses of the external air immediately in contact with the movable plate, which is thus thrown into a state of vibration at the rate of n for every revolution of the plate. The result is a note whose pitch rises as the velocity of rotation increases, and becomes steady when that velocity reaches its constant value. If, then, we can determine the number m of revolutions performed by the plate in every second, we shall at once have the number of vibrations per second corresponding to the audible note by multiplying m by n.

For this purpose the steel axis is furnished at its upper part with a screw working into a toothed wheel, and driving it round, during each revolution of the plate, through a space equal to the interval between two teeth. An index resembling the hand of a watch partakes of this motion, and points successively to the divisions of a graduated dial. On the completion of each revolution of this toothed wheel (which, if the number of its teeth be 100, will comprise 100 revolutions of the movable plate), a projecting pin fixed to it catches a tooth of another toothed wheel and turns it round, and with it a corresponding index which thus records the number of turns of the first toothed wheel. As an example of the application of this syren, suppose that the number of revolutions of the plate, as shown by the indices, amounts to 5400 in a minute of time, that is, to 90 per second, then the number of vibrations per second of the note heard amounts to $90n$, or (if number of holes in each plate = 8) to 720.

50. Dove, of Berlin, has produced a modification of the syren by which the relations of different musical notes may be more readily ascertained. In it the fixed and movable plates are each furnished with four concentric series of perforations, dividing the circumferences into different aliquot parts, as *p. ex.*, 8, 10, 12, 16. Beneath the lower or fixed plate are four metallic rings furnished with holes corresponding to those in the plates, and which may be pushed round by projecting pins, so as to admit the air-current through any one or more of the series of perforations in the fixed plate. Thus, may be obtained, either separately or in various combinations, the four notes whose vibrations are in the ratios of the above numbers, and which therefore form the fundamental chord (CEGC_1). The inventor has given to this instrument the name of the *many-voiced syren*. Dove's syren.

51. Helmholtz has further adapted the syren for more extensive use, by the addition to Dove's instrument of another chest containing its own fixed and movable per- Helmholtz's double syren.

forated plates and perforated rings, both the moveable plates being driven by the same current and revolving about a common axis. Annexed is a figure of this instrument (fig. 11).

Vibrographs

52. The relation between the pitch of a note and the frequency of the corresponding vibrations has also been studied by *graphic* methods. Thus, if an elastic metal slip or a pig's bristle be attached to one prong of a tuning-fork, and if the fork, while in vibration, is moved rapidly over a glass plate coated with lamp black, the attached slip touching the plate lightly, a wavy line will be traced on the plate answering to the vibrations to and fro of the fork. The same result will be obtained with a stationary fork and a movable glass plate; and, if the time occupied by the plate in moving through a given distance can be ascertained, and the number of complete undulations exhibited on the plate for that distance, which is evidently the number of vibrations of the fork in that time, is reckoned, we shall have determined the numerical vibration-value of the note yielded by the fork. Or, if the same plate be moved in contact with two tuning-forks, we shall, by comparing the number of sinuosities in the one trace with that in the other, be enabled to assign the ratio of the corresponding numbers of vibrations per second. Thus, if the one note be an octave higher than the other, it will give double the number of waves in the same distance. The motion of the plate may be simply produced by dropping it between two vertical grooves, the tuning-forks being properly fixed to a frame above.

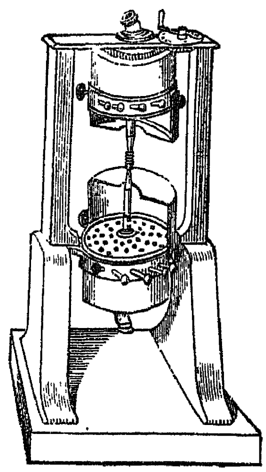


Fig. 11.

The Phonautograph.

53. Greater accuracy may be attained with the so-called *Vibrograph* or *Phonautograph* (Duhamel's or Kœnig's), consisting of a glass cylinder coated with lamp-black, or, better still, a metallic cylinder round which a blackened sheet of paper is wrapped. The cylinder is mounted on a horizontal axis and turned round, while the *pointer* attached to the vibrating body is in light contact with it, and traces therefore a wavy circle, which, on taking off the paper and flattening it, becomes a wavy straight line. The superiority of this arrangement arises from the comparative facility with which the number of revolutions of the cylinder in a given time may be ascertained. In Kœnig's phonautograph, the axis of the cylinder is fashioned as a screw, which works in fixed nuts at the ends, causing a sliding as well as a rotatory motion of the cylinder. The lines traced out by the vibrating pointer are thus prevented from overlapping when more than one turn is given to the cylinder.

Any sound whatever may be made to record its trace on the paper by means of a large parabolic cavity resembling a speaking-trumpet, which is freely open at the wider extremity, but is closed at the other end by a thin stretched membrane. To the centre of this membrane is attached a small feather-fibre, which, when the reflector is suitably placed, touches lightly the surface of the revolving cylinder. Any sound (such as that of the human voice) transmitting its rays into the reflector, and communicating vibratory motion to the membrane, will cause the feather to trace a sinuous line on the paper. If, at the same time, a tuning-fork of known number of vibrations per second be made to trace its own line close to the other, a comparison of the two lines gives the number corresponding to the sound under consideration.

Part V.

Stationary Waves.

Stationary waves produced by two opposite progressive waves.

54. We have hitherto, in treating of the propagation of waves of sound, assumed that the medium through which it took place was unlimited in all directions, and that the source of sound was single. In order, however, to understand the principles of the production of sound by musical instruments, we must now direct our attention to the case of two waves from different sources travelling through the same medium in opposite directions. Any particle of the medium being then affected by two different vibrations at the same instant will necessarily exhibit a different state of motion from that due to either wave acting separately from the other, and we have to inquire what is the result of this mutual *interference* (as it is termed) of the two given waves. Supposing, as sufficient for our purpose, that the given waves are of equal lengths and of equal amplitudes, in other words, that the corresponding notes are of the same pitch and equally loud; and supposing, further, that they are advancing in exactly opposite directions, we shall now show that the result of the mutual interference of two such waves is the production of a *stationary wave*, that is, taking any line of particles of the medium along the direction of motion of the component waves, certain of them, such as a, c, e . . . at intervals each $=\frac{\lambda}{2}$, will remain constantly in their usual undisturbed positions. All the particles situated between a and c will vibrate (transversely or longitudinally, as the case may be) to and fro in the same direction as they would if affected by only one of the interfering waves, but with different amplitudes of vibration, ranging from zero at a to a maximum at b and thence to zero at c. Those between c and e will vibrate in like manner, but always in an opposite direction to the similarly placed particles in ac, and so on alternately.

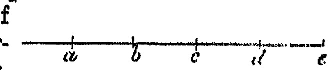


Fig. 12.

The annexed figures will represent to the eye the states of motion at intervals of time $=\frac{1}{4}$ of the time T of a complete vibration of the particles. In fig. 13, 1, the particles in ac are at their greatest distances from their undisturbed positions (*above* or *to the right*, according as the motion is *transversal* or *longitudinal*). In fig. 13, 2, they are all in their undisturbed positions. In fig. 13, 3, the displacements are all reversed relatively to fig. 13, 1. In fig. 13, 4, the particles are again passing through their equilibrium positions, resuming the positions indicated in fig. 13, 1, after the time T.

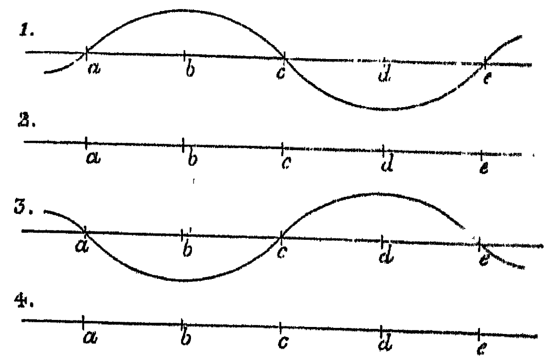


Fig. 13.

Nodes and ventral segments

The points ace, &c., which remain stationary are termed *nodes*, and the vibrating parts between them *ventral segments*.

Proof

54a. *Proof.* In fig. 14, 1, the full curved line represents the two interfering waves at an instant of time such that,

in their progress towards each other, they are then coincident. It is obvious that the particles of the medium will at the moment in question be displaced to double the extent of the displacement producible by either wave alone, so that the *resultant* wave may be represented by the *dotted* curve. In fig. 14, 2, the two interfering waves, represented by the full and dotted curves respectively, have each

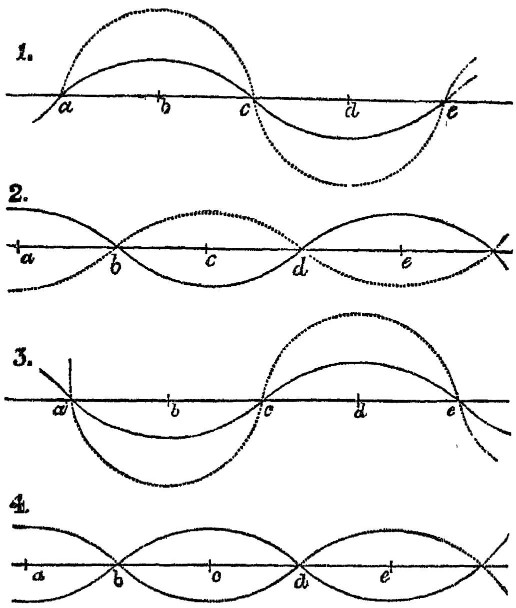


Fig. 14.

passed over a distance $= \frac{1}{4}\lambda$, the one to the right, the other to the left, and it is manifest that any disturbance of the medium, producible by the one wave, is completely neutralised by the equal and opposite action of the other. Hence, the particles of the medium are now in their undisturbed positions. In fig. 14, 3, a further advance of the two waves, each in its own direction, over a space $= \frac{1}{4}\lambda$, has again brought them into coincidence, and the result is the wave represented by the dotted line, which, it will be remarked, has its *crests*, where, in fig. 1, are found *troughs*. In fig. 14, 4, after a further advance $= \frac{1}{4}\lambda$, we have a repetition of the case of fig. 14, 2, the particles are now again unaffected by the waves. A still further advance of $\frac{1}{4}\lambda$, or of λ reckoned from the commencement, brings us back to the same state of things as subsisted in fig. 14, 1. An inspection and inter-comparison of the dotted lines in these figures are now sufficient to establish the accuracy of the laws, before mentioned, of *stationary waves.*

Part VI.

Musical Strings.

Musical strings.

55. We have in musical strings an instance of the occurrence of stationary waves.

Let AB (fig. 15) be a wire or string, supposed meanwhile to be fixed only at one extremity B, and let the wire be, at any part, excited (whether by passing a violin bow across or by friction along it), so that a wave (whether of transversal or longitudinal vibrations) is propagated thence towards B. On reaching this point, which is fixed, reflexion will occur, in consequence of which the particles there will suffer a complete reversal of velocity, just as when a perfectly elastic ball strikes against a smooth surface perpendicularly, it rebounds with a velocity equal and opposite to that it previously had. Hence, the displacement due to the incident wave being BM, the displacement after reflexion will be BN equal and opposite to BM, and a reflected wave will result, represented by the faint line in the fig., which will travel with the same velocity, but in the opposite direction to the incident wave fully lined in the fig. The interference of these two oppositely progressing waves will consequently give rise to a stationary wave (fig. 16), and if we take on the wire distances BC, CD, DE, &c. $= \frac{1}{2}\lambda$, the points B, C, D, E, . . . will be *nodes*, each of which separate portions of the wire vibrating in opposite directions, *i.e., ventral segments.*

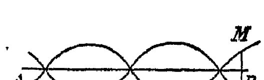


Fig. 15.

Fig. 16.

56. Now, it is obvious that, inasmuch as a node is a point which remains always at rest while other parts of the medium to which it belongs are vibrating, such point may be absolutely fixed without thereby interfering with the oscillatory motion of the medium. If, therefore, a length AB of wire be taken equal to any multiple of $\frac{\lambda}{2}$, A may be fixed as well as B, the motion remaining the same as before, and thus we shall have the usual case of a musical string. The two extremities being now both fixed, there will be repeated reflexions at both, and a consequent persistence of two progressive waves advancing in opposite directions and producing together the stationary wave above figured.

Fundamental and harmonics.

57. We learn from this that a musical string is susceptible of an infinite variety of modes of vibration corresponding to different numbers of subdivision into ventral segments.

Thus, it may have but *one* ventral segment (fig. 17), or but two nodes formed by its fixed extremities. In this case, the note emitted by it is the lowest which can possibly be obtained from it, or, as it is called, its *fundamental* note. If l denote the length of the wire, by what has been already proved, $l = \frac{\lambda}{2}$, and therefore the length of the wave $\lambda = 2l$. Hence, V being the velocity of propagation of the wave through the wire, the number n_1 of vibrations performed in the unit of time with the fundamental note is $\frac{V}{2l}$.

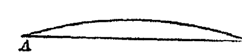


Fig. 17.

The next possible sub-division of the wire is into *two* ventral segments, the three nodes being the two fixed ends A, B, and the middle point C (fig. 18). Hence, $l = \lambda$, and the number of vibrations $n_2 = \frac{V}{l}$ or double of those of the fundamental. The note, therefore, now is an 8ve higher.

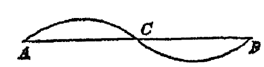


Fig. 18.

Reasoning in a like manner for the cases of three, four, &c., ventral segments, we obtain the following general law, which is applicable alike to *transversely* and to *longitudinally* vibrating wires:

A wire or string fixed at both ends is capable of yielding, in addition to its fundamental note, any one of a series of notes corresponding to 2, 3, 4 *times, &c., the number of vibrations per second of the fundamental, viz., he octave, twelfth, double octave, &c.*

These higher notes are termed the *harmonics* or (by the Germans) the *overtones* of the string.

It is to be remarked that the overtones are in general fainter the higher they are in the series, because, as the number of ventral segments or independently vibrating parts of the string increases, the extent or amplitude of the vibrations diminishes.

May be heard together.

58. Not only may the fundamental and its harmonic-

be obtained independently of each other, but they are also to be heard simultaneously, particularly, for the reason just given, those that are lower in the scale. A practised ear easily discerns the coexistence of these various tones when a pianoforte or violin string is thrown into vibration. It is evident that, in such case, the string, while vibrating as a whole between its fixed extremities, is at the same time executing subsidiary oscillations about its middle point, its points of trisection, &c., as shown in fig. 19, for the fundamental and the first harmonic.

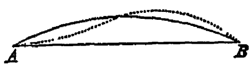


Fig. 19.

Harmonics, how best obtained.

59. The easiest means for bringing out the harmonics of a string consists in drawing a violin-bow across it near to one end, while the feathered end of a quill or a hair-pencil is held lightly against the string at the point which it is intended shall form a node, and is removed just after the bow is withdrawn. Thus, if a node is made in this way, at $\frac{1}{3}$ of AB from A, the note heard will be the twelfth. If light paper rings be strung on the cord, they will be driven by the vibrations to the nodes or points of rest, which will thus be clearly indicated to the eye.

Comparison of fundamentals of strings vibrating transversely and longitudinally.

60. The formula $n_1 = \frac{V}{2l}$ shows that the pitch of the fundamental note of a wire of given length rises with the velocity of propagation of sound through it. Now we have learned (§ 28) that this velocity, in ordinary circumstances, is enormously greater for a wire vibrating longitudinally than for the same wire vibrating transversely. The fundamental note, therefore, is far higher in pitch in the former than in the latter case.

As, however, the quantity V depends, for longitudinal vibrations, solely on the nature of the medium, the pitch of the fundamental note of a wire rubbed along its length depends—the material being the same, brass for instance—on its length, not at all on its thickness, &c.

But as regards strings vibrating transversely, such as are met with in our instrumental music, V, as we have seen (§ 27), depends not only on the nature of the substance used, but also on its thickness and tension, and hence the pitch of the fundamental, even with the same length of string, will depend on all those various circumstances.

Transversely vibrating string $n \propto \frac{1}{l}$.

61. If we put for V its equivalent expressions before given, we have for the fundamental note of transversely vibrating strings:

$$n = \frac{\sqrt{gc}}{2l} \quad \text{or } n = \frac{1}{2l}\sqrt{\frac{gP}{w}},$$

whence the following inferences may be easily drawn:

If a string, its tension being kept invariable, have its length altered, the fundamental note will rise in pitch in exact proportion with its diminished length, that is, n varies then inversely as l.

Hence, on the violin, by placing a finger successively on any one of the strings at $\frac{8}{9}, \frac{4}{5}, \frac{3}{4}, \frac{2}{3}, \frac{3}{5}, \frac{8}{15}, \frac{1}{2}$, we shall obtain notes corresponding to numbers of vibrations bearing to the fundamental the ratios to unity of the following, viz., $\frac{9}{8}, \frac{5}{4}, \frac{4}{3}, \frac{3}{2}, \frac{15}{8}$, 2, which notes form, therefore, with the fundamental, the complete scale.

$n \propto \sqrt{\text{Tension}}$

62. By *tightening* a musical string, its length remaining unchanged, its fundamental is rendered higher. In fact, then, n is proportional to the square root of the tension. Thus, by quadrupling the tension, the note is raised an octave. Hence, the use of keys in tuning the violin, the pianoforte, &c.

$n \propto \frac{1}{\text{thickness}}$

63. Equal lengths of strings of the same density and equally stretched, but of different thicknesses, give fundamentals which are higher in pitch in proportion to diminution of thickness (*i.e.*, n varies inversely as the thickness). Thus, of two strings of same kind of gut, same length and same tension, if one be twice as thick as the other, its fundamental will be an octave lower. Hence, three of the strings of the violin, though all of gut, have different fundamentals, because unequally thick.

$n \propto \frac{1}{\sqrt{\text{weight of given length}}}$

64. Equally long and equally stretched strings or wires of different thickness and different material, have fundamentals higher in pitch the less the weights of the strings; n here varies inversely as the square root of the weight w of a given length of the string.

$n \propto \frac{1}{\sqrt{\text{density}}}$

65. If, in last case, the thicknesses of the strings which are to be compared together are equal, then n varies inversely as the square root of the density.

Hence, in the violin and in the pianoforte, the lower notes are obtained from wires formed of denser material. Thus, the fourth string of the violin is formed of gut covered with silver wire.

Melde's experimental illustration.

66. A highly ingenious and instructive method for illustrating the above laws of musical strings, has been recently contrived by M. Melde, and consists simply in attaching to the ventral segment of a vibrating body, such as a tuning-fork or a bell-glass, a silk or cotton thread, the other extremity being either fixed or passing over a pulley and supporting weights by which the thread may be stretched to any degree required. The vibrations of the larger mass are communicated to the thread which, by proper adjustment of its length and tension, vibrates in unison and divides itself into one or more ventral segments easily discernible by a spectator. If the length of the thread be kept invariable, a certain tension will give but one ventral segment; the fundamental note of the thread is then of same pitch as the note of the body to which it is attached. By reducing the tension to $\frac{1}{4}$ of its previous amount, the number of ventral segments will be seen to be increased to two, indicating that the first harmonic of the thread is now in unison with the solid, and consequently that its fundamental is an octave lower than it was with the former tension; thus confirming the law that n varies as $\sqrt{P}$. In like manner, on further lowering the tension to $\frac{1}{9}$, three ventral segments will be formed, and so on.

The law that, *cæt. par.*, n varies inversely as the thickness may be tested by forming a string of four lengths of the single thread used before, and consequently of double the thickness of the latter, when, for the same length and tension, the compound thread will exhibit double the number of ventral segments presented by the single thread.

The other laws admit of similar illustration.

PART VII.

Stiff Rods, Plates, &c.

Rod, fixed at one end, vibrating transversely.

67. If, instead of a string or thin wire, we make use of a rod or narrow plate, sufficiently stiff to resist flexure, we may cause it to vibrate transversely when fixed at one end only. In this case the number of vibrations corresponding to the fundamental note varies as the thickness directly, and as the square of the length inversely. The annexed figures represent the modes of vibration corresponding to the fundamental and the first two overtones, the rod passing to and fro between the positions AGKC and AHLD. In all cases

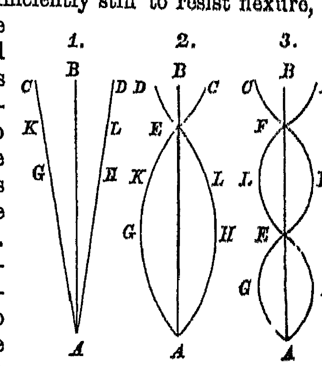


Fig. 20.

being fixed is necessarily a node, and B being free is the middle of a ventral segment. We have thus a succession of cases in which the rod contains $\frac{1}{2}$, $\frac{3}{2}$, $\frac{5}{2}$, &c. ventral segments. The numbers of vibrations per second are as the squares of these, or, as 1 : 9 : 25 : &c. The reason of this is, that (taking the case of fig. 20, 3) the part FB, which may be regarded as an independent rod fixed at the end F, is evidently $\frac{1}{5}$ of the length of AB, and consequently, since $n \propto \frac{1}{l^2}$, has a proper note of 5^2 or 25 times the rapidity of vibration in fig. 20, 1.

By attaching, with a little bees' wax, stiff hog's bristles to one prong of a tuning-fork, or to the edge of a bell-glass, or even a common jar, and clipping them on trial to suitable lengths, we shall find that, on drawing a note in the usual way from the tuning-fork or glass, the bristles will divide into one or more separately vibrating segments, as in the above figs.

Tuning-fork.

68. The *tuning-fork* itself may be regarded as belonging to the class of stiff rods. When emitting its fundamental note, it vibrates, as in fig. 21, with nodes at b and d and extreme positions $abcde$ and $fbgdh$.

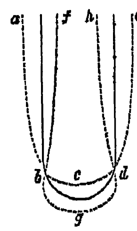


Fig. 21.

Thinplates. Chladni's figures.

69. The transversal vibrations of thin square, circular, and other plates of metal or glass, are interesting, because, if these are kept in a horizontal position, light dry sand or powder sifted over the upper surface, will be thrown off the ventral segments to the nodal lines, which will thus be rendered manifest to the eye, forming what are termed *Chladni's figures.* As in the case of a musical string, so here we find that the pitch of the note is higher for a given plate the greater the number of ventral segments into which it is divided; but the converse of this does not hold good, two different notes being obtainable with the same number of such segments, the position of the nodal lines being, however, different.

Square plates.

70. The upper line of annexed figures shows how the sand arranges itself in three cases, when the plates are square. The lower line gives the same in a sort of

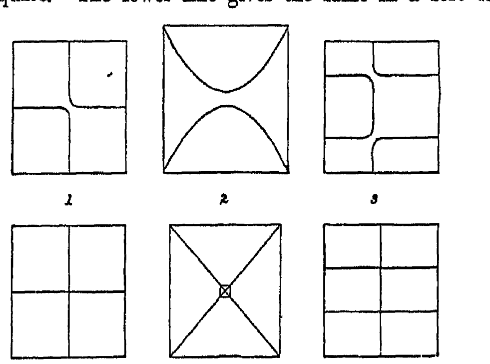


Fig. 22.

idealised form, and as usually to be found in acoustical works. Fig. 22, 1 corresponds to the lowest possible note of the particular plate used; Fig. 22, 2 to the *fifth* higher; Fig. 22, 3 to the *tenth* or octave of the *third*, the numbers of vibration in the same time being as 2 to 3 to 5.

If the plate be small, it is sufficient, in order to bring out the simpler sand-figures, to hold the plate firmly between two fingers of the same hand placed at any point where at least two nodal lines meet, for instance the centre in (1) and (2), and to draw a violin bow downwards across the edge near the middle of a ventral segment. But with larger plates, which alone will furnish the more complicated figures, a clamp-screw must be used for fixing the plate, and at the same time, one or more other nodal points ought to be touched with the fingers while the bow is being applied. In this way, any of the possible configurations may be easily produced.

Circular plates.

71. By similar methods, a circular plate may be made to exhibit nodal lines dividing the surface by diametral lines into four or a greater, but always *even*, number of sectors, an odd number being incompatible with the general law of stationary waves that the parts of a body adjoining a nodal line on either side must always vibrate oppositely to each other.

Another class of figures consists of circular nodal lines along with diametral (fig. 23).

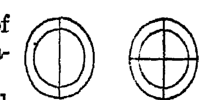


Fig. 23.

Circular nodal lines unaccompanied by intersecting lines cannot be produced in the manner described; but may be got either by drilling a small hole through the centre, and drawing a horse-hair along its edge to bring out the note, or by attaching a long thin elastic rod to the centre of the plate, at right angles to it, holding the rod by the middle and rubbing it lengthwise with a bit of cloth powdered with resin, till the rod gives a distinct note; the vibrations are communicated to the plate, which consequently vibrates transversely, and causes the sand to heap itself into one or more concentric rings.

Theory of Chladni's figures.

72. The theory of the vibrations of plates has not yet been put on a quite satisfactory basis. The following law may, however, be regarded as confirmed by experiment, viz., that when two different plates of the same substance present the same nodal configuration, the numbers of vibrations are to each other directly as the thicknesses, and inversely as the superficial areas.

Vibrations of membranes.

73. Paper, parchment, or any other thin membrane stretched over a square, circular, &c., frame, when in the vicinity of a sufficiently powerful vibrating body, will, through the medium of the air, be itself made to vibrate in unison, and, by using sand, as in previous instances, the nodal lines will be depicted to the eye, and seen to vary in form, number, and position with the tension of the plate and the pitch of the originating sound. The membrana tympani or drum of the ear has, in like manner and on the same principles, the property of repeating the vibrations of the external air which it communicates to the internal parts of the ear.

Longitudinal vibrations of rods.

74. Rods vibrating longitudinally are, as we have already remarked, subject to the laws of stationary waves. If, for instance, a wooden rod fixed at one end, be rubbed near the top between the finger and thumb previously coated with powdered resin, it will yield a fundamental note when it so vibrates as to have only *one* node (at the fixed extremity) and half a ventral segment reaching from that extremity to the other, that is, when the length l of the rod is $\frac{1}{4}\lambda$, or $\lambda = 4l$, and therefore $n = \frac{V}{4l}$. But it may also give overtones corresponding to 2, 3, &c. nodes, the free end being always the middle of a ventral segment, and for which therefore the lengths of waves are $\frac{4l}{3}$, $\frac{4l}{5}$, &c. (as will be easily seen by referring to figs. in § 67, which may equally represent transversal and longitudinal displacements). Hence, the fundamental and harmonics of a rod such as we are now considering, have vibrations whose rates are as the successive odd numbers.

A series of like rods, each fixed at one end into a block of wood, and of lengths bearing to each other, the ratios 1 : $\frac{8}{9}$: &c. (as in § 61), will give the common scale when rubbed in the manner already mentioned. This follows from the fundamental having $n = \frac{V}{4l}$, and therefore $n \propto \frac{1}{l}$

Glass rods or tubes may also be made to vibrate longitudinally by means of a moist piece of cloth; but it is advisable to clamp them firmly at the centre, when each half will vibrate according to the same laws as the wooden rods above. The existence of a motion of the particles of glass to and fro in the direction of its length may be well exhibited, by allowing a small ball of stone or metal suspended by a string to rest against one extremity of the rod, when, as soon as the latter is made to sing by friction, the ball will be thrown off with considerable violence.

Part VIII.

Theory of Pipes.

Air is the essential source of sound in pipes.

75. The *longitudinal* vibrations of air enclosed in pipes are of greater practical importance than those of other bodies, because made available to a very great extent for musical purposes. In the flute, horn, trumpet, and other wind instruments, it is the contained air that forms the essential medium for the production of sound, the wood or metal enclosing it having no other effect but to modify the *timbre* or acoustic colour of the note.

Principles of Bernouilli's theory.

76. In dealing with the theory of pipes, we must treat the air precisely in the same manner as we have dealt with elastic rods vibrating lengthwise, a pipe stopped at both ends being regarded as equivalent to a rod fixed at both ends, a pipe open at both ends to a rod free at both ends, and a pipe stopped at one end and open at the other to a rod fixed at one end and free at the other. When therefore the air within the pipe is anywhere displaced along the length of the pipe, two waves travel thence in opposite directions, and being reflected at the extremities of the pipe, there results a stationary wave with one or more fixed nodal sections, on one side of which the air is at any moment being displaced in one direction, while on the other side it is displaced in the opposite. Hence, when the air on both sides of the node is moving in towards it, there is condensation going on at the node, followed by rarefaction on the reversal of the motion of the air. The full lines in annexed figs. are curves of *displacements*, the dotted lines curves of *velocity* and *density* (*vid.* § 10 and 14).

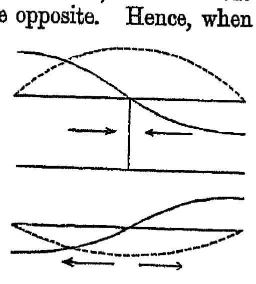


Fig. 24.

As a stopped end prevents any motion of the air, a nodal section is always found there. And as, at the open end, we may conceive the internal air to be maintained at the same density as the external air, we may assume that such end coincides with the middle of a ventral segment.

From these assumptions, which form the basis of Bernouilli's Theory of Pipes, we infer:

Pipe stopped at both ends.

77. That in a pipe stopped at both ends, as in a rod fixed at both ends, the fundamental note (fig. 25, 1), corresponds to $\lambda = 2l$, and therefore to $n = \frac{V}{2l}$, V denoting the velocity of sound in air, and the overtones to numbers of vibrations $= 2n$, $3n$, and so on. Fig. 25, 2, represents the octave.

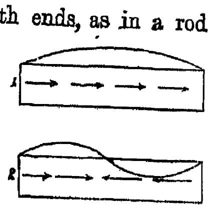


Fig. 25.

Open pipe.

78. That in a pipe open at both ends the same holds good as in the previous case. For (fig. 26, 1) $AC = \frac{1}{4}\lambda$ $\therefore \lambda = 4\ AC = 2l$, and in fig. 26, 2, $AD = \frac{1}{4}\lambda$, and also $= \frac{1}{4}\ l$ $\therefore \lambda = l$, or $\frac{1}{2}$ its value for the fundamental; and similarly for the other harmonics.

Pipe stopped at one end only.

79. That in a pipe open at one end and stopped at the other (or, as it is usually termed, a *stopped* pipe, case § 77, being purely imaginary), the fundamental note has $n = \frac{V}{4l}$, and the overtones correspond to $3n$, $5n$. . . .

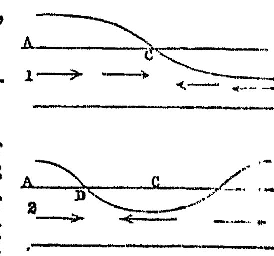


Fig. 26.

For, in fig. 27, 1, AB or $l = \frac{1}{4}\lambda$, and in fig. 27, 2, CB or $\frac{1}{4}\lambda$ is evidently $= \frac{1}{3}$ AB or $\frac{1}{3}\ l$, whence $\lambda = \frac{4}{3}l$, which being $\frac{1}{3}$ of value of λ in previous case, shows that the number of vibrations is three times greater. Similarly for the other overtones.

Harmonics in pipes.

80. It follows from the above, that a given pipe (whether open or stopped) may be made to emit, in addition to or in combination with its fundamental, a series of overtones, which, in an open pipe, follow the natural numbers, and hence are the octave, twelfth, &c., but, in a *stopped pipe*, follow the *odd* numbers, so as to want the octave and other notes represented by the even numbers. The succession of overtones may be practically obtained by properly regulating the force of the blast of air by which the air-column is put into vibration.

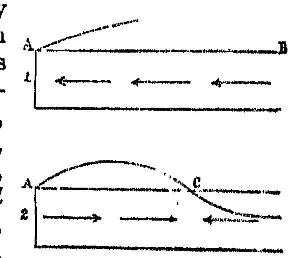


Fig. 27.

Notes of open and stopped pipes of equal lengths.

81. If the fundamental notes of two pipes of equal lengths, but of which one is open, the other stopped, be compared together, they will be found to differ in pitch by an octave, the stopped being the lower. This fact is in keeping with the theory, for the numbers of vibrations being respectively $\frac{V}{2l}$ and $\frac{V}{4l}$, are in the ratio of 2 to 1.

$n \propto \frac{1}{l}$.

82. By altering the length of the same pipe, we can vary the pitch of the fundamental at pleasure, since n varies inversely as l. This is effected in the flute and some other wind instruments by means of openings along part of the pipe, which, being closed or opened by means of keys and of the fingers, increase or diminish the length of the vibrating air-column. In this manner the successive notes of the scale are usually obtained within the range of an octave. The scale is further extended by bringing into play the higher harmonics.

Length of C pipe.

83. Since in an open pipe $n = \frac{V}{2l}$, and therefore $l = \frac{V}{2n}$, if for V we put 1090 ft., and for n 264, which is the number of vibrations per second usually assigned to the note C, we get $l = 2$ ft. very nearly. This, accordingly, is the length of the so-called C open pipe. The C stopped pipe must, by what has been stated above, be 4 feet in length.

Velocity in any gas derived from pipes.

84. Conversely it is obvious that the velocity V of sound in air, and generally in any gas, may be deduced from the equation $V = 2nl$, and that if two pipes of equal length contain respectively air and any other gas, the velocities in the two media being to each other directly as the number of vibrations of the notes they respectively emit, we may, from the well-ascertained value of the velocity in air, determine in this way the velocities in other gases, and thence the values of their coefficients γ (*vid.* § 21).

Defects of Bernouilli's theory.

85. While the inferences drawn by means of Bernouilli's theory agree, to a certain extent, with actual observation, there are discrepancies between the two which point to the existence of some flaw in one or both of the hypotheses on which the theory rests. In truth, the conditions assumed by Bernouilli are such as do not fully occur in

practice. The stopped extremity of a pipe is always to some extent of a yielding nature, and does not therefore exactly coincide with a nodal surface; nor can the internal air immediately adjoining the open end be perfectly free from variation of density during the vibrations of the whole mass, particularly so at the *embouchure*, where the blast is introduced by which the tone is originated. It would appear from recent experiments that the pitch of a pipe is somewhat lower than the above theory would indicate.

Reed pipes. 86. The reed-pipe differs in many respects from the simple pipe which we have been considering. A small elastic strip of metal, fixed at one extremity (the *reed*), lies over a slit of the same shape, and is set in transverse vibration by a current of air acting underneath. If, as is the case in the accordion and harmonium, the reed is unprovided with a pipe, the pitch of its note is regulated altogether by the dimensions of the reed, in conformity with the law of tranversely vibrating plates; although, it is to be remarked, the note is really due to the vibrations of the air which alternately escapes through the slit of the reed, and is prevented doing so exactly as often as the reed executes a movement to and fro. The proper note of the reed itself is very poor and faint.

Influence of pipe on reed. 87. In the reed-pipe there is added above the reed a pipe the air in which partakes of the vibratory motion, and improves the quality of the sound. The pitch is, however, not affected by this pipe, unless it exceed a certain length l, when the pitch begins to fall, and continues to do so as l is increased, till, when the length of pipe is $2l$, the note is again restored to its original pitch, &c.

Weber's theory of reed pipe. 88. M. Weber, to whom we are indebted for these and other curious facts respecting reed pipes, has explained them thus:—If the reed be exactly at that part of the vibrating air-column where the air-displacements are at their maximum, and where consequently the air suffers no variation of density during the vibratory motion of the column, the oscillations of the reed are not at all affected by the air-vibrations, and consequently the pitch of the reed-pipe is the same as that of the reed itself. But if the reed be situated at any other part of the air-column, and especially at a nodal section, where the air is undergoing alternate condensation and rarefaction, then, when the air-blast from the wind chest pushes in the reed, the air in the pipe is in the act of rarefaction, and consequently tends to accelerate the reed inwards, whereas the elasticity of the reed tends in an opposite direction. When, again, the reed is passing to the other extreme of its vibration, the air in the pipe is in the act of condensation, and tends to accelerate the reed outwards or in the opposite direction to the elasticity of the reed. Hence the reed is affected just as if its elasticity, and therefore the rapidity of its vibrations, were diminished, and thus the pitch is lowered.

PART IX.

Singing Flames.

Gas harmonicon. 89. The *chemical* or *gas harmonicon*, which consists of a small flame of hydrogen or of coal gas, burning at the lower part of the interior of a glass tube, and giving out a very distinct note, exhibits considerable analogy with the reed-pipe. For, as Sondhaus seems to have established, the primary cause of the note lies in the oscillations of the gas within the burner and the feeding-pipe, which therefore play exactly the same part as does the reed portion of the reed-pipe. The air in the glass tube being heated by the flame ascends, and the pressure above the flame being thence diminished, the flame is forced upwards by the gas beneath, until an influx of atmospheric air at the top of the tube forces the flame back. Thus a periodic agitation of the flame ensues, accompanied by a corresponding disturbance of the air-column in the glass tube. The size of the flame and its position within the tube must be so regulated as to bring out the best possible note, which will then be found to be the same as the air in the tube would itself emit, according to the laws of pipes, allowance being made for the high temperature of the air. A series of tubes may thus be arranged of suitable lengths to give the common scale. It sometimes happens, particularly with short tubes, that the note will not come out spontaneously, all that is required, then, is either by blowing gently at the top of the tube, or by singing in unison with the *expected* note, to give to the air the requisite initial movement.

The flame, which burns steadily with a yellowish light before the tube sounds, will, as soon as the note is heard, be seen to flicker up and down, changing rapidly from yellow to blue and blue to yellow, its intensity also changing periodically. These fluctuations are best seen by viewing the image of the flame reflected by a small plane mirror, held in the hand and moved to and fro. Before the note is heard, the image of the then quiescent flame, being impressed on different points of the retina, appears as a continuous luminous strip; but, when the harmonicon speaks, the various images become quite detached from one another, showing that the portion of the retina over which the reflected light passes is sensibly affected only at certain points of it, which evidently correspond to the instants of time at which the flame, in its periodical fluctuations, is at its brightest.

90. Naked flames, that is, flames unaccompanied by tubes, may also give out musical notes, and many singular instances are mentioned by Tyndall and others of their sensitiveness to external sounds. Naked flames.

91. Koenig of Paris has constructed an apparatus intended to indicate the modes of vibration of the different parts of vibrating bodies, such as columns of air, &c., by means of flames, and to which he has given the name of the *Flame Manometer*. We will here describe its application to the case of organ-pipes. An open pipe has three apertures along one side, one at the middle, o (fig. 28), *i.e.*, at a node of the fundamental tone, and the two others, a, b, half way between o and the extremities of the pipe, and coinciding therefore with the nodes of the first overtone or octave. These openings are closed by thin flexible membranes forming the ends of small boxes or *capsules*, the spaces within which communicate by caoutchouc tubes with a coal-gas reservoir, and also by separate tubes with small gas burners arranged on a vertical stand. The gas being introduced, and the three flames kindled and adjusted to equal heights of about $\frac{3}{4}$ of an inch; if the pipe be made now to utter its first overtone, the flame connected with o will remain stationary and of the same brightness as before, but those communicating with a and b will become longer and thinner, and assume a bluish and faint luminosity. But, if the fundamental be brought out of the pipe, then it is o's flame that is violently affected, while those of a and b are scarcely affected at all. If the flames be originally made less in height (say $\frac{1}{4}$ inch), those of a and b in the former case, and of o in the latter, will be extinguished. These results are due to the condensations and rarefactions of the air in the pipe which are at their maximum at a node, causing the membrane placed there to vibrate outwards and inwards, and hence to force more or less of the gas into the burner. Flame manometer.

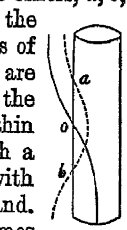


Fig. 28.

In order to compare together the notes of different pipes, four plane-reflecting surfaces are connected together in the form of a cube, which is mounted on a vertical axis about which it is capable of being turned round. Each pipe is

furnished with one opening, a membrane, &c. (as above), at its middle. As pointed out (§ 87), if any of the pipes be made to sound, the reflector being at the same time put in motion, a series of separate images will be seen. On sounding another pipe, whose fundamental is an octave higher, we shall have a second line of images separated from each other by half the interval of those in the former series. This is best observed when the two flames are placed in the same vertical line. If the note of the second pipe is a fifth higher than the first, and consequently its vibrations to those of the first as 3 to 2, then the same space which contains two images of the lower note will contain three of the higher, and so on, for other combinations. When more complicated ratios are to be tested, it is preferable to connect both capsules with the same burner, either with or without the reflector.

Part X.

Communication of Vibrations.

Communication between gases, solids, and liquids.

92. The communication of sonorous vibrations from one body to another plays so essential a part in acoustics that a few words must here be given to the subject. It appears to be well established that while the vibrations of a solid are in general most readily communicated to other solids in contact with it, they are not so to liquids, and still less so to air and other aeriform fluids. Thus, a tuning-fork is inaudible at any moderate distance unless applied to a table, by whose extended surface the air can be more intensely affected. So likewise a musical string sounds very poorly unless connected with a resonant cavity or wooden chest, to the wood of which it first imparts its vibratory motion, which then produces stationary waves in the continued air.

Kundt's experiments.

93. A few years ago M. Kundt made known a method founded on the communicability of vibration, by which the velocities of sound in different media may be compared together with great facility. Take a glass tube 3 feet or upwards in length, drop into it a small quantity of the fine powder of the club-moss or lycopodium, and turn the tube round so as to spread the powder over the internal surface of the tube. Stop both ends of the tube with corks, clamp it at its centre, and rub one of its halves lengthwise with a moist cloth, so as to cause the glass to sound a note. It will then be found that, the air within the tube taking up the motion, and a stationary wave being formed in it, the powder is driven off from the ventral segments and forms little heaps at the nodes. The dust-heaps are, by the laws of stationary waves, separated therefore from each other by intervals each equal to half the length of an air-wave, or $\frac{\lambda}{2}$. If, then, the number of heaps $=m$, and the length of the tube $=l$; $\lambda=\frac{2l}{m}$.

But, by the laws of longitudinal vibrations of rods, the length λ' of the glass-wave $=4\left(\frac{l}{2}\right)=2l$. Hence $\frac{\lambda'}{\lambda}=m$, that is, the number of dust-heaps is equal to the ratio of the lengths of a wave of sound in glass and in air, and consequently to the ratio of the velocities of sound in those media. (For the vibrations being in unison, their number in a given time must be the same for the glass and the air, *i.e.*, $\frac{V}{\lambda'}=\frac{V}{\lambda'}$; V, V′ being the velocities).

Kundt found 16 to be the number of heaps; prior experiments of a different kind had, as we have before mentioned, given this as the number of times that the velocity of sound in glass exceeds its velocity in air.

Instead of producing the air-vibrations by friction of the tube containing the air, it is preferable to make use of a smaller tube or rod, furnished with a cork at one end, which fits like a piston into the tube, and projecting at its outer end through an opening in the cork which closes the air-tube. The rod thus inserted is the one which is rubbed longitudinally and communicates its vibrations to the air in the enclosing tube. By means of an apparatus of this kind, Kundt determined the ratio to the velocity of sound in air of its velocity in various solids, and also (replacing the air in the tube by different gases) of its velocity in these gases.

Part XI.

Interference of Sound.

Meaning of interference.

94. When two or more sonorous waves travel through the same medium, each particle of the air being simultaneously affected by the disturbances due to the different waves, moves in a different manner than it would if only acted on by each wave singly. The waves are said mutually to interfere. We shall exemplify this subject by considering the case of two waves travelling in the same direction through the air. We shall then obviously be led to the following results:—

Two waves of equal lengths.

95. If the two waves are of equal length λ, and are in the same phase (that is, each producing at any given moment the same state of motion in the air-particles), their combined effect is equivalent to that of a wave of the same length λ, but by which the excursions of the particles are increased, being the sum of those due to the two component waves respectively.

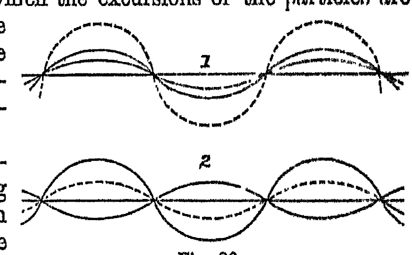


Fig. 29.

If the two interfering waves, being still of same length λ, be in opposite phases, or so that one is in advance of the other by $\frac{\lambda}{2}$, and consequently one produces in the air the opposite state of motion to the other, then the resultant wave is one of the same length λ, but by which the excursions of the particles are decreased, being the difference between those due to the component waves. If the amplitudes of vibration which thus mutually interfere are moreover equal, the effect is the total mutual destruction of the vibratory motion.

Thus we learn that two musical notes, of the same pitch, conveyed to the ear through the air, will produce the effect of a single note of the same pitch, but of increased loudness, if they are in the same phase, but affect the ear very slightly, if at all, when in opposite phases. If the difference of phase be varied gradually from zero to $\frac{1}{2}\lambda$, the resulting sound will gradually decrease from a maximum to a minimum.

Experimental illustrations.

96. Among the many experimental confirmations which may be adduced of these proportions, we will mention the following:—

Vibrating plate.

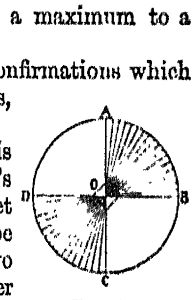


Fig. 30.

Take a circular plate, such as is available for the production of Chladni's figures (§ 71), and cut out of a sheet of pasteboard a piece of the shape ABOCD (fig. 30), consisting of two circular quadrants of the same diameter as the plate. Let, now, the plate be made in the usual manner to vibrate so as to exhibit two nodal lines coinciding with two rectangular diameters. If the ear be placed right above the centre of the plate, the sound will be scarcely audible. But, if the pasteboard be interposed so as to intercept the vibrating segments AOB, DOC, the note becomes much more distinct. The reason

of this is, that the segments of the plate AOD, BOC always vibrate in the same direction, but oppositely to the segments AOB, DOC. Hence, when the pasteboard is in its place, there are two waves of same phase starting from the two former segments, and reaching the ear after equal distances of transmission through the air, are again in the same phase, and produce on the ear a conjunct impression. But when the pasteboard is removed, then there is at the ear opposition of phase between the first and the second pair of waves, and consequently a minimum of sound.

Hopkins's experiment.

97. A tubular piece of wood shaped as in fig. 31, and having a piece of thin membrane stretched over the opening at the top C, some dry sand being strewn over the membrane, is so placed over a circular or rectangular vibrating plate, that the ends A, B lie over the segments of the plate, such as AOD, COB in the previous fig., which are in the same state of motion. The sand at C will be set in violent movement. But if the same ends A, B, be placed over oppositely vibrating segments (such as AOD, COD), the sand will be scarcely, if at all, affected.

Fig. 31.

Tuning fork.

98. If a tuning-fork in vibration be turned round before the ear, four positions will be found in which it will be inaudible, owing to the mutual interference of the oppositely vibrating prongs of the fork. On interposing the hand between the ear and either prong of the fork when in one of those positions, the sound becomes audible, because then one of the two interfering waves is cut off from the ear. This experiment may be varied by holding the fork over a glass jar into which water is poured to such a depth that the air-column within reinforces the note of the fork when suitably placed and then turning the fork round.

Double syren.

99. Helmholtz's double syren (§ 51) is well calculated for the investigation of the laws of interference of sound. For this purpose a simple mechanism is found in the instrument, by means of which the fixed upper plate can be turned round and placed in any position relatively to the lower one. If, now, the apparatus be so set that the notes from the upper and lower chest are in unison, the upper fixed plate may be placed in four positions, such as to cause the air-current to be cut off in the one chest at the exact instant when it is freely passing through the other, and *vice versa*. The two waves, therefore, being in opposite phases, neutralise one another, and the result is a faint sound. On turning round the upper chest into any intermediate position, the intensity of the sound will increase up to a maximum, which occurs when the air in both chests is being admitted and cut off contemporaneously.

Flame manometer.

100. If two pipes, in exact unison, and furnished with flame manometers, are in communication with the same wind-chest, and the two flames be placed in the same vertical line, on introducing the current from the bellows, we shall find that the two lines of reflected images will be so related that each image in one lies between two images in the other. This shows that the air-vibrations in one pipe are always in an opposite phase to the other, or that condensation is taking place in the one when rarefaction occurs in the other. This arises from the current from the bellows passing alternately into the one and the other pipe. There will also be a remarkable collapse of the sound when both pipes communicate with the wind-chest compared with that produced from one pipe alone.

Interference of two sets of vibrations for which $\frac{n}{n'}=\frac{m}{m'}$.

101. If the two interfering waves are such as produce vibrations whose numbers per second are n, n' respectively, these being to each other in the ratio of two integers m, m' when expressed in its lowest terms, then the lengths of the waves λ, λ' being inversely as n to n', will be to each other as $m':m$, and consequently $m\lambda=m'\lambda'$. Particles therefore of the air separated by this distance from each other will be in the same phase, that is, the length of the *resultant* wave will be $m\lambda$ or $m'\lambda'$, and if N denote the corresponding number of vibrations $N=\frac{n}{m}$ or $\frac{n'}{m'}$.

Fundamental and octave.

Thus, for the fundamental and its octave $\frac{n}{n'}=\frac{1}{2}$, and therefore $N=n$ or $\frac{n}{2}$; that is, the note of interference is of the same pitch as the fundamental.

Fundamental and major third.

For the fundamental and its major third, $\frac{n}{n'}=\frac{4}{5}$. Hence $N=\frac{n}{4}$ or $\frac{n'}{5}$, that is, the resulting sound is two octaves lower than the fundametal.

Fundamental and major sixth.

For the fundamental and its major sixth, $\frac{n}{n'}=\frac{3}{5}$; N therefore $=\frac{n}{3}$ or $\frac{n'}{5}$, and the resulting sound is a twelfth below the lower of the two interfering notes.

Case of $m-m'=1$.

If m and m' differ by 1, then $N=n-n'$; for $m-m'$ or $1=\frac{n}{N}-\frac{n^1}{N}$. Hence, if the ratio of the vibrations of two interfering sounds is expressible in its lowest terms by numbers whose difference is unity, the resulting note has a number of vibrations simply equal to the difference of those of the interfering notes.

The results stated in this section may be tested on a harmonium. Thus, if the notes B, C, at the extreme right of the instrument be struck together, there will be heard an interference note four octaves lower in pitch than the above C, because the interval in question being a semitone, is $\frac{16}{15}$, and, consequently, by last case, the interference note is lower than the C by interval $\frac{1}{16}$.

Other notes may be heard resulting from the mutual interference of the overtones.

Beats

102. When two notes are not quite in tune, the resulting sound is found to alternate between a maximum and minimum of loudness recurring periodically. To these periodical alternations has been given the name of *Beats*. Their origin is easily explicable. Suppose the two notes to correspond to 200 and 203 vibrations per second; at some instant of time, the air-particles, through which the waves are passing, will be similarly displaced by both, and consequently the joint effect will be a sound of some intensity. But, after this, the first or less rapidly vibrating note will fall behind the other, and cause a diminution in the joint displacements of the particles, till, after the lapse of $\frac{1}{6}$ of a second, it will have fallen behind the other by $\frac{1}{2}$ a vibration. At this moment, therefore, opposite displacements will be produced of the air-particles by the two notes, and the sound due to them will be at a minimum. This will be followed by an increase of intensity until the lapse of another sixth of a second, when the less rapidly vibrating note will have lost another half-vibration relatively to the other, or one vibration reckoning from the original period of time, and the two component vibrations will again conspire and reproduce a maximum effect. Thus, an interval of $\frac{1}{3}$ of a second elapses between two successive maxima or beats, and there are produced three beats per second. By similar reasoning it may be shown that the number of beats per second is always equal to the difference between the numbers of vibrations in the same time corresponding to the two interfering notes. The more, therefore, these are out of tune, the more rapidly will the beats follow each other.

Beats are also heard, though less distinctly, when other concords such as *thirds*, *fifths*, &c., are not perfectly in tune; thus, 200 vibrations and 303 vibrations per second, which form, in combination, an imperfect fifth, produce beats occurring at the rate of three per second.

Examples of beats. 103. The phenomena of beats may be easily observed with two organ-pipes put slightly out of tune by placing the hand near the open end of one of them, with two musical strings on a resonant chest, or with two tuning-forks of same pitch held over a resonant cavity (such as a glass jar, *vid.* § 97), one of the forks being put out of tune by loading one prong with a small lump of bees'-wax. In the last instance, if the forks are fixed on one solid piece of wood which can be grasped with the hand, the beats will be actually felt by the hand. If one prong of each fork be furnished with a small plain mirror, and a beam of light from a luminous point be reflected successively by the two mirrors, so as to form an image on a distant screen, when one fork alone is put in vibration, the image will move on the screen and be seen as a line of a certain length. If both forks are in vibration, and are perfectly in tune, this line may either be increased or diminished permanently in length, according to the difference of phase between the two sets of vibrations. But if the forks be not quite in tune, then the length of the image will be found to fluctuate between a maximum and a minimum, thus making the beats sensible to the eye. The vibrograph (§ 52, 53) is also well suited for the same purpose, and so in an especial manner is Helmholtz' double syren (§ 51), in which, by continually turning round the upper box, a note is produced by it more or less out of tune with the note formed by the lower chest, according as the handle is moved more or less rapidly, and most audible beats ensue. The gas harmonica and the flame manometer also afford excellent illustrations of the laws of beats.

The number of vibrations of a note found by beats. 104. Advantage has been taken of these laws for the purpose of determining the absolute number of vibrations per second corresponding to any given note in music, whence may be derived the number for all the other notes (§ 45). The human ear may be regarded as most correctly appreciating two notes differing by an octave. Two tuning-forks then are taken, giving respectively the note A and its lower octave, and a number of other forks are prepared intermediate in pitch to these, say 54, and by means of bees'-wax these are so tuned, that the first gives four beats with the A fork, the second four beats with the fourth, and so on up to the last, which also gives four beats with the A_{-1} fork. Now, if $n=$ the unknown number of vibrations for the note A, $n-4$, $n-8$ ... $n-55\times 4$, will be the numbers for all the successive forks down to the A_{-1} fork, which being an octave below A, we have $\frac{n-55\times 4}{n}=\frac{1}{2}$ and consequently $n=440$.

Tuning by beats. 105. Beats also afford an excellent practical guide in the tuning of instruments, but more so for the higher notes of the register, inasmuch as the same number of beats, that is, the same difference between the numbers of vibrations, for two notes of high pitch, indicates greater deviation from perfect unison, than it does for two notes of low pitch. Thus, two low notes of 32 and 30 vibrations respectively, whose interval is therefore $\frac{32}{30}$ or $\frac{16}{15}$ *i.e.*, a semitone, give two beats per second, while the same number of beats are given by notes of 32×16 (four octaves higher than the first of the preceding) or 512 and 514 vibrations, which are only slightly out of tune.

Irritating effect of rapid beats. 106. As the interval between two notes, and consequently the number of beats increases, the effect on the ear becomes more and more unpleasant, and degenerates at last into an irritating rattle. With the middle notes of the musical register, this result occurs when the number of beats comes up to 20 or 30 per second, the musical interval between the two interfering notes being then between half and a whole tone. Helmholtz attributes the disagreeable impression of beats on the ear, to the same physiological cause to which is due the painful effect on the eye of a faint flickering light, as, for instance, the light streaming through a wooden paling with intervening openings when the individual affected is passing alongside. In this case, the retina, which, when continuously receiving the same amount of light, thereby loses its sensitiveness in a great degree, is unable to do so.

It is, however, remarked by the above-mentioned author that the same number of beats, which has so irritating an effect when due to two notes in the middle of the register, is not attended by the same result when due to notes of much lower pitch. Thus, the notes C, D forming a tone give together 33 beats per second, while a note two octaves lower than C also gives 33 beats with its fifth; yet the former combination forms a discord, the latter a most pleasing concord.

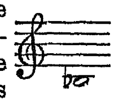
107. When the number of beats reaches to 132 or upwards per second, the result is a continuous and not unpleasing impression on the ear, and it was formerly held that the effect was always equivalent to that of a note having that number of vibrations. Helmholtz has shown that this opinion is inaccurate, except when the interfering tones are very loud, and consequently accompanied by very considerable displacements of the particles of the vibrating medium. These resultant tones being, as to their vibration-number, equal to the difference between the numbers corresponding to the two primaries, are termed *difference-tones*, and may be best observed with the double syren. The same author was led also, on theoretical grounds, to surmise the formation of *summation-tones* by the interference of two loud primaries, the number of resultant vibrations being then equal to the sum of the numbers for the two components, and appealed for experimental proof to his syren. But, at the last meeting of the British Association (1872), Koenig, the celebrated Parisian acoustician, maintained that the notes of the syren, thus held to be summation-tones, were in reality the *difference-tones* of the harmonics. Difference tones. Summation-tones.

108. By reference to the laws of the interference of vibrations, Helmholtz has been enabled to offer a highly satisfactory explanation of the cause whence arises difference of quality or timbre or acoustic colour between different sounds. He has shown conclusively that there are but few sounds which are of a perfectly simple character, that is, in which the fundamental is not accompanied by one or more overtones. Now, when a note is simple, there can be no jarring on the ear, because there is on room for interference of sound. Hence, the softness of the tuning-fork when its fundamental is reinforced by a resonant cavity, and also of the flute. The same character of softness belongs also to those instruments in which the powerful harmonics are limited to the vibration ratios 2, 3 ... 6 (§ 57, 80); because the mutual interference of the fundamental and their harmonics give rise to concords only. The piano, the open organ pipe, the violin, and the softer tones of the human voice, are of this class. But if the *odd* harmonics alone are present, as in the narrow stopped organ pipe, and in the clarionet, then the sound is poor, and even nasal; and if the higher harmonics beyond the sixth or seventh are very marked, the result is very harsh (as in reed-pipes). Helmholtz's explanation of acoustic colour

109. The *human voice* (for a description of the organ in which it originates, we refer to Art. *Physiology—Voice and Speech*) is regarded by the best authorities as being analogous to a reed-pipe, the vocal chords forming the reed, and the cavity of the mouth the pipe, and, like the reed, is rich in harmonics, as many as sixteen having been detected in a base voice. But their number and relative intensities differ much in different individuals, or even in the same person at different times; and it is on this variety that, agreeably to Helm- Voice.

holtz's theory of timbre, the peculiarities depend by which any one voice may be unmistakably distinguished from every other. Voices in which overtones abound are sharp, and even rough; those in which they are few or faint, are soft and sweet. In every voice, however, the number and relative intensity of the overtones depend on the form assumed by the cavity of the mouth, which acts relatively to the vocal chords precisely as a *resonator* does to a tuning-fork, or a pipe to a reed. This may be easily tested by holding a tuning-fork before the open mouth, when, by giving to the cavity a suitable form, the fundamental or some overtone of the fork may be heard distinctly reverberated from the interior of the mouth. Each vowel sound, as Helmholtz has shown, is simply the result of the reinforcements by the air in the cavity of the mouth, and its prolongation towards the larynx, of one or in some cases two overtones of determinate pitch, contained in the sound which proceeds from the vocal chords. Koenig assigns the following notes as characteristic of the simpler vowel sounds (adopting the foreign pronunciation):—To U, the note B♭ below the line in the G clef, corresponding to 225 vibrations per second; to O, the next higher octave, consequently of double the number of vibrations, and thence ascending by octaves for A, E, and I, the last of which is therefore characterised by a note of 3600 vibrations per second.

Vowel sounds.



The above theory of vowel sounds may be satisfactorily confirmed by means of tuning-forks, vibrating in front of resonant cavities, which can, by suitable combination, be made to utter any vowel sound.

Works on Acoustics.

Chladni, *Traité d'Acoustique*. Paris, 1809.
Herschel, Sir John. *Encycl. Metrop.*, art. "Sound." London, 1830.
Tyndall, *Lectures on Sound*, 2d edit. London, 1869.
Helmholtz, *Die Lehre von der Tonempfindungen*, 3d edit. Braunschweig, 1870, of which there is a French translation, and an English one is promised.

Besides the above, some account of the subject is to be found in such general works on Physics as Ganot's, 14th edit., Paris, 1870, of which a translation is published by Longmans, London; Deschanel's *Natural Philosophy*, translated by Prof. Everett, London, 1873; Jamin, *Cours de Physique*, 3d edit., Paris, 1871; Wüllner, *Physik*, 2d edit., Leipzig, 1870. (D. T.)

ALPHABETICAL INDEX.

The numerals refer to the sections.

ACQUI, a town of Northern Italy, in the province of Alessandria, 18 miles S.S.W. of the city of that name, on the left bank of the Bormida. It is a place of great antiquity; and its hot sulphur baths, which are still much frequented, were known to the Romans, who gave the place the name of *Aquæ Statiellæ*. There are still to be found numerous ancient inscriptions, and the remains of a Roman aqueduct. The town is the seat of a bishop, and has a fine cathedral, several convents, and a royal college. Good wine is produced in the vineyards of the district, and great attention is given to the rearing of silk-worms. There are also considerable silk manufactures. Population, 8600.

ACRE, a measure of surface, being the principal denomination of land-measure used in Great Britain. The word (akin to the Saxon *acer*, the German *acker*, and the Latin *ager*, a field) did not originally signify a determinate quantity of land, but any open ground. The English standard or imperial acre contains 4840 *square yards*, or 10 square chains, and is also divided into *roods*, of which it contains 4, the rood again being divided in 40 *perches*. The imperial acre has, by the Act 5 Geo. IV. c. 74, superseded the acres, of very different extent, that were in use in different parts of the country. The old Scottish acre was equal to 1·26118345 imperial acres. The Irish acre contains 7840 square yards. The acre is equivalent to ·40467, *i.e.*, about $\frac{2}{5}$ths, of the French *hectare* (now the basis of superficial measurement in Germany, Italy, and Spain, as well as in France), ·7 of the Austrian *joch*, ·37 of the Russian *desätine*, and 1·62 ancient Roman *jugera*. The *hectare* corresponds to 2 acres 1 rood 35·38 perches.

ACRE, AKKA, or ST JEAN D'ACRE, a town and seaport of Syria, and in ancient times a celebrated city. No town has experienced greater changes from political revolutions and the calamities of war. According to some this was the *Accho* of the Scriptures; and its great antiquity is proved by fragments of houses that have been found, consisting of that highly sun-burnt brick, with a mixture of cement and sand, which was only used in erections of the remotest ages. It was known among the ancients by the name of *Ace*, but it is only from the period when it was taken possession of by Ptolemy Soter, king of Egypt, and received from him the name of *Ptolemais*, that history gives any certain account of it. When the empire of the Romans began to extend over Asia, Ptolemais came into their possession. It is mentioned by Strabo as a city of great importance; and fine granite and marble pillars, monuments of its ancient grandeur, are still to be seen. During the Middle Ages Ptolemais passed into the hands of the Saracens. They were expelled from it in 1110 by the Crusaders, who made it their principal port, and retained it until 1187, when it was recovered by Saladin. In 1191 it was retaken by Richard I. of England and Philip of France, who purchased this conquest by the sacrifice of 100,000 troops. They gave the town to the knights of St John of Jerusalem, from whom it received the name of St Jean D'Acre. In their possession it remained for a century, though subject to continual assaults from the Saracens. It was at this time a large and extensive city, populous and wealthy, and contained numerous churches, convents, and hospitals, of which no traces now remain. Acre was finally lost to the Crusaders in 1291, when it was taken by the Saracens after a bloody siege, during which it suffered severely. From this time its prosperity rapidly declined. In 1517 it fell into the hands of the Turkish sultan, Selim I.; and in the beginning of the 18th century, with the exception of the residences of the French factors, a mosque, and a few poor cottages, it presented a vast scene of ruin. Towards the end of that century Acre was much strengthened and improved by the Turks, particularly by Djezzar Pacha, and again rose to some importance. It is memorable in modern history for the gallantry with which it was defended in 1799 by the Turks, assisted by Sir Sydney Smith, against Bonaparte, who, after spending sixty-one days before it, was obliged to retreat. It continued to enjoy an increasing degree of prosperity till 1832. Though fettered by imposts and monopolies, it carried on a considerable foreign trade, and had resident consuls from most of the great states of Europe. On the revolt of Mehemet Ali, the pacha of Egypt, Acre was besieged by his son, Ibrahim Pacha, in the winter of 1831–32. The siege lasted five months and twenty-one days, and, before the city was taken, its public and private buildings were mostly destroyed. Its fortifications were subsequently repaired and improved by the Egyptians, in whose hands it remained until 3d Nov. 1840, when the town was reduced to ruins by a three hours' bombardment from the British fleet, acting as the allies of the sultan. The Turks were again put in possession of it in 1841.

Acre is situated on a low promontory, at the northern extremity of the Bay of Acre. The bay affords no shelter in bad weather; and the port is scarcely capable of containing a dozen boats. Vessels coming to this coast, therefore, generally frequent the anchorage of Caiffa, on the south side of the bay. Acre is 80 miles N.N.W. of Jerusalem, and 27 S. of Tyre. Population, 10,000.

ACROBAT (from ἀκροβατέω, to walk on tiptoe), a rope-dancer. Evidence exists that there were very skilful performers on the tight-rope (*funambuli*) among the ancient Romans. Modern acrobats generally use a long pole, loaded at the ends, and by shifting this are enabled to maintain, or readily to recover, their equilibrium. By an extension of the meaning of the term, acrobatic feats now include trapèze leaping and similar performances.

ACROCERAUNIA, in *Ancient Geography*, a promontory in the N.W. of Epirus, which terminates the Montes Ceraunii, a range that runs S.E. from the promontory along the coast for a number of miles, and is supposed to have derived its name from being often struck with lightning. The cape (now called *Glossa* by the Greeks, and *Linguetta* by the Italians) is in lat. 40° 25′ N.

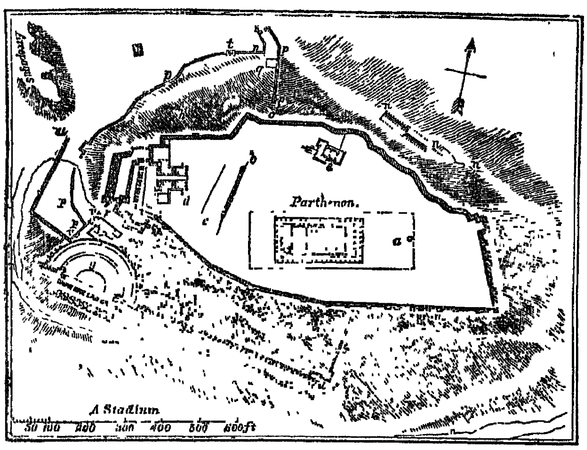
ACROGENÆ is the name applied to a division of acotyledonous or cryptogamous plants, in which leaves are present along with vascular tissue. In the higher divisions of Acrogens, as ferns and lycopods, the tissue consists of scalariform vessels, while in the lower divisions spiral cells are observed, which take the place of vessels. The term Acrogen means summit-grower, that is, a plant in which the stem increases specially by the summit. This is not, however, strictly accurate.

ACROLITH (ἀκρόλιθοι), statues of a transition period in the history of plastic art, in which the trunk of the figure was of wood, and the head, hands, and feet of marble. The wood was concealed either by gilding or, more commonly, by drapery, and the marble parts alone were exposed. Acroliths are frequently mentioned by Pausanias, the best known specimen being the Minerva Areia of the Platæans.

ACRON, a celebrated physician, born at Agrigentum in Sicily, who was contemporary with Empedocles, and must therefore have lived in the 5th century before Christ. The successful measure of lighting large fires, and purifying the air with perfumes, to put a stop to the pestilence that raged in Athens (430 B.C.), is said to have originated with him; but this has been questioned on chronological grounds. Pliny is mistaken in saying that Acron was the founder of the sect of the Empirici, which did not exist until the 3d century before Christ. The error probably arose from a desire on the part of the sect to establish for itself a greater antiquity than that of the Dogmatici. Suidas gives the titles of several works written by Acron.

on medical subjects, in the Doric dialect, but none of these now exist.

ACROPOLIS (Ἀκρόπολις), a word signifying the upper town, or chief place of a city, a citadel, usually on the summit of a rock or hill. Such buildings were common in Greek cities; and they are also found elsewhere, as in the case of the Capitol at Rome, and the Antonia at Jerusalem; but the most celebrated was that at Athens, the remains of which still delight and astonish travellers. It was enclosed by walls, portions of which show traces of extreme antiquity. It had nine gates; the principal one was a splendid structure of Pentelican marble, in noble Doric architecture, which bore the name of *Propylaia*. Besides other beautiful edifices, it contains the Παρθενών, or temple of the virgin goddess Athene, the most glorious monument of ancient Grecian architecture.



Ground plan of the Acropolis of Athens.

a, Pedestal of Rome and Augustus.
b, *c*, *d*, Sites of temples of Minerva, Diana, and Venus.
e, Erectheium.
f, Dionysiac theatre.
g, Odeon of Herodes.
h and *o*, Grottoes.
i, Ruined mosque.
k, *l*, Gate and portico.
m, Choragic monument of Thrasycles, now church of our lady of the grotto.
n, *n*, Remains of Pelasgic wall.
p, *u*, Walls of outworks, &c.
s, Gate to Propylæa.
q, *r*, *t*, Forts.
u, *v*, Ancient walls.

ACROSTIC (from ἄκρος and στίχος, meaning literally the extremity of a verse), is a species of poetical composition, so constructed that the initial letters of the lines, taken consecutively, form certain names or other particular words. This fancy is of considerable antiquity, one of the most remarkable examples of it being the verses cited by Lactantius and Eusebius in the 4th century, and attributed to the Erythræan sibyl, the initial letters of which form the words Ἰησοῦς Χριστὸς Θεοῦ υἱὸς σωτήρ: "Jesus Christ, the Son of God, the Saviour," with the addition, according to some, of σταυρός, "the cross." The initials of the shorter form of this again make up the word ἰχθύς, to which a mystical meaning has been attached (Augustine, *De Civitate Dei*, 18, 23), thus constituting another kind of acrostic. The arguments of the comedies of Plautus, with acrostics on the names of the respective plays, are probably of still earlier date. Sir John Davies (1570–1626) wrote twenty-six elegant *Hymns to Astræa*, each an acrostic on "Elizabetha Regina;" and Mistress Mary Fage, in *Fame's Roule*, 1637, commemorated 420 celebrities of her time in acrostic verses. The same form of composition is often to be met with in the writings of more recent versifiers. Sometimes the lines are so combined that the final letters as well as the initials are significant. Edgar Allan Poe, with characteristic ingenuity, worked two names—one of them that of Frances Sargent Osgood—into verses in such a way that the letters of the names corresponded to the first letter of the first line, the second letter of the second, the third letter of the third, and so on.

Generally speaking, acrostic verse is not of much value, and is held in slight estimation. Dr Samuel Butler says, in his "Character of a Small Poet," "He uses to lay the outsides of his verses even, like a bricklayer, by a line of rhyme and acrostic, and fill the middle with rubbish." Addison (*Spectator*, No. 60) found it impossible to decide whether the inventor of the anagram or the acrostic were the greater blockhead; and, in describing the latter, says, "I have seen some of them where the verses have not only been edged by a name at each extremity, but have had the same name running down like a seam through the middle of the poem." And Dryden, in *Mac Flecknoe*, scornfully assigned Shadwell the rule of

"Some peaceful province in acrostic land."

The name acrostic is also applied to alphabetical or "abecedarian" verses. Of these we have instances in some of the Hebrew psalms (*e.g.*, Ps. xxv. and xxxiv.), the successive verses of which begin with the letters of the alphabet in their order. The structure of Ps. cxix. is still more elaborate, each of the verses of each of the twenty-two parts commencing with the letter which stands at the head of the part in our English translation. Alphabetical verses have been constructed with every word of the successive lines beginning with the successive letters of the alphabet.

By an extended use of the term acrostic, it is applied to the formation of words from the initial letters of other words. Ἰχθύς, referred to above, is an illustration of this. So also is the word "Cabal," which, though it was in use before, with a similar meaning, has, from the time of Charles II., been associated with a particular ministry, from the accident of its being composed of Clifford, Ashley, Buckingham, Arlington, and Lauderdale. Akin to this are the names by which the Jews designated their Rabbis; thus Rabbi Moses ben Maimon (better known as Maimonides), was styled "Rambam," from the initials R. M. B. M.; Rabbi David Kimchi (R. D. K.), "Radak," &c.

A species of puzzle, scarcely known twenty years ago, but very common now (see *English Catalogue*, 1863–71, *s. v.* Acrostics), is a combination of enigma and double acrostic, in which words are to be guessed whose initial and final letters form other words that are also to be guessed. Thus Sleep and Dream may have to be discovered from the first and last letters of Sound, Lover, Europe, Elia, and Palm, all expressed enigmatically.

ACT, in *Dramatic Literature*, signifies one of those parts into which a play is divided to mark the change of of time or place, and to give a respite to the actors and to the audience. In Greek plays there are no separate acts, the unities being strictly observed, and the action being continuous from beginning to end. If the principal actors left the stage the chorus took up the argument, and contributed an integral part of the play, though chiefly in the form of comment upon the action. When necessary, another *drama*, which is etymologically the same as an *act*, carried on the history to a later time or in a different place, and thus we have the Greek trilogies or groups of three dramas, in which the same characters reappear. The Roman poets first adopted the division into acts, and suspended the stage business in the intervals between them. Their number was usually five, and the rule was at last laid down by Horace in the *Ars Poetica*—

"Neve minor, neu sit quinto productior actu
Fabula, quæ posci vult, et spectata reponi."

"If you would have your play deserve success,
Give it five acts complete, nor more nor less."
—*Francis.*

On the revival of letters this rule was almost universally observed by dramatists and that there is an inherent con-

venience and fitness in the number five is evident from the fact that Shakespeare, who refused to be trammelled by merely arbitrary rules, adopts it in all his plays. Some critics have laid down rules as to the part each act should sustain in the development of the plot, but these are not essential, and are by no means universally recognised. In comedy the rule as to the number of acts has not been so strictly adhered to as in tragedy, a division into two acts or three acts being quite usual since the time of Molière, who first introduced it.

It may be well to mention here Milton's *Samson Agonistes* as a specimen in English literature of a dramatic work founded on a purely Greek model, in which, consequently, there is no division into acts.

ACT, in *Law*, is an instrument in writing for declaring or justifying the truth of anything; in which sense records, decrees, sentences, reports, certificates, &c., are called *acts*. The origin of the legal use of the word *Act* is in the *acta* of the Roman magistrates or people, of their courts of law, or of the senate, meaning (1) what was done before the magistrates, the people, or the senate; (2) the records of such public proceedings.

ACT OF PARLIAMENT. An Act of Parliament may be regarded as a declaration of the Legislature, enforcing certain rules of conduct, or defining rights and conferring them upon or withholding them from certain persons or classes of persons. The collective body of such declarations constitutes the statutes of the realm or written law of the nation, in the widest sense, from Anglo-Saxon times to the present day. It is not, however, till Magna Charta that, in a more limited constitutional sense, the statute-book is generally held to open, and the Parliamentary records only begin to assume distinct outlines late in the reign of Edward I. The maladministration of the common law by the royal judges had gradually taught the people the necessity of obtaining written declarations of their rights—often acknowledged, still oftener violated. Insensibly almost, the Commons, whose chief function it originally was to vote supplies to the crown, began to couple their grants with petitions for the redress of grievances. The substance of these petitions and of the royal responses was in time made the groundwork of Acts which, as framed by court redactors, and appearing annexed to proclamation-writs after the dissolution of Parliament, were frequently found seriously to misrepresent its will. To check this evil an Act was passed (8 Henry IV.), authorising the Commons to be represented at the engrossing of the Parliament roll; but even this surveillance was not enough, for in the beginning of the reign of Henry V. it was enacted, at the instance of the Commons, that in regard to their petitions the royal prerogative should in future be limited to granting or refusing them *simpliciter*. In this way it became a fixed constitutional principle that an Act of Parliament, to be valid, must express concurrently the will of the entire Legislature. It was not, however, till the reign of Henry VI. that it became customary, as now, to introduce bills into Parliament in the form of finished Acts; and the enacting clause, regarded by constitutionalists as the first perfect assertion, in words, of popular right, came into general use as late as the reign of Charles II. It is thus expressed:—"Be it enacted by the King's most excellent Majesty, by and with the advice and consent of the Lords Spiritual and Temporal and Commons in this present Parliament assembled, and by the authority of the same." The use of the preamble with which Acts are usually prefaced, is thus quaintly set forth by Lord Coke,—"The rehearsal or preamble of the statute is a good meane to find out the meaning of the statute, and, as it were, a key to open the understanding thereof." Originally, the collective Acts of each session formed but one statute, to which a general title was attached, and for this reason an Act of Parliament is always cited as the chapter of a particular statute—*e.g.*, 24 and 25 Vict. c. 101. Titles were, however, prefixed to individual Acts as early as 1488. Since 33 Geo. III. c. 13, an Act of Parliament is complete whenever it receives the royal assent, and takes effect from that date, unless the Act itself fix some other. British Acts require no formal promulgation, for it is presumed that every subject of the realm is cognisant of the resolutions of Parliament, either by himself or his representative therein.

Modern Acts of Parliament are—1. *Public*. These are binding on all citizens, and are *ex officio* cognisable by the judges. Since 1850 every Act is held to be public unless the contrary be expressly declared. 2. *Private Acts*. These relate to particular classes, persons, or places. Private Acts are (1.) Personal, viz., those which relate to name, naturalisation, estate, &c., of particular persons. (2.) Local, affecting bridges, canals, docks, turnpikes, railways, &c. To prevent such Acts from being unduly passed, the promoters of private bills are required to comply with the standing orders of the two Houses, by which private bill procedure is regulated. Acts of Parliament, for convenience of reference, are classified as Public General Acts, Local and Personal Acts declared Public, Private Acts printed, and Private Acts not printed. Public General Acts (if no exception be expressed), extend to Great Britain and Ireland, exclusively only of the Channel Islands and the Isle of Man.

The first complete edition of English Acts of Parliament published by state authority appeared between the years 1810 and 1824. It includes the early charters, and ends with the reign of Queen Anne. Many private editions of the statutes had appeared previous to that of the Record Commissioners. The practice of printing Acts of Parliament commenced in the reign of Richard III. The charters and Acts were written in Latin till the *Statutum de Scaccario*, 51 Henry III. (1266), which is in French. The Acts of Edward I. are indiscriminately in Latin or French; but from the fourth year of Henry VII. Acts are exclusively in English.

Scotch Acts.—The earliest attempts at a written record of the proceedings of the Parliament of Scotland consisted of detached instruments or indentures, and the next step was the entering of these detached instruments on a roll for more permanent preservation. No such record, however, is preserved before the disputed succession, which commenced in 1289. The earliest roll of *placita in parliamento* is dated 1292; but the *Blak Buik*, containing a series of proceedings in Parliament from 1357 to 1402, is the most important of the earliest records of Parliament. The original books of Parliament of the reigns of James I. and James II. are not preserved, but from the year 1466 down to the Union a voluminous, but not unbroken, series has been preserved. Down to the reign of James V., scarcely any Act in the original registers is distinguished by a title or rubric; and even after that period the practice has not in this respect been uniform. In like manner there is no numeration of the Acts of Parliament during this period. The language of the earliest Scotch records is in Latin; but as early as 1398 some of the proceedings of Parliament or the Council-General were written in Scots, and subsequently to 1424 always in that language. Unlike the English Acts, French was never used in Scotch legislation. In 1541 a selection of the Acts of James V. was printed. The first edition of the Acts was published in 1566, the second in 1597, the third in 1681; and the great national work, the complete record of Parliament, has just been completed, with a general index to the whole Acts from 1124 to 1707, which forms the great repertory of the legal, constitutional, and political history of Scotland. In 1540 an Act was passed requiring all the Acts of Parliament to be pronounced in presence of the king and the estates,—the assent of the king being indicated by his touching them with the sceptre; and in 1641 it was ordained that the Acts passed in 1640 be published in the king's name, and with the consent of the estates. But during the civil war the Acts of Parliament were passed in name of the estates alone. These Acts, however, were rescinded after the restoration of Charles II. by Act 1661, c. 126, because "the power of making laws is an essential privilege of the royal prerogative." In 1457 an Act was passed for proclaiming the Acts of Parliament in the shires and burghs, that none be ignorant; and in 1581 it was ordained that Acts need not be proclaimed at the market-cross of the head burgh of each shire, but at the market-cross of Edinburgh only, the lieges obeying them forty days thereafter. The clerk of register was always bound to give extracts of Acts to the lieges in their particular affairs. In 1425 a committee, consisting of an equal number of each estate, was appointed to amend the books of law; and in 1567 a commission was issued to codify the laws, civil and municipal, dividing them into heads like the Roman law,—the heads as they are ready to be brought to Parliament to be confirmed. Lord Bacon recommended the Scotch Acts for their "excellent brevity." His lordship's praise applies very properly to the Acts down to the

reign of Queen Mary and the early part of the reign of James VI.; but the logomachy of subsequent legislation is intolerable to the consulter.

Irish Acts may be said to commence A.D. 1310, in the reign of Edward II., and to close with the union with the British Parliament in 1801. From the former date, however, there is a break till 1429. In 1495 *Poyning's Law* provided that no bill should be introduced into the Irish Parliament which has not previously received the royal assent in England; and till 1782 the Parliament of Ireland remained in tutelage to that of England. Since 1801 it has been incorporated with the Parliament of Great Britain.

ACT OF SEDERUNT, in *Scotch Law*, an ordinance for regulating the forms of procedure before the Court of Session, passed by the judges in virtue of a power conferred by an Act of the Scotch Parliament, 1540, c. 93. In former times this power was in several instances clearly exceeded, and such Acts of Sederunt required to be ratified by the Scotch Parliament; but for more than a century and a half Acts of Sederunt have been almost exclusively confined to matters relating to the regulation of judicial procedure. Many recent statutes contain a clause empowering the court to make the necessary Acts of Sederunt. A quorum of nine judges is required to pass an Act of Sederunt.

ACTS OF THE APOSTLES, the fifth among the canonical books of the New Testament. What has to be said on this book will naturally fall under the following heads: The state of the text; the authorship; the object of the work; the date and the place of its composition.

The State of the Text.—The Acts is found in two MSS. generally assigned to the 4th century, the *Codex Sinaiticus*, in St Petersburg, and the *Codex Vaticanus*, in Rome; in one MS. assigned to the 5th century, the *Codex Alexandrinus*, in the British Museum; in two MSS. belonging to the 6th century, the *Codex Bezæ*, in Cambridge, and the *Codex Laudianus*, in Oxford; and in one of the 9th century, the *Codex Palimpsestus Porfirianus*, in St Petersburg, with the exception of chapter first and eight verses of chapter second. Large fragments are contained in a MS. of the 5th century, the *Codex Ephræmi*, in Paris. Fragments are contained in five other MSS., none of which is later than the 9th century. These are all the uncial MSS. containing the Acts or portions of it.

The MSS. in Oxford and Cambridge differ widely from the others. This is especially the case with the Cambridge MS., the *Codex Bezæ*, which is said to contain no less than six hundred interpolations. Scrivener, who has edited this MS. with great care, says, "While the general course of the history and the spirit of the work remain the same as in our commonly received text, we perpetually encounter long passages in *Codex Bezæ* which resemble that text only as a loose and explanatory paraphrase recalls the original form from which it sprung; save that there is no difference in the language in this instance, it is hardly an exaggeration of the facts to assert that Codex D [*i.e.*, *Codex Bezæ*] reproduces the *textus receptus* of the Acts much in the same way that one of the best Chaldee Targums does the Hebrew of the Old Testament, so wide are the variations in the diction, so constant and inveterate the practice of expanding the narrative by means of interpolations." Scrivener here assumes that the additions of the *Codex Bezæ* are interpolations, and this is the opinion of nearly all critics. There is one, however, Bornemann, who thinks that the *Codex Bezæ* contains the original text, and that the others are mutilated. But even supposing that we were quite sure that the additions were interpolations, the *Codex Bezæ* makes it more difficult to determine what the real text was. Scrivener, with good reason, supposes that the *Codex Bezæ* is derived from an original which would most likely belong to the third century at the latest.

Authorship of the Work.—In treating this subject we begin with the external evidence.

The first mention of the authorship of the Acts in a well-authenticated book occurs in the treatise of Irenæus against heresies, written between the years 182 and 188 A.D. Irenæus names St Luke as the author, as if the fact were well known and undoubted. He attributes the third Gospel to him, and calls him "a follower and disciple of apostles" (*H.* iii. 10, 1). He states that "he was inseparable from Paul, and was his fellow-worker in the gospel" (*H.* iii. 14, 1). The next mention occurs in the *Stromata* of Clemens Alexandrinus, written about 195 A.D., where part of St Paul's speech to the Athenians is quoted with the words, "Even as Luke also, in the Acts of the Apostles, records Paul as saying" (*Strom.* v. xii. 82, p. 696, Pott). The Acts of the Apostles is quoted by Tertullian as Scripture, and assigned to St Luke (*Adv. Mar.* v. 2 and 3). Origen speaks of "Luke who wrote the Gospel and the Acts" (Eus. *H. E.* vi. 25); and Eusebius includes the Acts of the Apostles in his summary of the books of the New Testament (*Hist. Eccl.* iii. 25). The Muratorian canon, generally assigned to the end of the second or beginning of the third century, includes the Acts of the Apostles, assigns it to St Luke, and says that he was an eye-witness of the facts recorded. There is thus unanimous testimony up to the time of Eusebius that St Luke was the author of the Acts. This unanimity is not disturbed by the circumstance that some heretics rejected the work, for they did not deny the authorship of the book, but refused to acknowledge it as a source of dogmatic truth.

After the time of Eusebius we find statements to the effect that the Acts was little known. "The existence of this book," Chrysostom says, "is not known to many, nor the person who wrote and composed it." And Photius, in the ninth century, says, "Some maintain that it was Clement of Rome that was the writer of the Acts, others that it was Barnabas, and others that it was Luke the Evangelist."

Irenæus makes such copious quotations from the Acts that we can feel sure that he had before him substantially our Acts. We cannot go further back than Irenæus with certainty. If, as we shall see, the writer of the Acts was also the writer of the third Gospel, we have Justin Martyr's testimony (about 150 A.D.) for the existence of the third Gospel in his day, and therefore a likelihood that the Acts existed also. But we have no satisfactory evidence that Justin used the Acts, and there is nothing in the Apostolic Fathers, nor in any work anterior to the *Letter of the Churches of Vienne and Lyons*, written probably soon after 177 A.D., to prove the existence of the Acts.

The weight of external evidence therefore goes entirely for St Luke as the author of the Acts. But it has to be noticed, that the earliest testimony is more than a hundred years later than the events described in the Acts. We have also to take into account that Irenæus was not critical. We find him calling the *Pastor of Hermas* Scripture; Clemens Alexandrinus also calls the *Pastor* inspired; and Origen not merely attributes inspiration to the work, but makes the author of it the Hermas mentioned in the Epistle to the Romans. All scholars reject the testimony of Irenæus, Clemens Alexandrinus, and Origen in this matter. The question arises, How far are we to trust them in others of a similar nature?

We turn to the internal evidence. And in the very commencement we find the author giving himself out as the person who wrote the third Gospel. This claim has been almost universally acknowledged. There is a remarkable similarity of style in both. The same peculiar modes of expression continually occur in both; and throughout both there exist continual references backward and for-

ward, which imply the same authorship. There are some difficulties in the way of this conclusion. Two of these deserve special notice. If we turn to the last chapter of the Gospel, we find it stated there (ver. 13) that two disciples met Jesus on the day of the resurrection, as they were going to Emmaus. Towards nightfall (ver. 29) he entered the village with them; and as he reclined with them, he became known to them, and disappeared. Whereupon "at that very hour" (ver. 33) they rose up and returned to Jerusalem. They found the eleven assembled, and told them what had happened to them. "While they were saying these things, he himself stood in the midst of them" (ver. 36). The apostles gave him a piece of fish, and he ate it. "But he said to them" (ver. 44), so the narrative goes on, and it then relates his speech; and at ver. 50 it says, "He led them out to Bethany," and then disappeared from them. This disappearance was final; and if the words used in the Gospel make us hesitate in determining it to be his ascension, such hesitation is removed by the opening words of the Acts. According to the Gospel, therefore, all the events now related took place, or seem to have taken place, on the day of the resurrection, or they may possibly have extended into the next morning, but certainly not later. The Acts, on the contrary, states that Jesus was seen by the disciples for forty days, and makes him deliver the speech addressed to his disciples and ascend into heaven forty days after the resurrection. The other instance is perhaps still more singular. In the Acts we have three accounts of the conversion of St Paul—the first by the writer himself, the other two by St Paul in his speeches. The writer states that (ix. 4, 7) when the light shone round Paul, he fell to the ground, "but the men who were journeying with him stood dumb." St Paul himself says (xxvi. 14) that they all fell to the ground. The writer says (ix. 7) that St Paul's companions heard the voice, but saw no one. St Paul himself says (xxii. 9) that his companions saw the light, but did not hear the voice of him who spake to him. And finally, all these accounts differ in their report of what was said on the occasion. Notwithstanding these differences, even these very accounts contain evidence in them that they were written by the same writer, and they do not destroy the force of the rest of the evidence. The case would be quite different if Baur, Schwegler, and Wittichen were right in supposing that the Gospel of Luke contained documents of opposite tendencies. It would then be necessary to assume different authors for the different parts of the Gospel, and still another for the Acts. But this theory falls to the ground if the Tübingen theory of tendencies is rejected.

The Acts itself claims to be written by a companion of St Paul. In chap. xvi. 10, the writer, without any previous warning, passes from the third person to the first. St Paul had reached the Troad. There he saw a vision inviting him to go to Macedonia. "But when he saw the vision, straightway *we* sought to go out into Macedonia." The use of the "we" continues until Paul leaves Philippi. In chap. xx. Paul returns to Philippi, and the "we" is resumed, and is kept up till the end of the work. Irenæus (*H.* iii. 14, 1) quotes these passages as proof that Luke, the author, was a companion of the apostle. The minute character of the narrative, the accurate description of the various journeyings, the unimportance of some of the details, and the impossibility of contriving all the incidents of the shipwreck without experiencing them, are strong reasons for believing that we have the narrative of an eye-witness. And if we allow this much, we can scarcely help coming to the conclusion that this eye-witness was the author of the work; for the style of this eye-witness is exactly the style of the writer who composed the previous portions. Some have supposed that we have here the personal narrative of Timothy or of Silas; but this supposition would compel us to believe that the writer of the Acts was so careless as to tack documents together without remembering to alter their form. Such a procedure on the part of the skilful writer of the Acts is unlikely in the highest degree. The "we" is introduced intentionally, and can be accounted for only in two ways: either by supposing that the writer was an eye-witness, or that he wished to be thought an eye-witness, and borrowed the narrative of an eye-witness to facilitate the deception. Zeller has adopted this latter alternative; and this latter alternative is the only possible one for those who assign a very late date to the Acts.

We may test the writer's claim to be regarded as a companion of St Paul by comparing his statements with those of the other books of the New Testament. As might be expected, the great facts recorded in the Gospels are reproduced accurately in the Acts. There is only one marked difference. St Matthew says (xxvii. 5, 7) that Judas cast the traitor's money into the temple, and the priests bought with it a field for the burial of strangers. St Peter in Acts (i. 18) says, that Judas himself purchased a field with the reward of his iniquity. St Matthew says that he went and hanged himself, St Peter that he fell headlong and burst in the middle. St Matthew says, or rather seems to say, that the field was called the field of blood, because it was purchased with blood-money; St Peter seems to attribute the name to the circumstance that Judas died in it.

The Acts is divided into two distinct parts. The first deals with the church in Jerusalem, and especially narrates the actions of St Peter. We have no external means of testing this portion of the narrative. The Acts is the only work from which information is got in regard to these events. The second part pursues the history of the apostle Paul; and here we can compare the statements made in the Acts with those made in the Epistles. Now here again we have a general harmony. St Paul travels in the regions where his Epistles show that he founded churches. The friends of St Paul mentioned in the Acts are also the friends acknowledged in the Epistles. And there are many minute coincidences. At the same time, we learn from this comparison that St Luke is not anxious to give minute details. Timothy probably visited Athens while St Paul was there. This we learn from 1 Thess. iii. 1, but no mention is made of this visit in the Acts. Again, we gather from the Epistles to the Corinthians that St Paul paid a visit to Corinth, which is not recorded in the Acts. Moreover, no mention is made of Titus in the Acts. These, however, are slight matters; and it must be allowed that there is a general agreement. But attention has been drawn to two remarkable exceptions. These are the account given by St Paul of his visits to Jerusalem in the Epistle to the Galatians and that given by St Luke; and the character and mission of the apostle Paul, as they appear in his letters and as they appear in the Acts.

In regard to the first point, St Paul himself says in the Epistle to the Galatians, that after his conversion straightway he held no counsel with flesh and blood, nor did he go up to Jerusalem to the apostles who were before him; but he went away to Arabia and returned to Damascus; that then after three years he went up to Jerusalem to seek for Cephas, and he remained with him fourteen days. He at that time saw only two apostles,—Peter, and James the brother of the Lord. He then went away to Syria and Cilicia, and was unknown by face to the churches of Judea. He says that fourteen years after this he went up to Jerusalem with Barnabas, taking Titus with him. On this occasion he went up by revelation. St Paul introduces these facts for a purpose, and this purpose is that he might prove his independence as an apostle. He had acted

solely on the revelation given to himself. He had neither required nor obtained sanction from the other apostles. He was an apostle, not sent forth from men nor through men, but through Jesus and God. When we turn to the Acts, we find that no mention is made of the journey to Arabia. He stays some days at Damascus, and then begins to preach the gospel. He continues at this work a considerable time; and then, in consequence of the plots of the Jews, he secretly withdraws from Damascus and proceeds to Jerusalem. The brethren there are suspicious in regard to him, and their fears are not quieted until Barnabas takes him to the apostles; and after this introduction he goes in and out amongst them, and holds discussions wlth the Hellenists. Finally, when the Hellenists attempt to kill him, the brethren send him to Tarsus. In the Epistle to the Galatians St Paul does everything for himself, instigated by his inward feelings. In the Acts he is forced out of Antioch, and sent by the brethren to Tarsus. In the Galatians St Paul stays only a fortnight, and sees only St Peter and St James of the apostles, and was unknown by face to the churches of Judea. In the Acts Barnabas takes him to the *apostles*, and he continues evidently for a period much longer than a fortnight, going in and out amongst them. Then in chap. xi. 30, he goes up a second time to Jerusalem,—a visit which seems inconsistent with the narrative in the Epistle to the Galatians. And finally, when he goes up to Jerusalem, the Acts does not represent him going up by an independent revelation, but as being sent up; and it says nothing of his taking an independent part, but represents him as submitting to the apostles.

This, however, leads us to the treatment of the character of St Paul by the writer of the Acts. Some of the Tübingen critics assert that the writer shows ill-will to St Paul, but they are evidently wrong. On the contrary, the character of the apostle as given in the Acts is full of grand and noble traits. Yet still there are some singular phenomena in the Acts. St Paul claimed to be an apostle by the will of God. He had as good a right to be an apostle as St Peter or St James. Yet the writer of the Acts never calls him an apostle in the strict sense of the term. He is twice called an apostle, namely, in Acts xiv. 4 and 14. On both occasions his fellow-apostle is Barnabas; but Barnabas was not one of the twelve, and not an apostle in the strict sense of the term. And even in these verses the reading is doubtful. The *Codex Bezæ* omits the word *apostle* in the 14th verse, and makes the 4th liable to suspicion by inserting an addition to it. St Luke also brings prominently forward as the proper mark of an apostle, that he should have companied with the Lord from his baptism to his ascension, and describes the filling up of the number of the twelve by the election of Matthias. And if St Luke's narrative of St Paul's conversion be minutely examined, it will be perceived that not only does he not mention that St Paul saw Jesus, but the circumstances as related scarcely permitted St Paul to see Jesus. He was at once dazzled by the light, and fell to the ground. In this prostrate condition, with his eyes shut, he heard the voice; but at first he did not know whose it was. And when he opened his eyes, he found that he was blind. The words of Ananias imply that St Paul really did see Jesus, but St Luke abstains from any such statement. And St Paul is not treated by the Jewish Christians in the Acts as an independent apostle. He is evidently under submission to the apostles at Jerusalem.

Furthermore, the point on which St Paul specially insists in the Epistle to the Galatians is, that he was appointed the apostle to the Gentiles as St Peter was to the circumcision, and that circumcision and the observance of the Jewish law were of no importance to the Christian. St Paul's words on this point in all his letters are strong and decided. But in the Acts it is St Peter that opens up the way for the Gentiles. In St Peter's mouth occurs the strongest language in regard to the intolerable nature of the law. Not a word is said of the quarrel between St Peter and St Paul. The brethren in Antioch send St Paul and Barnabas up to Jerusalem to ask the opinion of the apostles and elders. St Paul awaits the decision of the apostles, and St Paul and Barnabas carry back the decision to Antioch. And throughout the whole of the Acts St Paul never stands forth as the champion of the Gentiles. He seems continually anxious to reconcile the Jewish Christians to himself, by observing the law of Moses. He circumcises Timothy, and he performs his vows in the temple. And he is particularly careful in his speeches to show how deep his respect for the law of Moses is. In this regard the letters of St Paul are very different from his speeches as given in the Acts. In the Epistle to the Galatians he claims perfect freedom for himself and the Gentiles from the observance of the law; and neither in it nor in the Epistle to the Corinthians does he take any notice of the decision to which the apostles are said to have come in their meeting at Jerusalem. And yet the narrative of St Luke implies a different state of affairs from that which it actually states in words; for why should the Jews hate St Paul so much more than the other apostles if there was nothing special in his attitude towards them?

We may add to this, that while St Luke gives a rather minute account of the sufferings of St Peter and the church in Jerusalem, he has not brought prominently forward the perils of St Paul. St Paul enumerates some of his sufferings in the second Epistle to the Corinthians (chap. xi. 23–28). St Luke has omitted a great number of these. Thus, for instance, St Paul mentions that he was thrice shipwrecked. St Luke does not notice one of these shipwrecks, that recorded in the Acts having taken place after the Epistles to the Corinthians were written. Some also think that St Luke details several occurrences which are scarcely in harmony with the character of St Paul. They say that the dismissal of John Mark, as recorded in the Acts, is a harsh act. St Paul's remark, "I wist not that he is the high priest" (xxiii. 5), they regard as doubtful in point of honesty. And the way by which he gained the Pharisees to his side, in opposition to the Sadducees, they describe as an expedient unworthy the character of this fearless apostle (xxiii. 6).

St Luke occasionally alludes, in the Acts, to events which took place outside of the church. We can test his accuracy in recording these events by comparing his narrative with the narratives of historians who treat of the same period. These historians are Josephus, Tacitus, and Suetonius. Now, here again we find that the accounts in the Acts generally agree. Indeed, Holtzmann has noticed that all the external events mentioned in the Acts are also to be found in Josephus. We may therefore omit Tacitus and Suetonius, and confine ourselves to Josephus. Three narratives deserve minute examination. The first is the death of Herod Agrippa. Josephus says (*Ant.* xix. 8, 2) that Herod was at Cæsarea celebrating a festival in honour of the Cæsar. On the second day of the spectacle, the king put on a robe made entirely of silver, and entered the theatre early in the day. The sun's rays fell upon the silver, and a strong impression was produced on the people, so that his flatterers called out that he was a god. He did not check their impiety, but soon, on looking up he saw an owl perched above his head on a rope. He at once recognised in the bird the harbinger of evil. Immediately he was attacked by violent pains in the bowels, and after five days' illness died. The Acts says that Herod was addressing a deputation of Tyrians and Sidonians in Cæsarea, seated on the tribunal and arrayed in a royal

robe. The people called out, "The voice of a god, and not of a man." "Immediately an angel of the Lord struck him because he gave not God the glory, and becoming worm-eaten, he died" (xii. 21–23). Both accounts agree in representing Herod as suddenly struck with disease because he did not check the impiety of his flatterers, but they agree in almost nothing else; and it is difficult to conceive that the one writer knew the account of the other. Which account is most to be trusted, depends upon the answer given to the question which is the more credible historian.

The second case relates to the Egyptian mentioned in the question of the tribune to St Paul, in Acts xxi. 38, "You are not then the Egyptian who, some time ago, made a disturbance, and led into the wilderness the four thousand of the sicarii?" Josephus mentions this Egyptian, both in his *Antiquities* (xx. 8, 6) and in the *Jewish War* (ii. 13, 5). In the *Jewish War* (ii. 13, 3), Josephus describes the sicarii, and then passes on, after a short section, to the Egyptian. He states that he collected thirty thousand people, led them out of the wilderness "to the mount called the Mount of Olives, which," he says (*Ant.* xx. 8, 6) in words similar to those in Acts i. 12, "lies opposite to the city five furlongs distant." On this Felix attacked him, killed some, captured others, and scattered the band. The Egyptian, however, escaped with some followers. Hence the question in the Acts. There are some striking resemblances between the words used by both writers. The numbers differ; but St Luke gives the numbers of the sicarii, Josephus the numbers of the entire multitude led astray.

The third case is the one which has attracted most attention. In the speech which Gamaliel delivers, in Acts v. 35–39, it is said, "Some time before this, Theudas rose up, saying that he was some one, to whom a number of about four hundred men attached themselves, who was cut off, and all who followed him were broken up and came to nought. After him rose up Judas the Galilean, in the days of the registration, and he took away people after him; and he also perished, and all that followed him were scattered." On turning to Josephus we find that both Theudas and Judas the Galilean are mentioned. The circumstances related of both are the same as in the Acts, but the dates are different. According to Josephus, Theudas gave himself out as a prophet, in the reign of Claudius, more than ten years after the speech of Gamaliel had been delivered, while Judas appeared at the period of the registration, and therefore a considerable time before Theudas. To explain this difficulty, some have supposed that there may have been another Theudas not mentioned by Josephus, or that Josephus is wrong in his chronology. Others suppose that St Luke made a mistake in regard to Theudas, and is right in regard to Judas. Keim maintains that St Luke has made the mistake, and suggests that possibly it may be based upon the passage of Josephus; and Holtzmann has gone more minutely into this argument. Holtzmann draws attention to the nature of the sections of Josephus which contain the references to Theudas and Judas (*Ant.* xx. 5, 1, 2). He says that nearly all the principal statements made in these short sections emerge somewhere in the Acts: the census of Quirinus, the great famine, Alexander as a member of a noble Jewish family, and Ananias as high priest. Moreover, St Luke has preserved the order of Josephus in mentioning Theudas and Judas; but Josephus says "the sons of Judas," whereas St Luke says "Judas." "Is it not likely," Holtzmann argues, "that St Luke had before his mind this passage of Josephus, but forgot that it was the sons of Judas that were after Theudas, and not the father?" He adds also, that in the short passage in the Acts there are five peculiar expressions, identical or nearly identical with the expressions used by Josephus, and comes to the conclusion that St Luke knew the works of Josephus. He finds further traces of this knowledge in the circumstance that, in Acts xiii. 20–21, St Luke agrees in his statements with Josephus where both differ from the Old Testament. He also adduces certain Greek words which he supposes St Luke derived from his reading of Josephus. Max Krenkel, in making an addition to this argument, tries to show, from a comparison of passages, that St Luke had Josephus before his mind in the narrative of the childhood of Christ; and he supposes that the expedient attributed to the apostle Paul, of setting the Pharisees against the Sadducees (Acts xxiii. 6), is based upon a similar narrative given in Josephus (*Bell. Jud.* ii. 21, 3, and *Vita*, 26 ff.). The importance of this investigation is great; for if Holtzmann and Krenkel were to prove their point, a likelihood would be established that the Acts of the Apostles, or at least a portion of it, was written after 93 A.D., the year in which the *Antiquities* of Josephus was published, according to a passage occurring in the work itself. Meanwhile, the fact that important portions of the narrative must have been written by an eye-witness of the events recorded, combined with the unity of style and purpose in the book, are cogent arguments on the other side.

The speeches in the Acts deserve special notice. The question occurs here, Did St Luke follow the plan adopted by all historians of his age, or is he a singular exception? The historians of his age claimed the liberty of working up, in their own language, the speeches recorded by them. They did not dream of verbal accuracy; even when they had the exact words of the speakers before them, they preferred to mould the thoughts of the speakers into their own methods of presentation. Besides this, historians do not hesitate to give to the characters of their history speeches which they never uttered. The method of direct speech is useful in producing a vivid idea of what was supposed to pass through the mind of the speaker, and therefore is used continually to make the narrative lively. Now it is generally believed that St Luke has followed the practice of his contemporaries. There are some of his speeches that are evidently the summaries of thoughts that passed through the minds of individuals or of multitudes. Others unquestionably claim to be reports of speeches really delivered. But all these speeches have, to a large extent, the same style as that of the narrative. They have passed to a large extent through the writer's mind, and are given in his words. They are, moreover, all of them the merest abstracts. The speech of St Paul at Athens, as given by St Luke, would not occupy more than a minute and a half in delivery. The longest speech in the Acts, that of the martyr Stephen, would not take more than ten minutes to deliver. It is not likely that either speech lasted so short a time. But this circumstance, while destroying their verbal accuracy, does not destroy their authenticity; and it must strike all that, in most of the speeches, there is a singular appropriateness, there is an exact fitting-in of the thoughts to the character, and there are occasionally allusions of an obscure nature, which point very clearly to their authenticity. The one strong objection urged against this inference, is that the speeches of St Peter and St Paul show no doctrinal differences, such as are said to appear in the Epistles; but the argument has no force, unless it be proved that St Paul's doctrine of justification is different from the creed of St Peter or St James.

Not the least important of the questions which influence critics in determining the authorship of the Acts is that of miracles. Most of those who think that miracles are impossible, come to the conclusion that the narratives containing them are legendary, and accordingly they maintain that the first portion of the Acts, relating to the early

hurch in Jerusalem and to St Peter, is in the highest legree untrustworthy. The writer, it is maintained, had 10 personal knowledge of those early days, and received he stories after they had gone through a long process of ransmutation. They appeal, for instance, to the account f the Pentecost, where the miracle of speaking with tongues s described. They say that it is plain, on a comparison of he Epistle to the Corinthians with the Acts, that St Paul neant one thing by the gift of tongues, and the writer of he Acts another. And the inference is at hand that, if he writer had known St Paul, he would have known what he gift of tongues was; and the possibility of such a nistake, it is said, implies a considerable distance from the ime of the apostles and the primitive church. They oint also to the curious parallelism between the miracles f St Peter and those of St Paul. St Peter begins his eries of miracles by healing a lame man (iii. 2); so does St Paul (xiv. 8). St Peter exorcises evil spirits (v. 16; viii. 7); o does St Paul (xix. 15; xvi. 18). If St Peter deals with he magician Simon, St Paul encounters Elymas. If St Peter punishes with death (v. 1 ff.), St Paul punishes with lindness (xiii. 6 ff.). If St Peter works miracles by his hadow (v. 15), not less powerful are the aprons and napkins of St Paul (xix. 12). And, finally, if St Peter can aise Tabitha from the dead (ix. 36), St Paul is equally uccessful in the case of Eutychus (xx. 9). It is easy to ee, also, that since there is no contemporary history with which to compare the statements in the Acts, and since nany of the statements are of a summary nature, and very ew dates are given, a critic who believes the narratives egendary will have no difficulty in finding many elements n the narratives confirmatory of his belief. But to those who believe in miracles the rest of the narrative seems plain and unvarnished. The parallelism between the niracles of St Peter and St Paul is accounted for by the act that they acted in similar circumstances, and that actual events were at hand on which to base the parallelism. At the same time, some who believe in the possibility of miracles think that the Acts presents peculiar lifficulties in this matter. They say that the healing by neans of shadows and aprons is of a magical nature; that he death of Ananias and Sapphira, and the other destructive miracles, are out of harmony with the rest of the niracles of the New Testament; and that the earthquakes hat release St Peter and St Paul seem purposeless. The lifficulties on this head, though real, are not however of great importance, nor do they tell very seriously against he received opinion that St Luke is the author of the work.

We have thus given a general summary of the questions which come up in investigating the authorship of the Acts, and of the arguments used in settling this point. The conclusions based upon this evidence are very different. Some join the traditional opinion of the church to the nodern idea of inspiration, and maintain that St Luke was the author of the work, that every discrepancy is nerely apparent, and that every speech contains the real and genuine words of the speaker. Others maintain that St Luke is the writer, and that the book is justly placed n the canon; that the narrative is, on the whole, thoroughly trustworthy, and that neither its canonicity nor credibility s affected by the existence of real discrepancies in the narrative. Others hold that St Luke is the author, but that we have got in the book an ordinary narrative, with portions credible and portions incredible; that for the early portions of the work he had to trust mainly to his memory, dulled by distance from the scene of action and by lapse of time, and that he has given what he knew with the uncritical indifference to minute accuracy in time, circumstance, and word, which characterises all his contemporaries. Others maintain that St Luke is the author, but that, being a credulous and unscientific Christian, he recorded indeed in honesty all that he knew, but that he was deluded in his belief of miracles, and is often inaccurate in his statement of facts. Others think that St Luke was not the author of the work. He may have been the original author of the diary of the Apostle Paul's travels in which the "we" occurs; but the author of the Acts did not write the diary, but inserted it into his narrative after altering it for a special purpose, and the narrative was written long after St Paul and St Luke were dead. Others think that in the Acts we have the work of Timothy or of Silas, or of some one else. A considerable number imagine that St Luke had different written documents before him while composing, and a very few think that the work is the work of more than one writer. But as we have intimated, the weight of testimony is in favour of St Luke's authorship.

Purpose.—We have seen that the Acts of the Apostles is the work of one author possessed of no inconsiderable skill. This author evidently omits many things that he knew; he gives a short account of others of which he could have supplied accurate details, and, as in the case of St Paul, he has brought forward one side of the character prominently, and thrown the other into the shade. What motive could have led him to act thus? What object had he in inserting what he has inserted, and omitting what he has omitted? Most of the answers given to these questions have no important bearing on the question of the authorship of the Acts. But the case is different with the answer of the Tübingen school. The Tübingen school maintains that St Paul taught that the law was of no avail to Jew and Gentile, and that, therefore, the observance of it was unnecessary; that St Peter and the other apostles taught that the observance of the law was necessary, and that they separated from St Paul on this point; and that the early Christians were divided into two great classes—those who held with St Paul, or the Gentile Christians, and those who held with St Peter, or the Jewish Christians. They further maintain that there prevailed a violent controversy between these two parties in the church, until a fusion took place towards the middle of the second half of the second century, and the Catholic Church arose. At what stage of this controversy was the Acts written? is the question they put. St Peter, we have seen, is represented in the Acts as opening the church to the Gentiles. St Peter and the rest of the apostles at Jerusalem admit the Gentiles on certain gentle conditions of refraining from things offered to idols, from animals suffocated, from blood, and from fornication. What could be the object of such statements but to convince the Jewish Christians that they were wrong in pertinaciously adhering to their entire exclusion of the Gentiles, or insisting on their observance of the entire law? But St Paul is represented as observing the law, as sent forth by St Peter and the other apostles, as going continually to the Jews first, and as appearing in the temple and coming up with collections for the Jerusalem church. Was not this also intended to reconcile the Jewish Christians to St Paul? Then the great doctrines of St Paul all but vanish—free grace, justification by faith alone, redemption through the blood of Christ,—all that is characteristic of St Paul disappears, except his universalism, and that is modified by the decree of the apostles, the circumcision of Timothy, and St Paul's observance of the law. The object of all this, they affirm, must be to reconcile the Jewish party by concessions. But there is said to be also another object, of minor importance indeed, but still quite evident and falling in with the other. Throughout the Acts St Paul is often accused of turning the world upside down and causing disturbances. The Jewish Christians may have thought that St Paul was to

blame in this matter, and that St Paul's opinions were peculiarly calculated to stir up persecution against the Christians. The stories in the Acts were devised to convince them that they were mistaken in this supposition. On every occasion in which St Paul is accused before magistrates, and especially Roman magistrates, he is acquitted. Gallio, the town-clerk of Ephesus, Lysias, Felix, and Festus, all declare that St Paul has done nothing contrary to the law. And while the Romans thus free him from all blame, it is the Jews who are always accusing him.

We have here reproduced the argument of Zeller, who has given the most thorough exposition of an opinion held also by Baur, Schwegler, and others. The argument fails to have effect if the assumption that St Paul and St Peter differed radically is rejected. It also suffers from the circumstance, that there is no historical authentication of the church being in such a state in the first half of the second century, that this attempt at reconciliation could take place within it. Moreover, the writing of a fictitious production seems an extraordinary means for any one to employ in order to effect reconciliation, especially if, as Zeller imagines, the church in Rome was specially contemplated. The church in Rome and the other Christian churches had St Paul's Epistles to the Romans, Corinthians, and Galatians before them. They could be in no doubt as to what were his sentiments. They must also have had some history of his career; and no object could be effected by attempting to palm upon them a decree of apostles which never existed, or a history of St Peter and St Paul contradicted by what they knew of both.

Overbeck, finding this solution of Zeller unsatisfactory, thinks that the object of the Acts is to help the Gentile-Christian Church of the first half of the second century, now far removed from Paulinism and strongly influenced by Judaism, to form a clear idea of its own past, especially of its own origin and of its founder St Paul. It is thus, he maintains, an historical novel, somewhat like the *Clementines*, devised to realise the state of the church at an earlier period.

It would be tedious to enumerate all the other objects which have been set forth as the special aim of the Acts. Some think that it was a work written for the private use of Theophilus, and aimed, therefore, at giving him the special information which he required. Others think that it is intended to describe the spread of the gospel from Jerusalem to Rome. Others believe that the writer wished to defend the character of the Apostle Paul. Some of the more recent members of the Tübingen school think that it was intended to distort the character of St Paul, and that the image of him given in the Acts is an intermediate stage between the real Paul and the caricature supposed by them to be made of him under the name of Simon in the *Clementines*.

Date.—There are no sure data for determining the date. Appeal used to be made to Acts viii. 26, "Unto the way which goeth down from Jerusalem to Gaza, which is desert." But most probably it is the way which is here said to be desert or lonely. But even if the word "desert" or "lonely" be applied to Gaza, we get nothing out of it. Accordingly, in the absence of data very various dates have been assigned. Some think that it was written at the time mentioned in the last chapter of Acts, when St Paul had been two years in Rome. Some think that it must have been written after the fall of Jerusalem, as they believe that the gospel was written after that event. Irenæus thought that it was written after the death of St Peter and St Paul (*H.* iii. 1). Others think that St Luke must have written it at a late period of his life, about the year 80 A.D. The Tübingen school think that it was written some time in the second century, most of them agreeing on the second or third decade of that century, about 125 A.D. They argue that a late date is proved by the nature of the purpose which occasioned the work, by the representation which it gives of the relation of the Christians to the Roman state, and by the traces of Gnosticism (xx. 29), and of a hierarchical constitution of the church (i. 17, 20; viii. 14, ff.; xv. 28; xx. 17, 28) to be found in the Acts.

Place.—There is no satisfactory evidence by which to settle the place of composition. Later fathers of the church and the subscriptions of late MSS. mention Achaia, Attica, Alexandria, Macedonia, and Rome. And these places have all had their supporters in modern times. Some have also tried to show that it was written in Asia Minor, probably at Ephesus. The most likely supposition is that it was written at Rome; Zeller has argued with great plausibility for this conclusion.

There is a large literature on the subject of this article, but the most important treatises are those of Schwanbeck, Schneckenburger, Lekebusch, Zeller, Trip, Klostermann, and Œrtel. Zeller's work deserves special praise for its thoroughness. Various other writers have discussed the subject in works dealing with this among others; as Baur in his *Paulus;* Schwegler in his *Nachapostolisches Zeitalter;* Ewald in his *History of Israel;* Renan in his *Apostles;* Hausrath in his *New Testament History;* and, in a more conservative manner, Neander, Baumgarten, Lechler, Thiersch, and Lange. Of commentaries, the best on the Tübingen side is that of De Wette, remodelled by Overbeck, and that of the more conservative Meyer is especially good. In English we have an able treatment of the subject in Dr Davidson's *Introduction to the Study of the New Testament;* we have commentaries by Biscoe, Humphry, Hackett, Cook, Wordsworth, Alford, and Gloag; and dissertations by Paley, Birks, Lewin, Conybeare, and Howson.

There are various other treatises claiming to be Acts of Apostles. One or two of these must have existed at an early date, though, no doubt, they have since received large interpolations. But most of them belong to a late period, and all of them are acknowledged to be apocryphal. They are edited by Tischendorf in his *Acta Apostolorum Apocrypha* (Lipsiæ, 1851), and have been translated, with an introduction giving information as to their origin and dates, by Mr Walker, in vol. xvi. of the *Ante-Nicene Library.* (J. D.)

ACTA CONSISTORII, the edicts of the consistory or council of state of the Roman emperors. These edicts were generally expressed in such terms as these: "The august emperors, *Diocletian* and *Maximian,* in council declare, That the children of decurions shall not be exposed to wild beasts in the amphitheatre."—The senate and soldiers often swore, either through flattery or on compulsion, upon the edicts of the emperor. The name of a senator was erased by Nero out of the register, because he refused to swear upon the edicts of Augustus.

ACTA DIURNA, called also *Acta Populi, Acta Publica,* and simply *Acta* or *Diurna,* was a sort of Roman gazette, containing an authorised narrative of the transactions worthy of notice which happened at Rome—as assemblies, edicts of the magistrates, trials, executions, buildings, births, marriages, deaths, accidents, prodigies, &c. Petronius has given us an imitation specimen of the *Acta Diurna,* one or two extracts from which may be made to show their style and contents. The book-keeper of Trimalchio pretends to read from the *Acta Urbis:*—"On the 30th of July, on the Cuman farm, belonging to Trimalchio, were born 30 boys and 40 girls; there were brought into the barn from the threshing-floor 125,000 bushels of wheat; 500 oxen were broken in.—On the same day the slave Mithridates was crucified for having slandered the tutelar deity of our

iend Gaius.—On the same day 100,000 sesterces, that ›uld not be invested, were put into the money-box.—On e samo day a fire broke out in the gardens of Pompey, hich arose in the steward's house," &c. The *Acta* differed om the *Annals* (which were discontinued in B.C. 133) in is respect, among others, that only the greater and more ıportant matters were given in the latter, while in the rmer things of less note also were recorded. The origin of e *Acta* is attributed to Julius Cæsar, who first ordered the ›eping and publishing of the acts of the people by public ficers. Some trace them back as far as Servius Tullius, ho it was believed ordered that the next of kin, on occa- ›n of a birth, should register the event in the temple of enus, and on occasion of a death, should register it in e temple of Libitina. The *Acta* were drawn up from day day, and exposed in a public place to be read or copied r all who chose to do so. After remaining there for a asonable time they were taken down and preserved with her public documents.

ACTA SENATUS, among the Romans, were minutes the discussions and decisions of the senate. These were so called *Commentarii Senatus*, and, by a Greek name, ›ομνήματα. Before the consulship of Julius Cæsar, inutes of the proceedings of the senate were written and casionally published, but unofficially. Cæsar first dered the minutes to be recorded and published autho- ›atively. The keeping of them was continued by ıgustus, but the publication was forbidden. Some pro- inent senator was usually chosen to draw up these *Acta.*

ACTÆON, in *Fabulous History*, son of Aristæus and ıtonoë, a famous hunter. He was torn to pieces by his m dogs. Various accounts are given of this occurrence; .t the best known story is that told by Ovid, who re- esents him as accidentally seeing Diana as she was .thing, when she changed him into a stag, and he was ırsued and killed by his dogs.

ACTIAN GAMES, in *Roman Antiquity*, solemn games stituted by Augustus, in memory of his victory over ıtony at Actium. See ACTIUM.

ACTINIA, a genus of cœlenterate animals, of which the ı-anemone is the type. See ACTINOZOA.

ACTINISM (from ἀκτίς, a ray), that property of the lar rays whereby they produce chemical effects, as in otography. The actinic force is greatest in the blue and ›let rays of the spectrum.

ACTINOMETER (*measurer of solar rays*), a thermo- ›ter with a large bulb, filled with a dark-blue fluid, and closed in a box, the sides of which are blackened; and e whole covered with a thick plate of glass. It was the vention of the late Sir John Herschel, and was first scribed in the *Edinburgh Journal of Science* for 1825. is used for measuring the heating power of the sun's ys, the amount of which is ascertained by exposing the lb for equal intervals of time in sunshine and shade ›ernately.

ACTINOZOA, a group of animals, of which the most miliar examples are the sea-anemones and "coral insects" the older writers. The term was first employed by Blainville, to denote a division of the Animal Kingdom ›ving somewhat different limits from that to which its plication is restricted in the present article; in which it applied to one of the two great divisions of the CŒLEN- ›RATA, the other being the *Hydrozoa.*

The *Actinozoa* agree with the *Hydrozoa* in the primitive .d fundamental constitution of the body of two membranes, *ectoderm* and an *endoderm*,—between which a middle yer or *mesoderm* may subsequently arise,—in the absence a completely differentiated alimentary canal, and in ›ssessing thread cells, or nematocysts; but they present a mewhat greater complexity of structure.

This is manifest, in the first place, in their visceral tube, or "stomach," as it is often called, which is continued from the margins of the mouth, for a certain distance, into the interior cavity of the body, but which is always open at its fundus into that cavity. And, secondly, in the position of the reproductive elements, which, in the *Hydrozoa*, are always developed in parts of the body wall which are in immediate relation with the external surface, and generally form outward projections; while, in the *Actinozoa*, they are as constantly situated in the lateral walls of the chambers into which the body cavity is divided. In consequence of this arrangement, the ova, or sexually generated embryos, of the *Actinozoa* are detached into the interior of the body, and usually escape from it by the oral aperture; while those of the *Hydrozoa* are at once set free on the exterior surface of that part of the body in which they are formed.

The *Actinozoa* comprise two groups, which are very different in general appearance and habit, though really similar in fundamental structure. These are—

1. The *Coralligena* or sea-anemones, coral animals, and sea-pens; and 2. The *Ctenophora.*

(1.) The *Coralligena.*—A common sea-anemone presents a subcylindrical body, terminated at each end by a disk. The one of these discoidal ends serves to attach the ordinarily sedentary animal; the other exhibits in the centre a mouth, which is usually elongated in one direction, and, at each end, presents folds extending down into the gastric cavity. This circumstance greatly diminishes the otherwise generally radial symmetry of the disk, and of the series of flexible conical tentacles which start from it; and, taken together with some other circumstances, raises a doubt whether even these animals are not rather bilaterally, than radially, symmetrical. Each tentacle is hollow, and its base communicates with one of the chambers into which the cavity of the body is divided, by thin membranous lamellæ, the so-called mesenteries, which radiate from the oral disk and the lateral walls of the body to the parietes of the visceral tube. The inferior edges of the mesenteries are free, and arcuated in such a manner as to leave a central common chamber, into the circumference of which all the intermesenteric spaces open, while above, it communicates with the visceral tube. The tentacles may be perforated at their extremities, and, in some cases, the body wall itself exhibits apertures leading into the intermesenteric spaces. The free edges of the mesenteries present thickenings, like the hem of a piece of linen, each of which is much longer than the distance between the gastric and the parietal attachment of the mesentery, and hence is much folded on itself. It is full of thread cells. The mesoderm, or middle layer of the body, which lies between the ectoderm and the endoderm, consists of a fibrillated connective tissue, containing fusiform or stellate nucleated cells, and possesses longitudinal and circular muscular fibres. These are prolonged into the mesenteries, and attain a great development in the disk of attachment, which serves as a sort of foot like that of a limpet.

The question whether the *Coralligena* possess a nervous system and organs of sense, hardly admits of a definite answer at present. It is only in the *Actinidæ* that the existence of such organs has been asserted; and the nervous circlet of *Actinia*, described by Spix, has been seen by no later investigator, and may be safely assumed to be non-existent. But Professor P. M. Duncan, F.R.S., in a paper "On the Nervous System of *Actinia*," recently communicated to the Royal Society, has affirmed the existence of a nervous apparatus, consisting of fusiform ganglionic cells united by nerve fibres, which resemble the sympathetic nerve fibrils of the *Vertebrata*, and form a plexus, which appears to extend throughout the pedal disk, and very probably into other parts of the body. In some of

the *Actinidæ* (*e.g.*, *Actinia mesembryanthemum*), brightly coloured bead-like bodies are situated on the oral disk outside the tentacles. The structure of these "chromatophores," or "bourses calicinales," has been carefully investigated by Schneider and Röttekem, and by Professor Duncan. They are diverticula of the body wall, the surface of which is composed of close-set "bacilli," beneath which lies a layer of strongly-refracting spherules, followed by another layer of no less strongly refracting cones. Subjacent to these Professor Duncan finds ganglion cells and nerve plexuses. It would seem, therefore, that these bodies are rudimentary eyes.

At the breeding season the ova or spermatozoa are evolved in the thickness of the mesenteries, and are discharged into the intermesenteric spaces, the ova undergoing their development within the body of the parent. The yelk, usually, if not always, enclosed in a vitelline membrane, undergoes complete division, and the outer wall of the ciliated blastodermic mass which results becomes invaginated, the embryo being thereby converted into a double walled sac—the external aperture of which is the future mouth, while the contained cavity represents the body cavity. In this stage the larval *Actinia* represents the *Gastrula* condition of sponges and *Hydrozoa*. The edges of the oral aperture grow inwards, giving rise to a circular fold, which is the rudiment of the visceral tube. This is at first connected with the body wall by only two mesenteries, which are seated at opposite ends of one of the transverse diameters of the body. As the mesenteries increase in number, the tentacles grow out as diverticula of the intermesenteric spaces.

In all the *Coralligena*, the development of which has been observed, the embryo is converted into a simple actinozoon in a similar manner; but from this point they diverge in two directions. In one great group, the mesenteries, and the tentacles which arise from the intermesenteric chambers, increase in number to six; and then, in the great majority of cases, the intermesenteric spaces undergo subdivision by the development of new mesenteries, according to curious and somewhat complicated numerical laws, until their number is increased to some multiple of five or six. In these *Hexacoralla* (as they have been termed by Haeckel) the tentacles also usually remain rounded and conical. In the other group, the *Octocoralla*, the mesenteries and the tentacles increase to eight, but do not surpass that number; and the tentacles become flattened and serrated at the edges, or take on a more or less pennatifid character.

There are no *Octocoralla* which retain the simple individuality of the young actinozoon throughout life; but all increase by gemmation, and give rise to compound organisms, which may be arborescent, and fixed by the root end of the common stem, as in the *Alcyonidæ* and *Gorgonidæ*; or may possess a central stem which is not fixed, and gives off lateral branches which undergo comparatively little subdivision, as in the *Pennatulidæ*.

The body cavities of the zoöids of these compound *Octocoralla* are in free communication with a set of canals which ramify through the *cœnosarc*, or common fabric of the stem and branches by which they are borne, and which play the part of a vascular system.

Except in the case of *Tubipora*, the zoöids and the superficial cœnosarc give rise to no continuous skeleton; but the deep or inner substance of the cœnosarc may be converted into a solid rod-like or branching stem.

In the *Hexacoralla*, on the other hand, one large group, that of the *Actinidæ*, consists entirely of simple organisms,—organisms that is, in which the primitive actinozoon attains its adult condition without budding or fission; or if it bud or divide, the products of the operation separate from one another. No true skeleton is formed, all are to some extent locomotive, and some (*Minyas*) float freely by the help of their contractile pedal region. The most remarkable form of this group is the genus *Cereanthus*, which has two circlets, each composed of numerous tentacles, one immediately around the oral aperture, the other at the margin of the disk. The foot is elongated, subconical, and generally presents a pore at its apex. Of the diametral folds of the oral aperture, one pair is much longer than the other, and is produced as far as the pedal pore. The larva is curiously like a young hydrozoon with free tentacles, and at first possesses four mesenteries, whence it may be doubted whether *Cereanthus* does not rather belong to the *Octocoralla*.

The *Zoanthidæ* differ from the *Actinidæ* in little more than their multiplication by buds, which remain adherent, either by a common connecting mass or cœnosarc or by stolons; and in the possession of a rudimentary, spicular skeleton.

On the other hand, the proper stone-corals (as contradistinguished from the red coral) are essentially *Actiniæ*, which become converted into compound organisms by gemmation or fission, and develope a continuous skeleton.

The skeletal parts[1] of the *Actinozoa*, to which reference has been made, consist either of a substance of a horny character; or of an organic basis impregnated with earthy salts (chiefly of lime and magnesia), but which can be isolated by the action of dilute acids; or finally, of calcareous salts in an almost crystalline state, forming rods or corpuscles, which, when treated with acids, leave only an inappreciable and structureless film of organic matter. The hard parts of all the *Aporosa*, *Perforata*, and *Tubulata* of Milne Edwards are in the last-mentioned condition; while, in the *Octocoralla* (except *Tubipora*) the *Antipathidæ*, and *Zoanthidæ*, the skeleton is either horny, or consists, at any rate, to begin with, of definitely formed spicula, which contain an organic basis, and frequently present a laminated structure. In the organ coral (*Tubipora*), however, the skeleton has the character of that of the ordinary stone-corals, except that it is perforated by numerous minute canals.

The skeleton appears, in all cases, to be deposited within the mesoderm, and in the intercellular substance of that layer of the body. Even the definitely shaped spicula of the *Octocoralla* are not the result of the metamorphosis of cells. In the simple aporose corals the calcification of the base and side walls of the body gives rise to the cup or *theca;* from this the calcification radiates inwards, in correspondence with the mesenteries, and gives rise to as many vertical *septa*, the spaces between which are termed *loculi;* while, in the centre, either by union of the septa or independently, a pillar, the *columella*, grows up. From the sides of adjacent septa scattered processes of calcified substance, or *synapticulæ*, may grow out toward one another, as in the *Fungidæ;* or the interruption of the cavities of the loculi may be more complete by the formation of shelves stretching from septum to septum, but lying at different heights in adjacent loculi. These are *interseptal dissepiments.* Finally, in the *Tabulata*, horizontal plates, which stretch completely across the cavity of the theca, are formed one above the other and constitute *tabular dissepiments.*

In the *Aporosa* the theca and septa are almost invariably imperforate; but in the *Perforata* they present apertures, and in some madrepores the whole skeleton is reduced to a mere network of dense calcareous substance. When the *Hexacoralla* multiply by gemmation or fission, and thus give rise to compound massive or aborescent aggregations, each newly-formed coral polype developes a skeleton

[1] See Kölliker's *Icones Histologicæ*, 1866.

of its own, which is either confluent with that of the others, or is united with them by calcification of the connecting substance of the common body. This intermediate skeletal layer is then termed *cœnenchyma*.

The *Octocoralla* (excepting *Tubipora*) give rise to no *thecæ* and their dependencies, the skeleton of each polype, and of the superficial portion of the polyparium, being always composed of loose and independent spicula. But in many, as the *Gorgonidæ*, *Pennatulidæ* (and in the *Antipathidæ* among the *Hexacoralla*), the central part of the common stem of the compound organism becomes hardened, either by conversion into a mere horny axis (which may be more or less impregnated with calcareous salts) without spicula; or the cornification may be accompanied by a massive development of spicula, either continuously or at intervals; or the main feature of the skeleton may, from the first, be the development of spicula, which become soldered together by a subcrystalline intermediate deposit, as in the red coral of commerce (*Corallium rubrum*).

It has seemed advisable to say thus much concerning the hard parts of the *Actinozoa* in this place, but the details of the structure and development of the skeleton of the *Coralligena* will be discussed under CORALS and CORAL REEFS.

The *Tabulata*, or Millepores, and the *Rugosa*, an extinct and almost exclusively Palæozoic group of stone-coral forming animals, are usually referred to the *Coralligena*. Judging by the figures given by Agassiz[1] of living Millepores, the polypes which cover its surface are undoubtedly much more similar to coryinform *Hydrozoa* than they are to any *Actinozoon*. But it is to be observed, firstly, that we have no sufficient knowledge of the intimate structure of the polypes thus figured; and, secondly, that the figures show not the least indication of the external reproductive organs which are so conspicuous in the *Hydrozoa*, and which surely must have been present in some one or other of the Millepores examined, were they really *Hydrozoa*. As regards the *Rugosa*, the presence of septa is a strong argument against their belonging to any group but the *Actinozoa*, though it is not to be forgotten that a tendency to the development of septiform prominence is visible in the walls of the gastric passages of certain calcareous sponges.

Phenomena analogous to the "alternation of generations," which is so common among the *Hydrozoa*, are unknown among the great majority of the *Actinozoa*. But Semper[2] has recently described a process of sexual multiplication in two species of *Fungiæ*, which he ranks under this head. The *Fungiæ* bud out from a branched stem, and then become detached and free, as is the habit of the genus. To make the parallel with the production of a *Medusa* from a *Scyphistoma* complete, however, the stem should be nourished by an asexual polype of a different character from the forms of *Fungiæ* which are produced by gemmation. And this does not appear to be the case.

Dimorphism has been observed by Kölliker to occur extensively among the *Pennatulidæ*. Each polypary presents at least two different sets of zoöids, some being fully developed, and provided with sexual organs, while the others have neither tentacles nor generative organs, and exhibit some other peculiarities.[3] These abortive zoöids are either scattered irregularly among the others (*e.g.*, *Sarcophyton*, *Veretillum*), or may occupy a definite position (*e.g.*, *Virgularia*).

(2.) The *Ctenophora*.—These are all freely swimming, actively locomotive, marine animals, which do not multiply by gemmation, nor form compound organisms such as the polyparies of the *Coralligena*. Like the latter they are composed of a cellular ectoderm and endoderm, between which a mesoderm, containing stellate connective tissue corpuscles and muscular fibres, is interposed. But, in most parts of the organism, the mesoderm acquires a great thickness and a gelatinous consistency; so that the body of one of these animals differs in this respect from that of an *Actinia* in the same way as the body of a *Cyanæa* differs from that of a *Hydra*. The bilateral symmetry, which is obscure in most of the *Coralligena*, becomes obvious in the *Ctenophora*, in which the parts are disposed symmetrically on each side of a vertical plane passing through the longitudinal axis of the body. The oral aperture is situated at one end of this axis (or its oral pole), while at the opposite extremity (or aboral pole) there is very generally situated a sac containing solid mineral particles—the *lithocyst*.

The oral aperture leads into a visceral tube, which undoubtedly performs the functions of a stomach. Nevertheless, as in the *Coralligena*, it is open at its aboral end, and its cavity is thus placed in direct communication with a chamber, whence canals are given off which penetrate the gelatinous mesoderm. Of these canals, one continues the direction of the axis of the body, and usually ends by two apertures at the aboral pole. The others take a direction in a plane more or less at right angles with the axis; and after branching out, terminate in longitudinal canals, which lie beneath the series of locomotive paddles, or come into relation with the tentacles when such organs are developed. In addition to these, two canals frequently extend along the sides of the stomach towards the oral pole. The paddle-like locomotive plates are disposed in eight longitudinal series (*ctenophores*) on the outer surface of the body. They are thick at the base; thin and, as it were, frayed out into separate filaments, at their free edges; and each plate is set transversely to the long axis of the series of which it forms a part. The ovaria and testes are developed in the side walls of the longitudinal canals. It is clear, therefore, that these canals answer to the intermesenteric spaces of an *Actinia*; that the common cavity into which they and the stomach open answers to the common cavity of the body of the *Actinia*; that the apertures at the aboral pole answer to the terminal aperture of *Cereanthus*; and that the wide interspaces between the longitudinal canals represent the mesoderm of the Actinian mesenteries immensely thickened.

In their development the *Ctenophora* resemble the *Coralligena* in all essential respects, though they differ from them in some details. Thus the process of yelk division goes on at a different rate in the two moieties of the egg, so that the vitellus becomes divided into one set of small and another set of large cells, whereof the latter become overlaid by the former, and give rise to a large-celled hypoblast, enclosed within a small-celled epiblast. But in the manner in which the body cavity is formed, and the visceral tube (which becomes the stomach) is developed, the *Ctenophora* resemble the *Actiniæ*. The paddles make their appearance at four points of the circumference of the body, in the form of elevations beset with short cilia; but each of these divides into two, and thus the eight definitive series are constituted.

There is a general agreement among anatomists respecting the structure of the *Ctenophora* thus far; but the question whether they possess a nervous system and sensory organs or not, is, as in the case of the *Coralligena*, one upon which there exists great diversity of opinion. Grant originally described a nervous ganglionated ring, whence longitudinal cords proceed in *Cydippe* (*Pleurobrachia*);

[1] *Contributions to the Natural History of the United States*. Vol. iii. Plate xv.

[2] *Ueber Generations-Wechsel bei Steinkorallen*. Leipzig, 1872.

[3] *Abhandlungen der Senkenbergischen Naturforschenden Gesellschaft*, bd. vii. viii.

but his observation has not been verified by subsequent investigations. According to Milne Edwards, followed by others (among whom I must include myself), the nervous system consists of a ganglion, situated at the aboral pole of the body, whence nerves radiate, the most conspicuous of which are eight cords which run down the corresponding series of paddles; and a sensory organ, having the characters of an otolithic sac, is seated upon the ganglion. Agassiz and Kölliker, on the other hand, have denied that the appearances described (though they really exist) are justly interpreted. And again, though the body, described as an otolithic sac, undoubtedly exists in the position indicated in all, or most, of the *Ctenophora*, the question has been raised whether it is an auditory or a visual organ.

These problems have been recently reinvestigated with great care, and by the aid of the refined methods of modern histology, by Dr Eimer,[1] who describes a nervous system, consisting of extremely delicate varicose ultimate nerve fibrils, which traverse the mesoderm in all directions, and are connected here and there with ganglionic corpuscles. These nerves are only discernible with high magnifying powers, as they are for the most part isolated, and are collected into bundles only beneath the longitudinal canals. The mass which lies beneath the lithocyst is composed of cells, but these have none of the special characters of nerve cells. Eimer states that he has traced the filaments, which he considers to be nerves, into direct continuity with muscular fibres; and, around the mouth, into subepidermal bodies, which he regards as rudimentary forms of tactile corpuscles. The lithocyst is recognised as an auditory organ, and, in addition, eye-spots are described.

With a fundamental similarity of organisation, the form of the body varies extraordinarily in the *Ctenophora*. One of the genera which is commonest on our coasts—*Cydippe* (*Pleurbrachia*) is spheroidal; others (*Beroë*) are more ovate; others are provided with large lobular processes (*Eucharis*), while an extreme modification, in which the body is ribbon shaped, is seen in *Cestum*.

The *Ctenophora* are divisible into two very unequal groups:[2]

I. *Eurystomata*, in which the large oral aperture occupies the truncated extremity of the oval body.
   1. *Beroidæ*.

II. *Stenostomata*, in which the oral aperture and the gastric sac are small relatively to the size of the body.
   2. *Saccatæ*.
   3. *Lobatæ*.
   4. *Tæniatæ*.

1. *Beroïdæ*.

The body is ovate, truncated at the oral pole, the aboral being more or less acuminate and mobile. The digestive cavity occupies a large portion of the body. The oral margin is simple in *Beroë* and *Idyia*; but in *Rangia* the interradial spaces are notched, and in each a short process projects. The radial canals are connected by a circumoral canal. No tentacles are present. The ctenophores of *Pandora* do not extend over more than half the body, as in the embryos of *Cydippe*. The development of the *Beroïdæ* is unaccompanied by metamorphosis.

2. *Saccatæ*.

The circumoral canal is absent. The oral aperture is laterally compressed, its long axis being at right angles to the plane of the tentacles, which are present in all the genera, and which are either simple (*Cydippe*), or furnished with lamellar and filamentous appendages (*Hormiphora*). The ctenophores are equal in length, or the lateral ones are fully developed, while the intermediate are shorter.

3. *Lobatæ*.

The oral and aboral pole, or the oral only, bear lobate appendages. *Bolinà* has a pair of oral lappets, into which the radial canals are prolonged. The ctenophores corresponding to these lobes are the longest, while the middle ones are much shorter, and are prolonged on to an auricle or finger-like lobe. The tentacles are represented by a tuft of short processes on either side of the mouth. The young *Bolinà* has the form of *Cydippe*, and like it bears a pair of long-fringed tentacles. The aboral region, bearing the lateral ctenophores, grows more rapidly than the oral, so as ultimately to project in two principal lobes, by which the similar outgrowth of the median aboral regions with its ctenophores is arrested, the auricles being the dwarfed representatives of these regions. These auricles in *Eucharis* are longer, so that the ctenophores are all of equal length. The tentacles of this genus are placed at the oral pole; the oral lobes are equivalent to the median ctenophores of *Cydippe*. *Eurhamphæa* has the oral lobes small, the body elongated, terminated by two conical projections, on which the median ctenophores are prolonged.

4. *Tæniatæ*.

The body of *Cestum* is laterally compressed and elongated in a direction which corresponds to one of the transverse diameters of *Cydippe*, the ribbon-like band thus formed being sometimes three or even four feet long. The tentacles are near the oral pole; the canals are ten in number; the medio-lateral canals terminate in trunks which follow the oral margin of the ribbon, and thus correspond to the circular canal of *Beroë*.

Many *Actinozoa* (*Pennatulidæ*, *Ctenophora*) are phosphorescent; but the conditions which determine the evolution of light have not been determined.

All *Actinozoa* are marine animals, and the distribution of many of the families (*Actinidæ*, *Turbinolidæ*, *Pennatulidæ*, *Beroïdæ*) is extremely wide, and bears no ascertainable relation to climate. (T. H. H.)

ACTION, *in Law*, is the process by which redress is sought in a court of justice for the violation of a legal right. The word is used by jurists in three different senses. Sometimes it is spoken of as a right—the right, namely, of instituting the legal process; sometimes, and more properly, it means the legal process itself; and sometimes the particular form which it assumes. The most universally recognised division of actions is the division established by the Roman lawyers into actions *in rem* and *in personam*. An action *in rem* asserts a right to a particular thing as against all the world; an action *in personam* asserts a right only as against a particular person. For the sake of convenience, the law relating to actions ought to form a separate section by itself in a properly constructed code.

In Roman law the action passed through three historical stages—

In the first period, which was brought to an end by the *Lex Æbutia*, about 573 A.U.C., the system of *legis actiones* prevailed. These were five in number,—the *actio sacramenti, per judicis postulationem, per condictionem, per manus injectionem, per pignoris captionem*. The first was the primitive and characteristic action of the Roman law, and the others were little more than modes of applying it to cases not contemplated in the original form, or of carrying the result of it into execution when the action had been decided.

ACTION, in *English Law*, means the form of civil process hitherto observed in the Courts of Common Law. The procedure in the Court of Chancery is totally distinct, but some account of the former may be desirable in order to explain the new form of action introduced for all the civil courts by the Judicature Act of 1873:—

Actions at law are divided by Blackstone into three classes, according to the relief which they are respectively intended to obtain. *Real* actions are those "whereby the plaintiff claims title to have any lands or tenements, rents, commons, or other hereditaments." In *personal* actions the claim is "for debt or personal duty, or damages in lieu thereof," or for "satisfaction in damages for some injury done to person or property." *Mixed* actions were supposed to partake of the nature of both of these; that is to say, there was a demand both for real property and for personal damages, as in the case of an action for waste. The distinction has long ceased to be of any value. Blackstone speaks of real actions as being in his time pretty generally laid aside, and successive enactments have obliterated the distinctions altogether. The statute 3 & 4 Will. IV. c. 27, abolished all the real and mixed actions, except three real actions, and ejectment, which was a mixed action. The Common Law Procedure Act of 1860 has assimilated the procedure in the former to an ordinary action, and the Common Law Procedure Act of 1852 now regulates the proceedings in ejectment. In these and other respects the three Common Law Procedure Acts of 1852, 1854, and 1860, very greatly simplified the proceedings in an action at law. The first of these rendered it unnecessary any longer to select a *form* of action in prosecuting a claim, and abolished many of the technicalities which had accompanied the older forms. The divi-

[1] *Zoologische Studien auf Capri*. 1873.

[2] Haeckel, "*Generelle Morphologie*," ii. lxi.

sions now observed may be regarded as indicating, not so much forms of action in the old sense, as the character of the injury sustained and the relief sought.

ACTION (under the Supreme Court of Judicature Act, 1873). By this Act, which establishes one supreme court in place of the Superior Courts of Common Law and the High Court of Chancery, action is the name given to the proceeding in the High Court of Justice, which takes the place of the old actions at common law, suits instituted by bill or information in the Court of Chancery, causes *in rem* in the Court of Admiralty, or by citation in the Court of Probate. For these various modes of obtaining redress the Act substitutes one uniform proceeding, which retains most of the essential features of the common law action. The form of action established by the Act is in some measure a compromise between the old action at law and Chancery suit. It may be described as putting an end to the unintelligible and even misleading formulæ of the one and reducing the prolixity and redundance of the other. (E. R.)

ACTIUM, in *Ancient Geography*, a promontory in the north of Acarnania, at the mouth of the Sinus Ambracius, opposite the town of Nicopolis, built by Augustus on the north side of the strait. Eastwards from the promontory the strait widens out and forms a safe harbour. On the promontory was an ancient temple of Apollo (who is hence called by Virgil *Actius*), which was enlarged by Augustus. Actium became famous on account of Augustus's victory over Antony and Cleopatra (B.C. 31), and for the quinquennial games he instituted there, called *Actia* or *Ludi Actiaci*. *Actiaca Æra* was a computation of time from the battle of Actium. There was on the promontory a small town, or rather village, also called *Actium*.

ACTON, a large village in Middlesex, about eight miles west of St Paul's. It was once much frequented because of its saline springs, but these have long lost their repute. Acton being near the metropolis and easily accessible by the Great Western Railway, and the price of building land being low, numerous villas have been erected in the neighbourhood. The population of the parish increased from 3151 in 1861 to 8306 in 1871.

ACTON, SIR JOHN FRANCIS EDWARD, son of Edward Acton, who practised as a physician at Besançon, was born there in 1736, and succeeded to the title and estates in 1791, on the death of his cousin in the third degree, Sir Richard Acton. He served in the navy of France, and afterwards in that of Tuscany, and commanded a frigate in the joint expedition of Spain and Tuscany against Algiers in 1774. His gallantry in rescuing three or four thousand Spanish soldiers from slavery led to his advancement. Entering the Neapolitan service, he gained the favour of Queen Mary Caroline, became commander-in-chief of the land and sea forces, then minister of finance, and ultimately prime minister. His policy was devised in concert with the English ambassador Hamilton, and, of course, was hostile to France and to the French party in Italy. He has been held responsible for the arbitrary and despotic measures which, in 1798–99, filled the prisons of Naples with political prisoners, and even brought some of them to the scaffold. In 1803 Acton was for a short time deprived of the reins of government at the demand of France; but he was speedily restored to his former position, which he held till, in Feb. 1806, on the entry of the French into Naples, he had to flee with the royal family into Sicily. He died at Palermo on the 12th Aug. 1811, leaving by his wife (eldest daughter of his brother, General Joseph Edward Acton, whom he had married by papal dispensation) three children, of whom the second, Charles Januarius Edward, was made Cardinal Santa Maria della Pace in 1842. It may be well to state that Sir John has very frequently been confounded with his above-mentioned brother, born in 1737, who was also employed in the Neapolitan service.

ACTUARY, in ancient Rome, was the name given to the clerks who recorded the *Acta Publica* of the Senate, and also to the officers who kept the military accounts and enforced the due fulfilment of contracts for military supplies. In its English usage the word has undergone a gradual limitation of meaning. At first it seems to have denoted any clerk or registrar; then more particularly the secretary and adviser of any joint-stock company, but especially of an insurance company; and it is now applied specifically to one who makes those calculations as to the probabilities of human life, on which the practice of life assurance and the valuation of reversionary interests, deferred annuities, &c., are based. The first mention of the word in law is in the Friendly Societies Act of 1819, where it is used in the vague sense, "actuaries, or persons skilled in calculation." The word has been used with precision since the establishment of the "Institute of Actuaries of Great Britain and Ireland" in 1848. The "Faculty of Actuaries in Scotland" was formed at Edinburgh in 1856, and incorporated by royal charter in 1868. The registrar in the Lower House of Convocation is also called the actuary.

ACUÑA, CHRISTOVAL D', a Spanish Jesuit, born at Burgos in 1597. He was admitted into the society in 1612, and, after some years spent in study, was sent as a missionary to Chili and Peru, where he became rector of the College of Cuença. In 1639 he was appointed by the Jesuits to accompany Pedro Texeira in his second exploration of the Amazon, in order to take scientific observations, and draw up a report that might be sent to Spain. The journey lasted for ten months; and, on their arrival at Peru, no ship being ready to convey the explorer to Spain, Acuña employed himself in the preparation of a narrative of his journey. This was published at Madrid in 1641, under the title *Nuevo Descubrimiento del Gran Rio de las Amazonas, &c.* The King of Spain received Acuña coldly, and, it is said, even tried to suppress his book, fearing that the Portuguese, who had revolted from Spain, would avail themselves of the information which it contained. A translation into French was published by Gomberville in 1682; and a translation from the French into English appeared in 1698. After occupying the positions of procurator of the Jesuits at Rome, and *calificador* (censor) of the Inquisition at Madrid, Acuña returned to South America, where he died, probably soon after the year 1675.

ACUPRESSURE, in *Surgery* (*acus*, a needle, *premo*, I press), a method of restraining hæmorrhage, introduced in 1869 by the late Sir J. Y. Simpson. The closure of the vessel near the bleeding point is attained by the direct pressure of a metallic needle, either alone or assisted by a loop of wire. The advantages claimed by the originator of this method over the old silk ligature were, that the needles can be removed within forty-eight hours after introduction, allowing the wound to heal rapidly; and that, being metallic and non-porous, they do not cause irritation and suppuration like the silk ligature. The catgut ligature, which is rapidly absorbed, is gradually superseding both the silk ligature and the acupressure needle. A volume entitled *Acupressure*, by Sir J. Y. Simpson, was published in 1864.

ACUPUNCTURE, the name of a surgical operation among the Chinese and Japanese, which is performed by pricking the part affected with a silver needle. They employ this operation in headaches, lethargies, convulsions, colics, &c.; and it has more lately been introduced into British practice for the cure of some forms of neuralgia.

ADAFUDIA, a large town of Western Africa, in the country of the Felattahs, in 13° 6′ N. lat., 1° 3′ E. long., about 400 miles S.E. of Timbuctoo. It is surrounded by a mud wall. The neighbouring country is rich and

fertile. The trade in native merchandise is said to be as great as that of Abomey, the capital of Dahomey; and there is also a considerable traffic in slaves. Population, about 24,000.

ADAL, a region in Eastern Africa, with a coast line extending, between 11° 30′ and 15° 40′ N. lat., from the Gulf of Tajurrah to the neighbourhood of Massowah. For about 300 miles it borders on the Red Sea, the coast of which is composed of coral rock. It stretches inland to the mountain terraces, to the west of which lie the Abyssinian table-lands of Shoa and Tigré, with a breadth near Massowah of only a few miles, but widening towards the south to 200 or 300 miles. The northern portion of this region, known as the Afar country, is traversed by two routes to Abyssinia—the one from Zulla near Massowah, and the other from Amphilla Bay. The former of these was selected for the British Abyssinian expedition of 1868, Annesley Bay being the place of debarkation and base of operations. There is a third route to Abyssinia through Adal, that from Tajurrah to Ankobar, the capital of Shoa, said to be preferred for trading purposes, as being less steep than the others. The river Hawash flows through the southern district of Adal in a N.E. direction, but is lost in Lakes Abbebad and Aussa. Near this river is Aussa, the chief town of the country. Volcanic rocks occur in various parts of this district; and two mountains, 4000 feet high, are mentioned, which have sent down streams of lava on all sides to the distance of 30 miles. The country contains two great salt plains or basins,—that of Asali in its northern portion, and Aussa in the south. The remarkable salt lake of Bahr Assal, near Tajurrah, is 570 feet below the level of the sea. The country as a whole is barren and uncultivated. A little barley is reared on the higher terraces, and some districts afford pasturage for domestic animals, large quantities of butter being annually sent to Massowah. In some parts of Adal the elephant is not uncommon. The salt of Asali and Aussa is a valuable article of commerce. There is no fixed government, the country being inhabited by various independent tribes, all speaking the Afar language and professing the Mahometan religion, and most of them of nomadic habits.

ADALBERT, Saint, one of the founders of Christianity in Germany, known as the Apostle of the Prussians, was born of a noble family in Slavonia, about 955; was educated at the monastery of Magdeburg; and, in 983, was chosen Bishop of Prague. The restraints which he tried to impose on the newly-converted Bohemians by prohibiting polygamy, clerical incontinency, and similar sins, raised against him so strong a feeling of hatred, that he was forced, in 988, to retire to Rome, where he resided at the monasteries of Monte Basino and St Alexis. In 993 he returned to his flock, in obedience to the command of the Pope. Finding little amendment, however, in their course of living, he soon afterwards went again to Rome, and obtained permission from the Pope to devote himself to missionary labours, which he carried on chiefly in North Germany and Poland. While preaching in Pomerania (997), he was thrust through the heart by a heathen priest.

ADALBERT, Archbishop of Bremen and Hamburg, born of the noble Saxon family of the Counts of Wettin, was one of the most remarkable ecclesiastics of the 11th century. Through the friendship of the emperor Henry III. he was elevated in 1043, when only about thirty years old, to the see of Bremen and Hamburg, which included the whole of Scandinavia, and he accompanied the monarch in his journey to Rome (1046). Here it is said that he was offered and that he refused the papal throne. The refusal certainly cannot have arisen from lack of ambition; for on his return in 1050, with a commission as legate to the northern courts from Pope Leo IX., he immediately set about carrying out the emperor's wishes by establishing himself in an independent patriarchate of the north. For this purpose he sought by every means to augment his already great influence, he adorned his two cathedrals, and enlarged and fortified the town of Bremen so that it might rival Rome. There was much in his favour, and he might even have succeeded in entirely separating the church of the north from the see of Rome, had it not been for the death of Henry III., and the opposition of Cardinal Hildebrand. Henry IV. being a minor at the time of his father's death, Adalbert was associated with Archbishop Hanno of Cologne as guardian and regent; and during the absence of the latter on a mission to Rome, he sought, by granting every indulgence, to gain the favour of the young prince, and so to be able to exercise an absolute power in the state (1062–65). The Archbishops of Mayence and Cologne secured his banishment from court after the government had been assumed by Henry in person (1066); and about the same time his diocese was invaded by the "natural enemies" of Bremen, the Saxon nobles. In 1069, however, he was recalled, and reinstated in his former position. He died at Goslar in 1072, having done much during his last years to inflame the Saxons' hatred of Henry, which resulted soon afterwards in their revolt.

ADAM, אדם, an appellative noun, meaning the first man. In Genesis ii. 7, 25, iii. 8, 20, iv. 1, &c., it assumes the nature of a proper name, and has the article, *the man*, the only one of his kind; yet it is appellative, correctly speaking. In Genesis i. 26, 27, v. 2, it is simply appellative, being applied to both progenitors of the human race; not to the first man alone as in the second, third, and fourth chapters. The etymology of the word is uncertain, but it is probably connected with a root signifying *red*, so that the idea is one *red* or *ruddy*.

The early part of Genesis contains two accounts of man's creation. These narratives need not be examined at present farther than man's origin is concerned. In Genesis i. 26, 27, we read, "And God said, Let us make man in our image, after our likeness; and let them have dominion over the fish of the sea, and over the fowl of the air, and over the cattle, and over all the earth, and over every creeping thing that creepeth upon the earth. So God created man in his *own* image; in the image of God created he him; male and female created he them." At the end of the sixth day of creation man appears, the noblest of earth's inhabitants. In Genesis ii. 7, 8, we also read, "And the Lord formed man *of* the dust of the ground, and breathed into his nostrils the breath of life; and man became a living soul. And the Lord God planted a garden eastward in Eden; and there he put the man he had formed." The woman's creation is thus narrated in subsequent verses of the same chapter—20, 21, 22, 23, "And Adam gave names to all cattle, and to the fowl of the air, and to every beast of the field: but for Adam there was not found an help meet for him. And the Lord God caused a deep sleep to fall upon Adam, and he slept: and he took one of his ribs, and closed up the flesh instead thereof. And the rib, which the Lord God had taken from man, made he a woman, and brought her unto the man. And Adam said, This *is* now bone of my bones, and flesh of my flesh: she shall be called Woman, because she was taken out of man." Between these accounts some discrepancy exists. The first represents the man and woman to have been created together, after the various creatures which the earth sustains on its surface; the second makes Adam to have been created first, then the various animals, with the woman last of all. The creation of animals separates the origin of the man and the woman. The first narrator states that man was

made in the image and form of God, without explaining his meaning more particularly. Hence interpreters differ in attempting to define it. The language need not be restricted either to man's *spirit* or to his *body*, but may refer to his united whole, including spiritual qualities and bodily form. The ancient Hebrew did not think of God without a certain form, but transferred the human one to him, divesting it of grossness, and giving it an ethereal luminousness of surpassing glory. The image of God, therefore, in which Adam is said to have been created, includes the whole man, with special reference to the spiritual nature within him. We cannot tell whether the writer thought of immortality as involved in the God-likeness. He may have done so. But the second account teaches that man was only mortal at first, because he is sent out of Paradise lest he should become immortal by eating of the tree of life.

The narrative in the first chapter is arranged according to a definite plan. Six days are allotted to the creation of the heavens and earth, with all their furniture animate and inanimate. After due preparation had been made by the formation of light, atmosphere, and land separated from water, life is called into existence, first vegetable, then animal, terminating in man the lord of this lower world. The narrative in chapters ii.–iv. does not present such orderly progress. In it man is the central figure, to whom all is subordinated. He is created first. For him plants and trees are made to spring up. He is placed in a delightful garden. The Lord God perceiving his solitary condition creates the beasts of the field and the fowls of the air; but when brought to the protoplast, they were insufficient to supply his mental void, so that woman was made, in whom he found a suitable partner. A number of questions connected with the first pair, not necessarily entering into the writer's main purpose in describing man's origin, but complementary and new, are, the means by which the ground yielded vegetable productions, the materials from which the man and the woman were formed, the cause of their intimate union, the place of their abode, the simplicity of their condition, and the way in which animals first received their names. By these traits preparation is made for the history of what befell the protoplasts in their primitive abode.

According to the second narrative, Jehovah planted a garden in Eden, eastward, and put the first man there. A spring or stream rising in Eden, and flowing through the garden, supplied it with water. In issuing from the garden it divided itself into four rivers, each having its own course. The writer gives their names, and the countries washed by three of them. This garden, usually termed *Paradise* after the Septuagint and Vulgate, has been eagerly sought for; but it has baffled curiosity. Though two of the rivers, the Euphrates and Tigris, are well known, the other two, Pison and Gihon, can only be identified with difficulty. They seem to be rivers of Northern India. The Tigris and Euphrates took their rise in the high land of Northern Armenia; the Pison, *i.e.*, Indus, rises in the Himalayas; and the Gihon, *i.e.*, Oxus, is connected with Ethiopia or Cush. The writer appears to have considered them all as having their source in the northern highlands of Asia, and flowing south, and therefore he placed Eden somewhere in the north of Asia. The names of two rivers belonging to a foreign tradition, and little known to the Hebrews because intercourse with India was then remote, were associated with those of two known ones incorporated in the national tradition. If the interpreter had to do with pure history, it might not be amiss to search for Eden in some definite locality; but, as the case stands, the examination would probably be fruitless.

The garden has two remarkable productions—the tree of life, and the tree of knowledge of good and evil. The former derives its name from the virtue of its fruit to impart perpetual life or immortality. The fruit of the latter communicates the knowledge of good and evil. It awakens moral consciousness. The one had to do with physical, the other with spiritual life. Such were the miraculous powers of the two trees in the midst of the garden.

The third chapter gives an account of the first pair falling away from the state in which they were created. What that state was may be clearly gathered from the words. It was one of innocent simplicity. The protoplasts had a child-like unconsciousness of evil; no knowledge of right and wrong, virtue and vice. They were in the happy condition of infancy. Their moral existence had not begun. Perfection, uprightness, righteousness, could not be predicated of them. But the world presents vice and its concomitant misery in strong colours. Misery and evil abound. The eyes of an Oriental especially must have been vividly struck with the phenomena of toilsome work, the pains of child-bearing, the slavery of woman, and the inevitable necessity of death. The Hebrews, accordingly, meditated on the cause. The writer seeks to connect with the problem incidental phenomena, as the love of man and wife, the form of the serpent different from that of other animals, the mutual hatred of man and serpents, &c. It is an old question, the introduction of evil into the world. As all the posterity of the first pair participate in sin and suffering, the cause must be looked for in connection with these. Yet it must not proceed from themselves. God had made them innocent and happy. The origin of evil must come from without. A serpent becomes the instrument of their temptation. That cunning and mischievous animal seduces them. The writer thought of nothing but the creature itself. Those who suppose that the devil employed the serpent as his instrument, or that the devil alone is spoken of, are confronted by the fact that the idea of Satan was of later introduction among the Hebrews than the age of the writer. The curse pronounced on the tempter sufficiently shows that none but the agent expressly named was thought of.

Are these narratives of the creation, primal abode, and fall of man, literal history? So some have always believed, with Augustine and the Reformers. The difficulties in the way of this interpretation are great. As it cannot be carried out consistently, its advocates resort to various expedients. They forsake the literal for the figurative wherever necessity demands. Thus they put a figurative construction on the language of the curse, because they allege that a literal one would be frigid, utterly unworthy of the solemn occasion, highly inconsistent with the dignity of the speaker and the condition of the parties addressed. Sometimes they even incline to regard the narrative as a sort of poem, or give it a poetical character. The atmosphere in which the accounts move is different from the literal one. Instead of assuming that God created the world and all it contains in a moment of time, and in harmonious arrangement, the first writer attributes creation to six successive days, represents the Almighty as addressing the newly-formed existences, looking upon them with satisfaction, pronouncing them good, and resting on the seventh day. He naturally chose the six days of the Hebrew week, with which he was familiar, for successive gradations of the creative power. In the second account we find a speaking serpent, God walking in a human way in the cool of the day through the garden, his jealousy of the aspiring Adam who had attained a higher knowledge, his cursing the serpent, and cherubim with a flaming sword. To explain all this as literal history, were to attribute other perfections to the

Deity than infinite power, spirituality, and wisdom. Hence the Church of England, according to Horsley, does not demand the literal understanding of the document contained in the second and third chapters, as a point of faith.

Are the narratives allegorical? So Philo[1] interprets them, followed by the Greek fathers of Alexandria, Clement and Origen,[2] as well as by Ambrose. In modern times Coleridge read the whole as an allegory.[3] So did Donaldson in his *Jashar*. There is no indication, however, that allegories were intended. Had this been the case, the truths meant to be conveyed would have been easily discovered. The embarrassment and capriciousness of the allegorical interpreters prove that they have followed a wrong method. The outward form is set aside, and an idea discovered beneath it with which the envelope has no necessary connection. Both should be retained; the shell suggesting the kernel, and the kernel showing itself to be the necessary evolution of central ideas.

According to another interpretation, more commonly accepted among scholars at the present day, both accounts are supposed to be, like the early records of other nations, traditional and mythical. This does not imply that they are fables or fictions; far from it. It is true that the oldest traditions of peoples are mainly subjective, the result of the national mind; but they are nevertheless real. Variable, developed in different forms, influenced by the characteristics of the people and by their intercourse with others, they are all that constitutes the earliest history of nations, the shapings of oral tradition before written records appeared. A mythological age stands at the head of all national histories; and that of the Hebrews seems to be no exception. The two narratives present philosophical mythi in a historical form. They represent the best ideas of the Hebrews at a certain stage of their history in explanation of the creation of man, his primeval abode and state, and the cause of his degeneracy. The first account is plain and simple. It assigns a high dignity to man, and traces all human beings to a single pair, in harmony with the best evidence of modern science that points to unity of origin, rather than to different centres of creation. There is a naturalness in the narrative that cannot be mistaken, while the writer adheres to generalities. (See Gabler's *Einleitung* to *Eichhorn's Urgeschichte*, vol. i. p. 11, &c.; and Gesenius's article "Adam," in *Ersch und Gruber's Encyklopædie*, vol. i.)

On the other hand, the narrator in the second, third, and fourth chapters manifests a more reflective spirit, seeking to explain causes, and to trace connections. Supplying particulars wanting in the older narrative, and correcting others, he enters into details, and though more anthropomorphic, has a finer perception of circumstances associated with the protoplasts. Tholuck himself admits his narrative to be a mythus. It is usual to designate the first writer the Elohist; the second, the Jehovist; because the one commonly uses Elohim as the name of God; the other Jehovah, or Jehovah Elohim in the second and third chapters.

The Adam in the second and third chapters, according to this view, is the progenitor and representative of humanity, who brought misery into the world by self-will. He is ideal man, becoming historical in every individual who, as soon as his moral nature is awakened, feels the power and the possibility of rising higher through reason and perception. Adam's procedure repeats itself in each individual, who has his paradise, eats of the tree of knowledge, and feels within him the roots of apostasy from God. On the other hand, his restoration and happiness are supposed to be in his own power. His salvation is practicable through the victory of reason over instinct, of faith over sense.[4]

The traditions of ancient nations present analogies to the creation of man given in the first chapter of Genesis. The Etrurian comes nearest to the Hebrew. There creation takes place in six periods of a thousand years each, and men appear in the last, after the earth, sun, moon, and stars, with all living things on the surface of the globe, had been brought into existence by God.[5] The Persian mythology, in like manner, makes Ormuzd, the god of light, create by his word *Honover* the visible world in six periods of a thousand years each, and man is formed last. The name of the first man is Kaiomorts.[6] The Chaldee myth, given by Berosus, presents little resemblance to the Hebrew narrative. Bel, the highest god, divided the darkness, and cut the woman, who ruled over the monstrous creatures found at first in *the all*, into two halves, out of which heaven and earth were formed. After that he cut off his own head. The blood trickling down was taken by other gods and mixed with earth, from which men were formed, who are therefore wise, and partakers of the divine intelligence.[7] The Phenician myth is still more unlike the Hebrew account.[8] But Ovid's teaching is that man was made in the image of the gods, and was intended to be ruler of the earth.[9] The Egyptian theology has no point of contact with the Hebrew.[10] The Indian accounts are very numerous, but often discrepant. Their likeness to the Hebrew narrative is remote; for the play of imagination appears in them to excess and absurdity. Among those myths in which the formation of men is described without allusion to any primordial distinction of castes, we may quote two. Prajapati, *i.e.*, the universe which was soul and only one, formed animals from his breaths, *a man* from his soul. The soul is the first of the breaths. Since he formed a man from his soul, therefore they say, "man is the first of the animals, and the strongest." The soul is all the breaths; for all the breaths depend upon the soul. Since he formed man from his soul, therefore they say, "man is all the animals;" for all these are man's.[11] Manu's account of the creation is that men of the four castes proceeded separately from different parts of Brahma's body prior to the division of that body into two parts. The doctrine of emanation appears in the Indian cosmogonies, as also that of absorption. Thus Brahma is reabsorbed into the supreme spirit, according to Manu.[12] According to the Bamians in India, God having made the world and the creatures belonging to it, created man, who came forth from the earth at the divine voice, his head appearing first, then his whole body, into whom life was conveyed. God gave him for companion a woman, and the two lived together as man and wife, feeding on the fruits of the ground. They had four sons of different temperaments, for whom God made four women, and the four quarters of the earth were peopled by their progeny.[13]

The paradisiacal state of the first pair, and their loss of it as described in the second and third chapters of Genesis, have their parallels in the myths of ancient nations. According to the Persian traditions, Meschia and Meschiane, the progenitors of mankind, were created for happiness in

1 *De mundi Opificio*, p. 37, vol. i. ed. Mangey.
2 *Philocalia*, cap. 1, and contra Cels.
3 *Aids to Reflection*, p. 241, note (Burlington edition of 1840).

4 See Tuch's *Kommentar ueber die Genesis*, p. 50.
5 *Suidas*, s. v. Τυῤῥηνία, vol. ii. pp. 1248–9, ed. Bernhardy.
6 *Kleuker*, i. 19, 20; iii. 59, &c.
7 Eusebius's *Chron. Bipartitum*, vol. i. p. 24, ed. Aucher.
8 See *Sanchoniatho*, translated by Cory, in the *Phenix*, p. 185, &c., ed. New York.
9 *Metamorphos*, i. 76, &c.; Opera ed. Burmann, tom. ii. p. 20.
10 Roeth's *Geschichte der Philos*. i. p. 131, &c.
11 Muir's *Sanskrit Texts*, vol. i. p. 24, 2d ed.
12 *Ibid*. p. 53, &c.
13 See Lord's *Display of two Foreign Sects in the East Indies*, chapter i. p. 1, &c.

this world and the next, on condition that they were good, and did not worship Dews. At first they acted according to their original nature, acknowledging that all beings were derived from Ormuzd. But they were seduced by an evil spirit, and clothed themselves in black for thirty days. After that they went out to hunt, and found a white goat, of whose milk they drank. In this they sinned against their body, and were punished. The evil spirit or Dew presented himself to them again, giving them fruits to eat, by which they forfeited a hundred enjoyments. At first they covered themselves with the skins of dogs, and ate the flesh of these animals. They hunted and made themselves clothing of the skins of deer.[1]

Abriman is represented as a poisonous serpent, and springs in this form from heaven to earth.[2] Dews often take the same form.[3]

The tree *Hom* among them is similar to the tree of life. It imparts immortality, and is called the king of trees.[4]

The holy mountain or paradise of Persian tradition is *Albordj*, the abode of Ormuzd and the good spirits, which sends forth great rivers.[5] This means the Hindu Koosh mountains where was *Airjana veedjo*, the first seat of the Aryan race. Here we have mention of a district *Heden;* and Zoroaster is said to have been born in *Hedenesch*, but elsewhere in *Airjana veedjo*.[6]

According to the religion of Lâma or the Calmucks, men lived in the first age of the world 80,000 years. They were holy and happy. But their happiness came to an end. A plant, sweet as honey, sprang out of the earth, of which a greedy man tasted, and made others acquainted with it. A sense of shame was awakened, and therefore they began to make themselves coverings of the leaves of trees. Their age and size decreased. Virtue fled, and all manner of vice prevailed.[7] The paradisiacal state of Thibetan mythology is one of perfection and spirituality. But the desire to eat of a sweet herb, *schima*, put an end to that condition. Shame sprang up within the fallen; the need of clothing was felt. They were driven to agriculture by necessity. Virtue fled, murder, adultery, and all other vices succeeded.[8]

Among the Indians, the holy mountain of the north, the seat of the gods, and the source of the great rivers, was *Meru*.[9] The tree *Parijata*, brought from heaven to earth by Krishna, with its heavenly flower and fruit, scares away hunger, thirst, disease, old age, &c.[10]

The Greek myths are remotely parallel. Hesiod describes the primitive state as one free from toil, sickness, and all kinds of evil. Mortals were contented with easily obtained, though poor, sustenance. But cunning Prometheus deceived Zeus, and stole fire from heaven. The latter, by way of punishment, sent a beautiful woman, Pandora, whom Epimetheus accepted as a gift. Having with her a vessel into which all sorts of misery had been put, she opened it out of curiosity, and evils flew forth in abundance, filling the earth. Hope alone remained at the bottom.[11]

The story is supplemented and modified in the *Theogony*. There Prometheus is twice punished, and woman becomes the source of man's evils, merely as the original mother of the race. There is also a reconciliation between Zeus and Prometheus.[12]

In Æschylus mankind are presented in the ignorance of infancy till Prometheus implanted in them the power of intellect, and the capability of knowledge. The fire from heaven is not the cause of the evils that broke in upon them; rather is it the teacher of every art, and the opener up of infinite resources; but Prometheus himself must endure fearful punishment for his self-will, in paying too much regard to mortals. Still there is an intimation of future reconciliation between the opposing powers, Zeus and Prometheus.

The points of similarity between the Old Testament and this Greek representative of man's fall are tolerably plain. In both there is an original state marked by freedom from sorrow, by complete earthly enjoyment and undisturbed peace with God. Both attach the origin of evil to the act of a free being putting himself in opposition to God—evil being the punishment of that act, arising by means of a woman. As the Old Testament narrative implies that the step taken by man was not a mere degeneracy, so Æschylus's description admits that it was for humanity the beginning of a richer and higher life, since man's proper destiny could not be worked out in a condition of childlike incapacity. Pandora reminds us of Eve; Epimetheus of Adam. Prometheus and the serpent both wish to make men like God in knowledge and happiness.[13] The tragic poet seems to regard Prometheus as the archetype of man, so that his fate is theirs. Like every strong-willed mortal, Prometheus flounders on the rock of presumption. He persists in acting contrary to the commands of Deity, and endures torture till he submits to a higher will, accepting the symbols of repentance and restraint within certain limits. Thus, like Adam, he is the representative of humanity.

The fundamental difference between the Hebrew and Greek narratives is, that the distinction between God and the world, spirit and nature, maintained with all sharpness in the one, is not carried out in the other. On the contrary, the Greek myth mixes the two spheres, so that the world appears as the original, independent element, of which spirit and deity are mere products. In the Hebrew narrative the spiritual features are presented clearly and simply; in the Greek they are indistinct, because transferred to the sensuous world and covered with a luxuriant growth of outer nature.[14]

Ovid paints the golden age in the manner of Hesiod, but with more details. It was pervaded by innocent simplicity, and the successive ages became still worse, till moral corruption reached such a height in the last or iron age that Jupiter sent a flood to destroy all mankind.[15]

Plato in his *Symposium*[16] explains the sexual and amatory inclination of the man and the woman by the fact that there were at first androgynous beings, whom Zeus separated into men and women. The two sexes were originally united.

In Corrodi's *Beiträge* (xviii. p. 14), the Indian *Ezour Vedam* is quoted, in which the first man is called *Adimo*, from whose body came Brahma, Vishnu, and Schiva. This statement is repeated by Knobel and others. But the *Ezour Vedam* (a corrupt pronunciation of Yajur Veda) is a spurious Veda from the pen of some Jesuit missionary.[17] Though it mentions Adimo (which simply means *the first*) in vol. i. p. 195, &c., and vol. ii. 205, genuine Indian mythology recognises no such name of the first man.

The second narrative, in some of its ideas, seems de-

[1] Kleuker's *Zend-Avesta*, part iii. pp. 84, 85.

[2] *Ibid.* iii. 62.

[3] *Ibid.* ii. 192.

[4] *Ibid.* iii. p. 105.

[5] *Ibid.* iii. 70, 91.

[6] *Ibid.* ii. 277, 299; iii. 118.

[7] Stäudlin in *Archiv. für Kirchengeschichte*, i. 3, p. 14.

[8] See Stäudlin's *Archiv.* i. 3, p. 15.

[9] Von Bohlen's *Das alte Indien*, i. 12; ii. 210.

[10] Wilson's *Vishnu Purana*, pp. 586, 613; and Langlois's translation of the *Harivansa*, tome ii. p. 3.

[11] *Opera et Dies*, 40–105.

[12] *Ibid.* 506–616.

[13] See Buttmann's *Mythologus*, Band i. p. 48, &c.

[14] See G. Baur in the *Studien und Kritiken* for 184$\frac{6}{7}$ p. 320, *et seq.*

[15] *Metamorphos.* i. 89, &c.; vol. ii. p. 14, &c., ed. Burmann.

[16] Cap. xv. ed. Stallbaum, 1827.

[17] The *Ezour Vedam* was printed at Paris in 1778. See Mr Ellis, in the *Asiatick Researches*, vol. xiv. p. 2, &c., and Dr Muir in the *Transactions of the Royal Society of Edinburgh*, vol. xxiii. part 2, p. 255, &c.

rived from Eastern Asia. Several features disclose this; such as the covering of fig leaves, the springing of four rivers from a common source, and the names of two of them which point to India. The tree of life and the seducing spirit have their place in the Persian and Indian religions. But its essence is adapted to the Hebrew theology, and contains genuine Hebrew traits; though it stands tolerably isolated in the circle of ideas which the Old Testament presents. Not till the Book of Wisdom do we find express reference to it (chap. ii. 23, 24), though the tree of life is spoken of in the Proverbs. Yet there is diversity amid similarity. As elaborated by the Hebrew mind, the narrative is a profound theory, with noble features worthy of the subject. Its verisimilitude is apparent. It shows a thoughtful contemplation of human nature, a fine sense of its capacities and weakness, of its aspirations and needs. Its lines are drawn with great discernment. The problem need expect no better solution in this life; for its depths cannot be fathomed by the sounding-line of a finite understanding. Here is the one philosophy of the subject that has taken the deepest hold of the human mind, engrafting itself on the religious systems of very different races, and enlisting the sympathies of the most civilised nations. Originating in the East, it has been transferred to the West, where it lives in pristine vigour. It is the essence of the best ideas and traditions of Eastern Asia, improved and enlarged by the Hebrew mind at a certain period. The more the narrative is examined, the more clearly will it appear the result of enlightened reason. It embodies national traditions of Hebrew reflectiveness. Free from the pantheism and dualism inherent in the mythologies of other peoples, the monotheism which distinguished the Hebrews as the depositaries of a divine truth pervades it. The tradition has two sides. It represents the transition of man to freedom and humanity, as Schiller describes it; his elevation by the awakening exercise of reason; his advance from nature's cradling-season to a consciousness of the divine within him; but it represents at the same time the inclination to follow his own will, to aspire to the forbidden contrary to his better conviction, to push reason beyond the limits within which alone it can be legitimately used; in short, to break away from the will of God in self-sufficient independence. While the fact was one of the most fortunate in man's history, it was also one of the saddest. When moral good was made possible, moral evil was introduced. A knowledge of the one brings that of the other.[1]

After Adam fell, God drove him from paradise, whose gates were guarded by cherubim to prevent access to the tree of life. The protoplasts had first three sons—Cain, Abel, Seth; then other sons and daughters. Adam died at the age of 930. According to the Elohist, the later race of men descended from Seth, the first born (Genesis v.); according to the Jehovist from Cain, who was the first born (Genesis iv.) A Jewish tradition represents him as buried in Hebron with the patriarchs; a Christian one makes Golgotha his resting-place.

A number of absurd fables, the fancies of Jewish writers, have gathered round the simple narratives of the Old Testament, and are incorporated in the Talmud. In these Adam is said to have been made as a man-woman out of dust collected from every part of the earth; his head reached to heaven, and the splendour of his face surpassed the sun. The very angels feared him, and all creatures hastened to pay him devotion. The Lord, in order to display his power before the angels, caused asleep to fall upon him, took away something from all his members, and when he awoke commanded the parts that had been removed to be dispersed over the globe, that the whole earth might be inhabited by his seed. Thus Adam lost his size, but not his completeness. His first wife was Lilith, mother of the demons. But she flew away through the air; and then the Lord created Eve from his rib, brought her to Adam in the most beautiful dress, and angels descending from heaven played on heavenly instruments; sun, moon, and stars dancing. He blessed the pair, and gave them a feast upon a table of precious stone. Angels prepared the most costly viands. But Adam's glory was envied by the angels; and the seraph Sammael succeeded in seducing him. The pair were driven out of paradise into the place of darkness, and wandered through the earth.[2]

According to the Koran, God created man of dried clay like an earthen vessel, animating the figure, and enduing it with an intelligent soul. When he had placed him in paradise, he formed Eve out of his left side. All the angels worshipped the new man except Eblis, who refused and became an unbeliever. Satan caused them to forfeit paradise, and turned them out of their state of happiness. On Adam's repentance, God pitied him, and had him taught the divine commandments by the archangel Gabriel; whereupon he was conducted to Arafat, a mountain near Mecca, and found Eve after a separation of 200 years. He was buried on Mount Abukais, near Mecca.[3] Many other fables of the later Jews respecting Adam are collected by Eisenmenger, and those of the Mahometans by Herbelot.

In the emanation systems of the Christian Gnostics and Manichæans, as well as in the gnosis of the Mandæans, Adam is represented as one of the first and holiest æons. Both catholic and heretical literature indulged in fictions respecting Adam. *A Life of Adam* was translated from the Ethiopic into German by Dillmann, in Ewald's *Jahrbuch*, v. *The Testament of Adam*, current in Syriac and Arabic, was published by Renan in the *Journal Asiatique*, série v. tom. 2. Both these seem to be derived from the *Spelunca Thesaurorum*, which exists in MS. in the Syriac tongue. The Sethites, a Gnostic sect, had *Apocalypses of Adam*; other Gnostics had a *Gospel of Eve*. *A Book of the Repentance of Adam* and *A Book concerning the Daughters of Adam*, are condemned in the decree of Gelasius. George Syncellus cites a Greek *Life of Adam*; and a fragment from *The Greek Book of Adam*, in a Florentine MS., is given in the *Literaturblatt des Orients* for 1850. Thus the Adam-literature is copious.[4] The *Book of Adam*, published by Norberg in 1816, is improperly so termed. It is a Mandæan or Sabian work, *Sidra Rabba*, which is now better known, since Petermann's critical edition of 1867, and Nöldeke's researches into the language. (S. D.)

ADAM OF BREMEN, ecclesiastical historian, was born in Upper Saxony, and in 1067, probably on the invitation of Archbishop Adalbert, came to Bremen, where he was appointed canon and *magister scholarum*. He died in 1076. His *Gesta Hammaburgensis Ecclesiæ Pontificum*, containing a history of the diocese of Hamburg and Bremen from 788 till the death of Adalbert in 1072, is of great importance as the chief source of information in regard to the state of the northern kingdoms during the period of which it treats. It is supposed to have been compiled partly from written documents and partly from the oral communications of the Danish king, Svend Estrithson. Its statements are generally trustworthy, though the chronology is sometimes confused, and the geographical informa-

[1] See Schelling's *Magisterdissertation* in vol. i. of his *Sämmtliche Werke*, p. 3, &c.

[2] Eisenmenger's *Entdecktes Judenthum*, Amsterdam, 1700, 4to.

[3] D'Herbelot's *Bibliotheque Orientale*, s. v. "Adam," p. 53, &c., ed. 1697, Paris.

[4] See Dillmann in Herzog's *Encyklopædie*, xii. p. 319.

tion often erroneous. The style is clear and interesting, though somewhat prolix. It was first published from MSS. at Copenhagen in 1579. The best edition is that of Lappenberg in Pertz's *Monumenta Germaniæ*. A supplement to the *Gesta*, a geographical work of considerable value, entitled *De Situ Daniæ et Reliquarum quæ trans Daniam sunt Regionum Natura*, was published at Stockholm in 1615, and at Leyden in 1629.

ADAM, Alexander, Rector of the High School, Edinburgh, was born on the 24th of June 1741, near Forres, in Morayshire. From his earliest years he showed uncommon diligence and perseverance in classical studies, notwithstanding many difficulties and privations. In 1757 he went to Edinburgh, where he studied at the University with such success that in eighteen months he was appointed head-master of Watson's Hospital, being at the time only nineteen. He was confirmed in the office of Rector of the High School on the 8th of June 1768, on the retirement of Mr Matheson, whose substitute he had been for some time before. From this period he devoted himself entirely to the duties of his office, and to the preparation of the numerous works he published in classical literature. His popularity and success as a teacher are strikingly illustrated in the facts that his class increased more than fourfold during his incumbency, and that an unusually large proportion of his pupils attained to eminence, among them being Sir Walter Scott, Lord Brougham, and Jeffrey. He succeeded in introducing the study of Greek into the curriculum of the school, notwithstanding the opposition of the University headed by Principal Robertson. In 1780 the University of Edinburgh conferred upon Mr Adam the honorary degree of Doctor of Laws. He died on the 18th December 1809, after an illness of five days, during which he occasionally imagined himself still at work, his last words being,—"But it grows dark; you may go." Dr Adam's first publication was his *Principles of Latin and English Grammar* (1772). This was followed by his *Roman Antiquities* (1791), his *Summary of Geography and History* (1794), and his *Latin Dictionary* (1805). The MS. of a projected larger Latin dictionary, which he did not live to complete, lies in the library of the High School.

ADAM, Melchior, German divine and biographer, was born at Grottkaw in Silesia after 1550, and educated in the college of Brieg, where he became a Protestant. He was enabled to pursue his studies there by the liberality of a person of quality, who had left several exhibitions for young students. In 1598 he went to Heidelberg, where, after holding various scholastic appointments, he became conrector of the gymnasium. In 1615 he published the first volume of his *Vitæ Germanorum Philosophorum*, &c. This volume was followed by three others; that which treated of divines was printed in 1619; his lives of lawyers and of physicians were published in 1620. All the learned men whose history is contained in these four volumes lived in the 16th or beginning of the 17th century, and are either Germans or Flemings; but he published in 1618 the lives of twenty divines of other countries in a separate volume, entitled *Decades duæ continentes Vitas Theologorum Exterorum Principum*. All his divines are Protestants. His industry as a biographer is commended by Bayle, who acknowledges his obligations to Adam's labours. Lutherans and Catholics accuse him of unfairness, but the charge is at least exaggerated. He died in 1622.

ADAM, Robert, architect, the second son of William Adam of Maryburgh, in Fife, was born in 1728. He studied at the University of Edinburgh, and probably received his first instruction in architecture from his father, who, whether a professional architect or not, gave proofs of his skill and taste in the designs of Hopetoun House and the Edinburgh Royal Infirmary. In 1754 young Adam visited the Continent, and spent three years in Italy for the purpose of examining the ruins of Roman architecture. The magnificence of the public baths erected at Rome in the time of Diocletian having impressed him with the idea that there had been a marked revival of architectural art during that emperor's reign, he resolved to visit the ruins of the private palace Diocletian had erected at Spalatro in Dalmatia. In company with Clerisseau, a French architect, he sailed from Venice in July 1754, and in a few weeks, with the help of two experienced draughtsmen, had completed plans and views of the fragments, from which he was afterwards able to execute a design of the entire building. The results were published in the *Ruins of the Palace of Diocletian*, &c. (1764). After his return to England he rose to the highest eminence in his profession, and was appointed architect to the king in 1762. Six years later he entered Parliament as representative of the county of Kinross, but he still continued to devote himself to the duties of his profession, resigning only his court appointment. In 1773–78 he and his brother James, also an architect of considerable note, published from time to time large folio engravings with letterpress description of their designs, the most important being,—Lord Mansfield's house at Caenwood; Luton House, Bedfordshire; the Register House, Edinburgh, &c. Among their later works may be mentioned the buildings erected in London by the two brothers, and hence called the Adelphi (ἀδελφοί), which proved an unsuccessful speculation; Portland Place, London; and the Infirmary of Glasgow. The leading characteristics of all these designs are lightness and elegance; and, though grave faults may be found with his style, it cannot be denied that English architecture, especially that of the streets of London, owes very much to Robert Adam. He continued actively engaged in his profession until his death in 1792. James, his brother and associate in labour, died in 1794.

ADAM, Right Hon. William, nephew of the preceding, eldest son of John Adam, Esq. of Blair-Adam, Kinross-shire, was born on the 2d August 1751, studied at the Universities of Edinburgh and Glasgow, and passed at the Scotch bar in 1773. Soon after he removed to England, where he entered Parliament in 1774, and in 1782 was called to the Common-law bar. He withdrew from Parliament in 1795, entered it again in 1806 as representative of the united counties of Clackmannan and Kinross, and continued a member, though with some interruptions, till 1811. A popular though not an eloquent speaker, Mr Adam soon took a prominent place in the House, making himself of importance by his sound judgment and firm general adherence to the Whig party. A duel in 1779 between him and Mr Fox, in which the latter was slightly wounded, did not interrupt their close and steady friendship. They both belonged to the small but noble band that opposed the encroachments of the Government on the Constitution during the period of the French Revolution. One of Mr Adam's most valuable parliamentary efforts was the agitation which he successfully raised, in March 1794, against the severe punishment awarded in the Scotch criminal court to certain persons who had been convicted of sedition. At the English bar he was as successful as any one can be who does not devote himself entirely to the profession. Though known to be much engaged in Parliament, and with the management of the pecuniary affairs of the Prince of Wales and the Duke of York, he obtained a very considerable practice. He was successively Attorney and Solicitor General to the Prince of Wales, one of the managers of the impeachment of Warren Hastings, and one of the counsel who defended the first Lord Melville when impeached (as Mr Dundas). During his party's brief tenure of office in 1806 he was Chancellor of the Duchy of Cornwall, and was afterwards a privy councillor

and lord-lieutenant of Kinross-shire. In 1814 he became a baron of Exchequer in Scotland, and in the following year was appointed chief commissioner of the newly-established Jury-Court for the trial of civil causes, over which he presided with much ability and acceptance till 1830, when it ceased to exist as a separate court, and became merged in the permanent supreme tribunal. Though little versed in the technicalities of law, he was in all practical matters an able manager; he was a shrewd observer of all that passed around him, and a most agreeable companion. He died at Edinburgh on the 17th February 1839.

ADAM'S BRIDGE, or *Rama's Bridge*, a chain of sandbanks, extending from the island of Manaar, near the N.W. coast of Ceylon to the island of Rameseram, off the Indian coast, and lying between the Gulf of Manaar on the S.W. and Palk Strait on the N.E. It is more than 30 miles long, and offers a serious impediment to navigation. Some of the sandbanks are dry; and no part of the shoal has a greater depth than 3 or 4 feet at high water, except three tortuous and intricate channels, a few feet deep, which in calm weather permit the passage of boats and small vessels.

ADAM'S PEAK, a lofty mountain in Ceylon, about 45 miles E. from Colombo, in N. lat. 6° 55′, E. long. 80° 30′. It rises steeply to a height of 7240 feet, and commands a magnificent prospect. Its conical summit terminates in an oblong platform, 74 feet by 24, on which there is a hollow, resembling the form of a human foot, 5 feet 4 inches by 2 feet 6 inches; and this has been consecrated as the footprint of Buddha. The margin of this supposed footprint is ornamented with gems, and a wooden canopy protects it from the weather. It is held in high veneration by the Cingalese, and numerous pilgrims ascend to the sacred spot, where a priest resides to receive their offerings, and bless them on their departure. By the Mahometans the impression is regarded as that of the foot of Adam, who here, according to their tradition, fulfilled a penance of one thousand years, while the Hindoos claim it as that of their god Siva.

ADAMAWA, a country of Central Africa, lies between 7° and 11° N. lat., and 11° and 16° E. long., about midway on the map between the Bight of Biafra and Lake Chad. Its boundaries cannot be strictly defined; but it stretches from S.W. to N.E. a distance of 200 miles, with a width of from 70 to 80 miles. This region is watered by the Benuwe and the Faro. The former, which ultimately unites with the Niger, flows through Adamawa, first in a northerly, then in a westerly direction; and is joined by the Faro, which rises in the south, 22 miles from Yolla, the capital of the country. Near their confluence the Benuwe is 800 yards wide, with a depth of about 11 feet; the Faro has a breadth of 600 yards, but is generally very shallow. Both rivers are subject to extraordinary floods, beginning in the end of September, and lasting forty days, during which the swamps of the adjacent country are covered for a great distance on both sides, and the Benuwe rises at least 30 feet. The most fertile parts of the country are the plains near the Benuwe, about 800 feet above the level of the sea. Further from that river the land rises to an elevation of 1500 feet, and is diversified by numerous hills and groups of mountains. Mount Alantika, about 25 miles S.S.E. of Yolla, is the loftiest mountain in Adamawa, and rises from the plain, an isolated mass, to the height of 9000 feet. The country, which is exceedingly rich, and is covered with luxuriant herbage, has many villages, and a considerable population. The grain known as *Holcus sorghum* or *durra*, ground-nuts, yams, and cotton are the principal products; and the palm and banana abound. Elephants are very numerous, and ivory is largely exported. In the eastern part of the country the rhinoceros is met with, and the rivers swarm with crocodiles, and with a curious mammal called the *ayu*, bearing some resemblance to the seal. Yolla, the capital of Adamawa, is situated, in N. lat. 9° 28′, E. long. 12° 13′, in the fertile plain between the Benuwe and the Faro. The houses are built of clay, and surrounded by court-yards, in which grain is grown; so that the town, though containing only about 12,000 inhabitants, is spread over a large extent of ground, and is 3 miles long from east to west. *Turkedi* (a dark-coloured cotton cloth), beads, salt, and calico are the principal articles exposed in the markets. Here and throughout Adamawa cotton is generally used as a medium of barter. A very large proportion of the population are slaves, many private individuals holding as many as 1000, while the governor is said to receive annually about 5000 in tribute. The government of Adamawa is in the hands of a Mahometan ruler, who owns a nominal allegiance to the Sultan of Sokoto, but is in reality an independent sovereign. Formerly the country was called Fumbina, and was possessed by various African tribes, until it was overrun by the Fulbe, a Mahometan people. It has not been entirely subjected by them, but they have detached settlements at various places; and numerous governors, as well of the Fulbe as of outlying pagan tribes, are in subjection to the ruler of Yolla. (See Barth's *Travels in Central Africa*, vol. ii.)

ADAMITES, or ADAMIANS, a sect of heretics that flourished in North Africa in the 2d and 3d centuries. Basing itself probably on a union of certain gnostic and ascetic doctrines, this sect pretended that its members were re-established in Adam's state of original innocency. They accordingly rejected the form of marriage, which, they said, would never have existed but for sin, and lived in absolute lawlessness, holding that, whatever they did, their actions could be neither good nor bad. During the Middle Ages the doctrines of this obscure sect, which did not at first exist long, were revived in Europe by the Brethren and Sisters of the Free Spirit, who in the 14th century were better known throughout Germany as Beghards. This name was originally borne by a religious party that was formed in the Netherlands a century earlier. The two sects came into contact on the Rhine frontier, associated with each other, gradually approximated in doctrine, and were at last identified by the application to both of the one name; though a distinct sect of Beghards, free from the excesses of the brethren, continued to exist in the Netherlands. *Picard* is simply another form which *Beghard* assumed in the harsh pronunciation of the Bohemians, and the common method of accounting for it by supposing a leader Picard has no sufficient warrant. The principal seat of the Picards in Bohemia was a small island in the river Luschnitz, where they lived in a state of nature, and had wives in common. In 1421 they were almost exterminated by Ziska, the leader of the Hussites, who committed many of them to the flames. In 1849 it appeared that the sect existed in a district of Austria, though small in number, and not ostentatious of its peculiar practices. (Rüdinger *de Eccl. Frat. in Bohem.*, &c.; Bossuet's *Variations of Protestant Churches*.)

ADAMNAN or ADOMNAN, SAINT, born in Ireland about the year 624, was elected Abbot of Iona in 679, on the death of Failbhe. While on a mission to the court of King Aldfrid of Northumberland (700–1), he was led to adopt the Roman rule in regard to the time for the observance of Easter; and on his return to Iona he tried to enforce the change upon the monks, but without success. It is said that the disappointment caused his death, which occurred in 703 or 704. Adamnan wrote a *Life of St Columba*, which, though abounding in fabulous matter, is of great interest and value. The best edition is that of Reeves.

published by the Irish Archæological and Celtic Society in 1857. Adamnan's other well-known work, *De Situ Terræ Sanctæ*, was based, according to Bede, on information received from Arculf, a French bishop, who, on his return from the Holy Land, was wrecked on the west coast of Britain, and was entertained for a time at Iona. This was first published by Gretser at Ingolstadt in 1619. (*Kalendars of the Scottish Saints*, by Bishop Forbes, 1872.)

ADAMS, JOHN, a distinguished statesman of the United States of North America. He was born on the 19th or (new style) 30th of October 1735, in that part of the township of Braintree, in Massachusetts, which on a subsequent division was called Quincy. His parents were of that class, then abounding in New England, who united the profession of agriculture with that of some one of the mechanic arts. His ancestor Henry had emigrated from Devonshire in the year 1632, and had established himself at Braintree with six sons, all of whom married: from one descended the subject of this memoir, and from another that Samuel Adams who, with John Hancock, was by name proscribed by an Act of the British Parliament, for the conspicuous part he acted in the early stages of the opposition to the measures of the mother country. When about fifteen years of age, his father proposed to his son John either to follow the family pursuits, and to receive in due time, as his portion, a part of the estate which they had cultivated, or to have the expense of a learned education bestowed upon him, with which, instead of any fortune, he was to make his way in future life. The son chose the latter alternative; and having received some preparatory instruction, was admitted a student at Harvard College in the year 1751. After graduating in 1755, he removed to the town of Worcester, where, according to the economical practice of that day in New England, he became a tutor in a grammar school, and at the same time was initiated into the practice of the law in the office of Mr Putnam, then an attorney and a colonel of militia, and subsequently a general of some celebrity in the revolutionary war. A letter he wrote at the early age of nineteen, shows a degree of foresight which, like many other predictions, may have led to its own accomplishment. It is dated 12th October 1754, and says—"Soon after the Reformation, a few people came over to this New World for conscience' sake. Perhaps this apparently trivial incident may transfer the great seat of empire to America. It looks likely to me; for if we can remove the turbulent Gallic (the French in Canada), our people, according to the exactest computation, will in another century become more numerous than England itself. Should this be the case, since we have, I may say, all the naval stores of the nation in our hands, it will be easy to obtain the mastery of the seas, and then the united force of all Europe will not be able to subdue us. The only way to keep us from setting up for ourselves is to disunite us."

He was admitted to practice in the year 1758, and gradually rose to the degree of eminence which a local court can confer; and obtained distinction by some essays on the subject of the canon and feudal law, which were directed to point to the rising difference which commenced between the mother country and the colonies, soon after the peace of 1763 had delivered the latter from all disquietude respecting the establishments of France in the adjoining province of Canada. His character rose, both as a lawyer and a patriot, so as to induce Governor Barnard, who wished to gain him over to the royal party, to offer him the office of advocate-general in the Admiralty Court, which was deemed a sure step to the highest honours of the bench. Two years after, he was chosen one of the representatives of his native town to the congress of the province. His first prominent interference in political affairs was at a meeting at Braintree in 1765, to oppose the Stamp Act. The resolutions he proposed were not only carried unanimously, but were afterwards adopted verbatim by more than forty other towns. In 1768 he found it necessary to remove to Boston, owing to the increase of his legal practice.

His professional integrity was soon after exhibited in the defence of Captain Preston and some soldiers, who were tried before a Boston jury on a charge of murder, April 1770. In this case Adams was counsel for the defence; and being considered by the people, then in an inflamed state against the troops, as a determined friend of liberty, his eloquence obtained a verdict of acquittal without lessening his popularity.

When it was determined, in 1774, to assemble a general congress from the several colonies, Mr Adams was one of those solicited for the purpose by the people of Massachusetts. Before departing for Philadelphia to join the congress, he parted with the friend of his youth, his fellow-student and associate at the bar, Jonathan Sewall, who had attained the rank of attorney-general, and was necessarily opposed to his political views. Sewall made a powerful effort to change his determination, and to deter him from going to the congress. He urged, that Britain was determined on her system, and was irresistible, and would be destructive to him and all those who should persevere in opposition to her designs. To this Adams replied: "I know that Great Britain has determined on her system, and that very fact determines me on mine. You know I have been constant and uniform in opposition to her measures; the die is now cast; I have passed the Rubicon; to swim or sink, live or die, survive or perish with my country, is my unalterable determination." The conversation was then terminated by Adams saying to his friend, "I see we must part; and with a bleeding heart, I say, I fear for ever. But you may depend upon it, this adieu is the sharpest thorn on which I ever set my foot."

When the continental congress was assembled Mr Adams became one of its most active and energetic leaders. He was a member of that committee which framed the Declaration of Independence, and one of the most powerful advocates for its adoption by the general body; and by his eloquence obtained the unanimous suffrages of that assembly. Though he was appointed chief-justice in 1776, he declined the office, in order to dedicate his talents to the general purpose of the defence of the country.

In 1777 he, with three other members, was appointed a commissioner to France. He remained in Paris about a year and a half, when, in consequence of disagreements among themselves, in which Adams was not implicated, all but Franklin were recalled. In the end of 1779 he was charged with two commissions,—one as a plenipotentiary to treat for peace, the other empowering him to form a commercial treaty with Great Britain. When he arrived in Paris, the French Government viewed with jealousy the purpose of the second commission; and Count de Vergennes advised him to keep it secret, with a view to prevail on the congress to revoke it. Mr Adams refused to communicate to the count his instructions on that subject; and an altercation arose, from a claim made by France for a discrimination in favour of French holders of American paper money in the liquidation of it. The count complained to Congress, transmitted copies of Mr Adams's letters, and instructed the French minister at Philadelphia to demand his recall. The demand was rejected, but afterwards four others were joined with him in the commission. Whilst these negotiations were in progress he went to Holland, and there, in opposition to the influence and talents of the British minister, Sir Joseph Yorke, succeeded both in negotiating a loan, and in procuring the assistance of that country in the defence against Great Britain. He formed a commercial treaty with

that republic, and joined in the ephemeral association called "the armed neutrality."

In 1785 Mr Adams was appointed ambassador to the court of his former sovereign, where his conduct was such as to secure the approbation of his own country, and the respect of that to which he was commissioned. Whilst in London, he published his work entitled *Defence of the American Constitution*, in which he combated ably the opinions of Turgot, Mably, and Price, in favour of a single legislative assembly; and thus perhaps contributed to the division of power and the checks on its exercise, which became established in the United States. At the close of 1787 he returned, after ten years devoted to the public service, to America. He received the thanks of Congress, and was elected soon after, under the presidency of Washington, to the office of Vice-President. In 1790 Mr Adams gave to the public his *Discourses* on Davila, in which he exposed the revolutionary doctrines propagated by France and her emissaries in other countries. On the retirement of Washington, the choice of President fell on Mr Adams, who entered on that office in May 1797. At that time the Government was entangled by the insolent pretensions of the French demagogues, and by their partisans in many of the states. Great differences of opinion arose between the individuals at the head of affairs: one party, with Mr Hamilton at their head, was disposed to resist the pretensions of France by open hostilities; whilst Mr Adams was disinclined to war, so long as there was a possibility of avoiding it with honour. Owing to this division of his own friends, rather than to a want of public confidence, at the conclusion of the four years for which the President is chosen, Mr Adams was not re-elected. Perhaps this was in some measure owing to the preponderance of the slave states, in which Mr Jefferson, his rival, and a proprietor of slaves, had a fellow-feeling among the chief of the people.

He retired with dignity, at 65 years of age, to his native place, formed no political factions against those in power, but publicly expressed his approbation of the measures which were pursued by him who had been his rival, who had become his successor in power, but had never ceased to be his firmly-attached friend.

The last public occasion on which Mr Adams appeared, was as a member of the convention for the revision of the constitution of Massachusetts, in which some slight alterations were requisite, in consequence of the province of Maine being separated from it.

He seems to have enjoyed his mental faculties to the close of his protracted life; and even on the last day of it, two hours only before its final close, on the 4th July 1826, the fiftieth anniversary of the Act of Independence, he dictated to a friend, as a sentiment to be given at the public dinner of the day, "Independence for ever." By a very singular coincidence Jefferson, his rival and friend, died a few hours earlier on the same day.

Mr Adams was considered a sound scholar, well versed in the ancient languages, and in many branches of general literature. His style in writing was forcible and perspicuous, and, in the latter years of his life, remarkably elegant. In person he was of middling stature; his manners spoke the courtesy of the old school; and his address, at least when he was in England, was dignified and manly.

ADAMS, John Quincy, eldest son of the preceding, was born at Braintree on the 11th July 1767. The greater part of his education was received in Europe, which he visited in company with his father in 1778, and again in 1780, when he attended for a time the university of Leyden. When only fifteen years old he went, as secretary, with Francis Dana on his unsuccessful mission to St Petersburg. Returning home after an interval spent in Holland, London, and Paris, he graduated at Harvard in 1788; and, after spending three years in a lawyer's office, was admitted to the bar in 1791. Three successive series of letters, on political subjects, contributed to a Boston newspaper, attracted much attention, and Washington appointed him ambassador to the Hague in 1794. An appointment to a similar post in Portugal, made just before the expiry of Washington's presidency, was set aside by his father, who sent him instead to Prussia, giving him the promotion by the express advice of Washington. During his residence as ambassador at Berlin, he succeeded in negotiating a commercial treaty with Prussia. On Jefferson becoming President (1801), Adams was recalled, and resumed the practice of law in Boston. In 1802 Suffolk county returned him a member of the Massachusetts Senate, and in the following year he was elected to Congress. Indebted for his position to the Federal party, Adams supported their views for four years, but separated from them by voting for Jefferson's proposed *embargo*. This course involved him in much controversy, and cost him his seat in the Senate. During his retirement he added to the employment arising from his profession the duties of the professorship of rhetoric and belles lettres at Harvard University, which he held for three years (1806–9). His lectures—the first ever read in an American university—were published in 1810, and were much thought of at the time, though now almost forgotten. In the winter following the resignation of his professorship, he visited Washington; and, in an interview with Jefferson, brought a charge against some of the Federal leaders of a design to dissolve the union, and form a separate confederation for the north. The charge was afterwards repeated in the newspapers; and, though resting on slender grounds, greatly affected the confidence of the other states in the New England representatives. In 1809 Madison, having obtained after some delay the concurrence of the Senate, entrusted Adams with the embassy to St Petersburg,—an appointment which the latter accepted against the wishes of his father, and continued to hold, though offered a seat on the circuit bench for New England some time after his arrival in Russia. When war broke out between England and the United States, Adams induced the Czar to make an offer of intervention, which, however, the English Government declined to accept. Independent negotiations were thereupon carried on for six months at Ghent (the representatives of America being Adams, Russell, and Clay), and resulted in the treaty of peace which was signed 24th December 1814. After serving for two years (1815–17) as minister in London, he again entered the arena of home politics as secretary of state under Monroe. In this office he distinguished himself specially by his arrangement of the treaty with Spain, which defined the boundaries of the ceded territories of Florida and Louisiana. An elaborate report on weights and measures gained for him also a name for scientific acquirements. In 1825 the election of a President fell, according to the constitution of the States, to the House of Representatives, since no one of the candidates had secured an absolute majority of the electors chosen by the States, and Adams, who had stood second to Jackson in the electoral vote, was chosen in preference to Jackson, Clay, and Crawford. The administration of Adams was marked by the imposition of a high tariff on foreign goods, with the view of promoting internal industry, and by the unsuccessful attempt to purchase Cuba from Spain. Notwithstanding the efforts of Clay, and the special claim he himself made on the voters of Virginia on account of his discovery of the so-called New England "plot" twenty years before, Adams failed to secure his re-election in 1829. Defeated by Jackson, who had 178 votes to his 83, he retired to Quincy, where his father's fortune, increased by his own efforts, afforded

him an ample competency. Two years later he was returned to Congress by the district in which he lived, and which he continued to represent until his death. Having been chosen merely on account of his determined resistance to secret societies, his position was independent of party politics, and correspondingly strong. He stood for the office of governor, and then for that of senator, of Massachusetts, but was on both occasions defeated by Davis. As chairman of the committee on manufactures, he strove to devise a middle policy in regard to tariffs, but his greatest effort at this period—perhaps the greatest service of his whole political life—was in connection with the abolition of slavery. In every form which the question took, he was the bold and determined advocate of abolition, gradually gathering an influential party around him, and so preparing for the triumphs, most of which have been won since his death. He himself witnessed, in 1845, the abolition of the "gag-rule," restricting the right of petition to Congress on the subject of slavery, which he had persistently opposed during the nine years it was in force. He died of paralysis on 23d February 1848, having been seized two days previously while attending the debates of Congress. Adams wrote a number of works, which are now of little importance. The style is fluent, but has none of the vigour and elegance of his father's. During his whole lifetime he kept a very voluminous journal, some portions of which have been published.

ADAMS, Richard, M.A., divine. Two contemporaries of the same name are frequently confounded with each other. The more eminent was son of the Rev. Richard Adams, rector of Worrall, in Cheshire. The family records seven clergymen of the Church of England in succession. The present worthy was born at Worrall, but the loss of the registers leaves the date uncertain. It is usually, but erroneously, stated that he studied at Cambridge University. He was admitted a student of Brazenose College, Oxford, March 24, 1646, and became a fellow, having proceeded through the usual degrees. It was at Brazenose he formed his life-long friendship with John Howe, who had a profound veneration for Adams. In 1655 he was appointed to the rectory of St Mildred's, Bread Street, London—John Milton being a parishioner. From this he was ejected by the Act of Uniformity of 1662. Thereupon he continued his ministry as opportunity offered, and at length was settled as pastor of a congregation in Southwark. This Richard Adams is a typical example of the consistent and meek labourers of the early and struggling period of Nonconformity. His holy and beautiful life inspired Howe's noblest eloquence in his funeral sermon. He died in a ripe old age, on 7th Feb. 1698. His principal literary work is his contribution of annotations on Philippians and Colossians to Pool's celebrated *Annotations*. Along with Veal he edited the works of Charnock. (A. B. G.)

ADAMS, Samuel, American statesman, born at Boston, Sept. 27, 1722, was second cousin to John Adams. He studied at Harvard, but, owing to his father's misfortunes in business in connection with a banking speculation,—the "manufactory scheme,"—he had to leave before completing his course, and to relinquish his intention of becoming a Congregational clergyman. He received his degree, however, and it is worthy of note, as showing the tendency of his political opinions, that his thesis was a defence of the affirmative reply to the question, "Whether it be lawful to resist the supreme magistrate, if the commonwealth cannot otherwise be preserved?" The failure of the banking scheme above referred to, in consequence of the limitations imposed by English law, made Adams still more decided in his assertion of the rights of American citizens, and in his opposition to Parliament. He gave up his business, in which he had little success, and became tax-collector for the city of Boston, whence he was called by his political opponents, "Samuel the publican." In all the proceedings which issued at last in the declaration of independence Adams was a conspicuous actor. He took part in the numerous town meetings, drafted the protest which was sent up by Boston against the taxation scheme of Grenville (May 1764); and, being chosen next year a member of the general court of Massachusetts, soon became one of the leaders in debate. Upon his entry into the House he was appointed clerk, and had thus much influence in arranging the order of business and in drawing up papers. Attempts were more than once made by the English governor to win him over by the offer of a place, but Adams proved inflexible. His uncompromising resistance to the British Government continued; he was a prominent member of the continental Congress at Philadelphia, and was one of those who signed the Declaration of Independence in 1776. He was a member of the convention which settled the constitution of Massachusetts, and became president of its Senate. From 1789 to 1794 he was lieutenant-governor of the State, and governor from 1794 to 1797, retiring in the latter year partly on account of age, but partly also because the Federalists were then in the ascendant, and he himself was inclined to the Jefferson or Republican party. He died on the 3d Oct. 1803. In an oration on American independence, delivered in Philadelphia, 1st Aug. 1776, Adams characterises the English as "a nation of shopkeepers." The oration was translated into French, and published at Paris; and it is therefore not unlikely that Napoleon's use of this phrase was not original.

ADAMS, Thomas—"*the prose Shakspeare of Puritan theologians*," as Southey named him—has left as few personal memorials behind him as the poet himself. The only facts regarding the commonplaces of his biography are furnished by epistles-dedicatory and epistles to the reader, and title-pages. From these we learn that he was, in 1612, "a preacher of the gospel at Willington," in Bedfordshire, where he is found on to 1614, and whence issued his *Heaven and Earth Reconciled*, *The Devil's Banquet*, and other works; that in 1614–15 he was at Wingrave, in Buckinghamshire, probably as vicar, and whence a number of his works went forth in quick succession; that in 1618 he held the preachership at St Gregory's, under St Paul's Cathedral, and was "observant chaplain" to Sir Henrie Montague, the Lord Chief-Justice of England; that during these years his epistles show him to have been on the most friendly terms with some of the foremost men in state and church; and that he must have died before the Restoration of 1660. His "occasionally" printed sermons, in small quartos, when collected in 1630, placed him beyond all comparison in the van of the preachers of England. Jeremy Taylor does not surpass him in brilliance of fancies, nor Thomas Fuller in wit. His numerous works display great learning, classical and patristic, and are unique in their abundance of stories, anecdotes, aphorisms, and puns. He was a Puritan in the church, in distinction from the Nonconformist Puritans, and is evangelically, not dry-doctrinally, Calvinistic in his theology. His works have been recently collected by Drs Joseph Angus and Thomas Smith (3 vols. 8vo, 1862). (A. B. G.)

ADAMSON, Patrick, a Scottish prelate, Archbishop of St Andrews, was born in the year 1543, in the town of Perth, where he received the rudiments of his education. He afterwards studied philosophy, and took his degree of master of arts at the University of St Andrews. In 1564 he set out for Paris as tutor to the eldest son of Sir William Macgill. In the month of June of the same year, Mary Queen of Scots being delivered of a son, afterwards James VI. of Scotland and I. of England, Mr Adamson

wrote a Latin poem, in which he gave the prince the title of king of France and England. This proof of his loyalty involved him in difficulties. The French court was offended, and ordered him to be arrested; and he was confined for six months. He was released only through the intercession of Queen Mary and some of the principal nobility, who interested themselves in his behalf. As soon as he recovered his liberty, he retired with his pupil to Bourges. He was in this city during the massacre at Paris; and the same persecuting spirit prevailing among the Catholics at Bourges as at the metropolis, he lived concealed for seven months in a public-house, the aged master of which, in reward for his charity to heretics, was thrown from the roof, and had his brains dashed out. Whilst Mr Adamson lay thus in his sepulchre, as he called it, he wrote his Latin poetical version of the book of Job, and his tragedy of Herod in the same language. In the year 1573 he returned to Scotland, and, having entered into holy orders, became minister of Paisley. In the year 1575 he was appointed one of the commissioners, by the General Assembly, to settle the jurisdiction and policy of the church; and the following year he was named, with Mr David Lindsay, to report their proceedings to the Earl of Morton, then regent. About this time the earl appointed him one of his chaplains; and, on the death of Archbishop Douglas, promoted him to the archiepiscopal see of St Andrews. This gave rise to a protracted conflict with the Presbyterian party in the Assembly. Soon after his promotion, he published a catechism in Latin verse, dedicated to the king, a work highly approved even by his enemies, who nevertheless still continued to persecute him with great violence. In 1578 he submitted himself to the General Assembly, which procured him peace but for a very little time; for, the year following, fresh accusations were brought against him. A Provincial Synod was held at St Andrews in April 1586; the archbishop was here accused and excommunicated. He appealed to the king and the states, but this availed him little. At the next General Assembly, a paper being produced containing the archbishop's submission, he was absolved from the excommunication. In 1588 fresh accusations were brought against him. The year following he published the Lamentations of the prophet Jeremiah in Latin verse, which he dedicated to the king, complaining of his hard usage. Towards the end of the same year he published a translation of the Apocalypse in Latin verse, and a copy of Latin verses. The king was unmoved by his application, and granted the revenue of his see to the Duke of Lennox, so that the prelate and his family were literally reduced to the want of bread. During the remaining part of his unfortunate life he was supported by charitable contributions, and died in 1592. He had previously made a written recantation of his alleged errors in regard to Episcopacy, though the genuineness of this is doubted by Spottiswoode. (See Cunningham's *Church History of Scotland*, vol. i.) The character of this prelate has been variously represented, according to the sentiments of religion and politics which prevailed. But there is little doubt that he encouraged and supported, under the authority of the king, oppressive and injurious measures. The panegyric of the editor of his works, Mr Wilson, is extravagant and absurd. He says that "he was a miracle of nature, and rather seemed to be the immediate production of God Almighty than born of a woman."

ADANA, a city of Asia Minor, the capital of the province of the same name, on the right bank of the Sihun, about 30 miles from the sea, in N. lat. 37° 1′, E. long. 35° 18′. It is built on the site of the ancient *Antiochia ad Sarum*. Its position, commanding the passage of the mountains to the north of Syria, rendered it important as a military station in the contest between the Egyptians and the Turks in 1832. After the defeat of the Turkish army at Konieh, it was taken possession of by Ibrahim Pacha, and continued to be held by the Egyptians till the treaty of July 1840 restored it to the Porte. In the streets of the town there are numerous beautiful fountains, supplied with water from the river, which is here spanned by a stately bridge of fifteen arches, said to have been erected by Justinian. In winter the climate is mild and healthy, but in summer the heat is so great that the principal inhabitants betake themselves to various cool retreats in the neighbouring mountains. The adjoining plain of Adana is rich and fertile. The chief productions of the province are cotton, corn, sesame, and wool, which are largely exported. The population of the town is 20,000.

ADANSON, Michel, a celebrated French naturalist, descended from a Scottish family which had at the Revolution attached itself to the fortunes of the house of Stuart, was born the 7th of April 1727, at Aix, in Provence, where his father was in the service of M. de Vintimille, archbishop of that province. On the translation of this prelate to the archbishopric of Paris, about the year 1730, the elder Adanson repaired thither with his five children, who were all provided for by their father's patron. A small canonry fell to the lot of Michel, the revenue of which defrayed the expenses of his education at the college of Plessis. While there he was distinguished for great quickness of apprehension, strength of memory, and mental ardour; but his genius took no particular bent, until he received a microscope from the celebrated Tuberville Needham, who was struck with admiration of the talents and acquirements he displayed at a public examination. From that time to the last hour of his life he persevered with a zeal almost unexampled in the observation and study of nature. On leaving college, his youthful ardour was well employed in the cabinets of Reaumur and Bernard de Jussieu, as well as in the Jardin des Plantes. Such was his zeal, that he repeated the instructions of the professors to his less apt fellow-students; and before completing his nineteenth year he had actually described (for his own improvement) 4000 species of the three kingdoms of nature. In this way he soon exhausted the rich stores of accumulated knowledge in Europe; and having obtained a small appointment in the colony of Senegal, he resigned his canonry, and embarked on the 20th of December 1748 for Africa. Senegal, from the unhealthiness of its climate, was a *terra incognita* to naturalists; and this determined his choice of that country as a field for exploration. His ardour remained unabated during the five years of his residence in Africa. He collected and described, in greater or less detail, an immense number of animals and plants; collected specimens of every object of commerce; delineated maps of the country; made systematic meteorological and astronomical observations; and prepared grammars and dictionaries of the languages spoken on the banks of the Senegal. On his return to Paris in February 1754 he found himself without resources, but fortunately secured the patronage of M. de Bombarde, who encouraged him in the publication of the scientific results of his travels. In his *Histoire Naturelle du Sénégal* (Paris, 1757) he made use of a small portion of the materials at his disposal; and the work has a special interest from the essay on Shells, printed at the end of it, where Adanson proposed his *universal method*, a system of classification distinct from those of Buffon and Linnæus. He founded his classification of all organised beings on the consideration of each individual organ. As each organ gave birth to new relations, so he established a corresponding number of arbitrary arrangements. Those beings possessing the greatest number of similar organs were referred to one great division, and the relationship was considered more remote in pro-

portion to the dissimilarity of organs. The chief defect of this method consists in presupposing a knowledge of species and their organisation altogether beyond the existing stage of knowledge. It gives, however, distinct ideas of the degree of affinity subsisting between organised beings, independent of all physiological science. Until the appearance of this work, the Testacea had scarcely been made the subject of serious study. Adanson's methodical distribution, founded on not less than twenty of the partial classifications already alluded to, is decidedly superior to that of any of his predecessors. For the first time there was presented in this department of natural history a classification of the animals themselves, and not merely of the shells which contain them. Like every first attempt, however, it had its imperfections, which arose chiefly from ignorance of the anatomical structure of the animals. It was owing to this that he omitted, in his arrangement of the *Mollusca*, all molluscous animals without shells. He abandoned his original plan of publishing his Senegal observations in eight volumes, and applied himself entirely to his *Familles des Plantes*, which he published in 1763. Here he developed the principle of arrangement above mentioned, which, in its adherence to natural botanical relations, was based on the system of Tournefort, and had been anticipated to some extent nearly a century before by Ray. The success of this work was hindered by its innovations in the use of terms, which were ridiculed by the defenders of the popular sexual system of Linnæus; but it did much to open the way for the establishment, by means principally of Jussieu's *Genera Plantarum* (1789), of the natural method of the classification of plants. In 1774 Adanson submitted to the consideration of the Academy of Sciences an immense work, containing what may be called the *universal application of his universal method;* for it extended to all known beings and substances. This work consisted of 27 large volumes of manuscript, employed in displaying the general relations of all these matters, and their distribution; 150 volumes more, occupied with the alphabetical arrangement of 40,000 species; a vocabulary, containing 200,000 words, with their explanations; and a number of detached memoirs, 40,000 figures, and 30,000 specimens of the three kingdoms of nature. The committee to which the inspection of this enormous mass was intrusted strongly recommended Adanson to separate and publish all that was peculiarly his own, leaving out what was merely compilation. He obstinately rejected this advice; and the huge work, at which he continued to labour, was never published. He had been elected a member of the Academy of Sciences in 1759, and he latterly subsisted on a small pension it had conferred on him. Of this he was deprived on the dissolution of the Academy by the Constituent Assembly, and was consequently reduced to such a depth of poverty as to be unable to appear before the French Institute when it invited him to take his place among its members. Government afterwards conferred upon him a pension sufficient to relieve the simple wants of the great naturalist. He died, after months of severe suffering, on the 3d of August 1806, requesting, as the only decoration of his grave, a garland of flowers gathered from the 58 families he had differentiated—"a touching though transitory image," says Cuvier, "of the more durable monument which he has erected to himself in his works." His zeal for science, his unwearied industry, and his talents as a philosophical observer, are conspicuous in all his writings. The serenity of his temper, and the unaffected goodness of his heart, endeared him to the few who knew him intimately. On his return from Africa in 1754, he laid before the French Indian Company a scheme for the settlement of a colony in Senegal, where articles of African produce might be cultivated by free negroes. His propositions were unheeded by his countrymen, and by a misdirected patriotism he refused to present them to the Abolitionists of England. A similar feeling led him to refuse to settle in Austria, Russia, or Spain, on the invitation of the sovereigns of those countries. His most important works are his *Natural History of Senegal* and his *Families of Plants.* He contributed a number of papers to the Memoirs of the Academy of Sciences, on the Ship-worm, the Baobab tree (the largest tree known, to which, in honour of Adanson, Linnæus gave the name *Adansonia digitata*), the origin of the varieties of cultivated plants, gum-producing trees, and the *Oscillatoria Adansonia*, an animal regarded by him as a spontaneously moving plant. Besides these essays, he contributed several valuable articles in natural history to the earlier part of the Supplement to the first *Encyclopédie;* and he is also the reputed author of an essay on the *Electricity of the Tourmaline* (Paris, 1757), which bears the name of the Duke of Noya Caraffa.

ADAPTATION, in *Biology*, is the process by which an organism or species of organisms becomes modified to suit the conditions of its life. Every change in a living organism involves adaptation; for in all cases life consists in a continuous adjustment of internal to external relations. The term is usually restricted, however, to imply such modifications as arise during the life of an individual, when an external change directly generates some change of function and structure. Thus, since the adjustments of organisms arise partly in direct response to causes acting on the individual, and partly in response to causes acting not directly on the individual but on the species as a whole, adaptation is to be regarded as the complement of natural selection. While natural selection acts primarily on the species, adaptation acts only indirectly, through the *inheritance* of modifications directly generated in the individual. All adaptation is limited, since an organ can only vary to a certain limited extent from its congenital structure. Adaptations are sometimes distinguished as *indirect* (for instance, by Haeckel, *Generelle Morphologie*, vol. ii.), which are directly generated in an organism, but only become apparent in its offspring. These form an important class, and seem to suggest that the phenomena of adaptation, thoroughly understood, would go far to explain all the difficult cases of so-called spontaneous variation.

ADDA, the ancient *Addua*, a river of Northern Italy, formed by the union of several small streams, near the town of Bormio, in the Rhætian Alps, flows westward through the Valtellina into the Lake of Como, near its northern extremity. Issuing from the Lecco arm of the lake, it crosses the plain of Lombardy, and finally, after a course of about 150 miles, joins the Po, 8 miles above Cremona. The Adda was formerly the boundary between the territories of Venice and Milan; and on its banks several important battles have been fought, notably that of Lodi, where Napoleon defeated the Austrians in 1796.

ADDER, the common viper (*Vipera communis*). The death adder (*Acanthopis tortor*) of Australia, and the puff adder (*Clotho arietans*) of South Africa, are both highly poisonous.

ADDINGTON, Henry, Viscount Sidmouth, prime minister of England, eldest son of Dr Anthony Addington, was born at Reading on the 30th May 1757. He was educated at Winchester and at Brazenose College, Oxford. In 1784 he was called to the bar at Lincoln's Inn, but being elected about the same time member of Parliament for Devizes, he did not enter on legal practice. He was already on terms of intimacy with the younger Pitt, his father having been Lord Chatham's medical adviser (a circumstance that secured for young Addington the nickname in Parliament of "the Doctor"); and he attached himself, as was natural, to the party of the great commoner.

His fidelity to Pitt received a speedy and ample acknowledgment when he was elected, in May 1789, speaker of the House, in succession to Grenville. For a period of twelve years he discharged the duties of the chair to the general satisfaction of all parties, if with no very marked ability. In 1801, when Pitt resigned on the question of Catholic emancipation, Addington succeeded him in the offices of prime minister and chancellor of the exchequer. He was head of the party that had come to be known as "the king's friends," and took office, it is said, on the urgent personal solicitation of his majesty. The most memorable event of his brief administration was the negotiation of the peace of Amiens, which was concluded on terms that were considered very favourable. It proved, however, but a short-lived truce, the ambition of the First Consul necessitating a renewal of hostilities in May 1803. From this period Pitt assumed a critical attitude towards the ministry, and at length he joined Fox and the opposition in demanding more vigorous measures for the defence of the country. The result was that Addington was compelled to resign, and Pitt was restored to power in May 1804. Addington abstained from all factious opposition, and indeed gave a general support to the Government. In January 1805 he joined the cabinet as president of the council, accepting at the same time the dignity of a peerage, which he had previously declined. He resigned office, however, in July of the same year, in consequence of the share he took in the prosecution of Lord Melville having estranged him from Pitt. After the death of the latter in 1806, he became lord privy seal, and subsequently lord president in the cabinet of Fox and Grenville, but resigned office in 1807. He became a third time lord president under Mr Perceval in 1812, and in June of the same year received the seals of the Home Office under the administration of Lord Liverpool. He held this position for ten eventful years, during which he received his full share of the hostile criticism to which home secretaries are peculiarly exposed. His administration had the merit of being vigorous, fearless, and consistent; but it frequently occasioned great irritation, and all but provoked rebellion. The policy of repression which he pursued in regard to the reform meeting at Manchester in 1819, was not justifiable even according to the limited ideas of liberty prevalent at that time. Lord Sidmouth resigned office in 1822, retaining his seat in the cabinet, however, until 1824. He died on the 15th Feb. 1844, at the advanced age of 87. (*Life and Correspondence of Lord Sidmouth*, by Dean Pellew, 3 vols. 8vo, 1847; *Life of William Pitt* by Lord Stanhope, 4 vols. p. 8vo, 1867.)

ADDISON, Joseph, was the eldest son of Lancelot Addison, Dean of Lichfield, and was born at his father's rectory of Milston in Wiltshire, on the 1st day of May 1672. After having passed through several schools, the last of which was the Charter-house, he went to Oxford when he was about fifteen years old. He was first entered of Queen's College, but after two years was elected a scholar of Magdalen College, having, it is said, been recommended by his skill in Latin versification. He took his master's degree in 1693, and held a fellowship from 1699 till 1711.

The eleven years extending from 1693, or his twenty-first year, to 1704, when he was in his thirty-second, may be set down as the first stage of his life as a man of letters. During this period, embracing no profession, and not as yet entangled in official business, he was a student, an observer, and an author; and though the literary works which he then produced are not those on which his permanent celebrity rests, they gained for him in his own day a high reputation. He had at first intended to become a clergyman; but his talents having attracted the attention of leading statesmen belonging to the Whig party, he was speedily diverted from his earlier views by the countenance which these men bestowed on him. His first patron (to whom he seems to have been introduced by Congreve) was Charles Montague, afterwards Earl of Halifax, who was himself a dabbler in literature, and a protector of literary men; and he became known afterwards to the accomplished and excellent Somers. While both of them were quite able to estimate justly his literary merits, they had regard mainly to the services which they believed him capable of rendering to the nation or the party; and accordingly they encouraged him to regulate his pursuits with a view to public and official employment. For a considerable time, however, he was left to his own resources, which cannot have been otherwise than scanty.

His first literary efforts were poetical. In 1693 a short poem of his, addressed to Dryden, was inserted in the third volume of that veteran writer's *Miscellanies*. The next volume of this collection contained his translation, in tolerable heroic couplets, of "all Virgil's *Fourth Georgic*, except the story of Aristæus." Two and a half books of Ovid were afterwards attempted; and to his years of early manhood belonged also his prose *Essay on Virgil's Georgics*, a performance which hardly deserved, either for its style or for its critical excellence, the compliment paid it by Dryden, in prefixing it to his own translation of the poem. The most ambitious of those poetical essay-pieces is the *Account of the Greatest English Poets*, dated April 1694, and addressed affectionately to Sacheverell, the poet's fellow-collegian, who afterwards became so notorious in the party-quarrels of the time. This piece, spirited both in language and in versification, is chiefly noticeable as showing that ignorance of old English poetry which was then universal. Addison next, in 1695, published one of those compositions, celebrating contemporary events, and lauding contemporary great men, on which, during the half-century that succeeded the Revolution, there was wasted so much of good writing and of fair poetical ability. His piece, not very meritorious even in its own class, was addressed "To the King," and commemorates the campaign which was distinguished by William's taking of Namur. Much better than the poem itself are the introductory verses to Somers, then lord keeper. This production, perhaps intended as a remembrancer to the writer's patrons, did not at once produce any obvious effect: and we are left in considerable uncertainty as to the manner in which about this time Addison contrived to support himself. He corresponded with Tonson the bookseller about projected works, one of these being a Translation of Herodotus. It was probably at some later time that he purposed compiling a Dictionary of the English Language. In 1699 a considerable collection of his Latin verses was published at Oxford, in the *Musæ Anglicanæ*. These appear to have interested some foreign scholars; and several of them show curious symptoms of his characteristic humour.

In the same year, his patrons, either having still no office to spare for him, or desiring him to gain peculiarly high qualifications for diplomatic or other important business, provided for him temporarily by a grant, which, though bestowed on a man of great merit and promise, would not pass unquestioned in the present century. He obtained, on the recommendation of Lord Somers, a pension of £300 a year, designed (as Addison himself afterwards said in a memorial addressed to the crown) to enable him "to travel, and qualify himself to serve His Majesty." In the summer of 1699 he crossed into France, where, chiefly for the purpose of learning the language, he remained till the end of 1700; and after this he spent a year in Italy. In Switzerland, on his way home, he was stopped by receiving notice that he was to be appointed envoy to Prince Eugene, then engaged in the war in Italy. But his Whig friends

were already tottering in their places; and, in March 1702, the death of King William at once drove them from power and put an end to the pension. Indeed Addison asserted that he never received but one year's payment of it, and that all the other expenses of his travels were defrayed by himself. He was able, however, to visit a great part of Germany, and did not reach Holland till the spring of 1703. His prospects were now sufficiently gloomy: he entered into treaty, oftener than once, for an engagement as a travelling tutor; and the correspondence in one of these negotiations has been preserved. Tonson had recommended him as the best person to attend in this character the son of the Duke of Somerset, commonly called "The Proud." The duke, a profuse man in matters of pomp, was economical in questions of education. He wished Addison to name the salary he expected; this being declined, he announced, with great dignity, that he would give a hundred guineas a year; Addison accepted the munificent offer, saying, however, that he could not find his account in it otherwise than by relying on his Grace's future patronage; and his Grace immediately intimated that he would look out for some one else. Towards the end of 1703 Addison returned to England.

Works which he composed during his residence on the Continent were the earliest that showed him to have attained maturity of skill and genius. There is good reason for believing that his tragedy of *Cato*, whatever changes it may afterwards have suffered, was in great part written while he lived in France, that is, when he was about twenty-eight years of age. In the winter of 1701, amidst the stoppages and discomforts of a journey across the Mount Cenis, he composed, wholly or partly, his *Letter from Italy*, which is by far the best of his poems, if it is not rather the only one among them that at all justifies his claim to the poetical character. It contains some fine touches of description, and is animated by a noble tone of classical enthusiasm. While in Germany he wrote his *Dialogues on Medals*, which, however, were not published till after his death. These have much liveliness of style, and something of the gay humour which the author was afterwards to exhibit more strongly; but they show little either of antiquarian learning or of critical ingenuity. In tracing out parallels between passages of the Roman poets and figures or scenes which appear in ancient sculptures, Addison opened the easy course of inquiry which was afterwards prosecuted by Spence; and this, with the apparatus of spirited metrical translations from the classics, gave the work a likeness to his account of his travels. This account, entitled *Remarks on Several Parts of Italy*, &c., he sent home for publication before his own return. It wants altogether the interest of personal narrative: the author hardly ever appears. The task in which he chiefly busies himself is that of exhibiting the illustrations which the writings of the Latin poets, and the antiquities and scenery of Italy, mutually give and receive. Many of the landscapes are sketched with great liveliness, and there are not a few strokes of arch humour. The statistical information is very meagre; nor are there many observations on society; and politics are no further meddled with than to show the moderate liberality of the writer's own opinions.

With the year 1704 begins a second era in Addison's life, which extends to the summer of 1710, when his age was thirty-eight. This was the first term of his official career; and, though very barren of literary performance, it not only raised him from indigence, but settled definitively his position as a public man. His correspondence shows that, while on the Continent, he had been admitted to confidential intimacy by diplomatists and men of rank; immediately on his return he was enrolled in the Kitcat Club, and brought thus and otherwise into communication with the gentry of the Whig party. Although all accounts agree in representing him as a shy man, he was at least saved from all risk of making himself disagreeable in society, by his unassuming manners, his extreme caution, and that sedulous desire to oblige, which his satirist Pope exaggerated into a positive fault. His knowledge and ability were esteemed so highly, as to confirm the expectations formerly entertained of his usefulness in public business; and the literary fame he had already acquired soon furnished an occasion for recommending him to public employment. Though the Whigs were out of office, the administration which succeeded them was, in all its earlier changes, of a complexion so mixed and uncertain, that the influence of their leaders was not entirely lost. Not long after Marlborough's great victory at Blenheim, it is said that Godolphin, the lord treasurer, expressed to Lord Halifax a desire to have the great duke's fame extended by a poetical tribute. Halifax seized the opportunity of recommending Addison as the fittest man for the duty; stipulating, we are told, that the service should not be unrewarded, and doubtless satisfying the minister that his protegé possessed other qualifications for office besides dexterity in framing heroic verse. *The Campaign*, the poem thus written to order, was received with extraordinary applause; and it is probably as good as any that ever was prompted by no more worthy inspiration. It has, indeed, neither the fiery spirit which Dryden threw into occasional pieces of the sort, nor the exquisite polish that would have been given by Pope, if he had stooped to make such uses of his genius; but many of the details are pleasing; and in the famous passage of the Angel, as well as in several others, there is even something of force and imagination.

The consideration covenanted for by the poet's friends was faithfully paid. A vacancy occurred by the death of another celebrated man, John Locke; and in November 1704, Addison was appointed one of the five commissioners of appeal in Excise. The duties of the place must have been as light for him as they had been for his predecessor; for he continued to hold it with all the appointments he subsequently received from the same ministry. But there is no reason for believing that he was more careless than other public servants in his time; and the charge of incompetency as a man of business, which has been brought so positively against him, cannot possibly be true as to this first period of his official career. Indeed, the specific allegations refer exclusively to the last years of his life; and, if he had not really shown practical ability in the period now in question, it is not easy to see how he, a man destitute alike of wealth, of social or fashionable liveliness, and of family interest, could have been promoted, for several years, from office to office, as he was, till the fall of the administration to which he was attached. In 1706 he became one of the under-secretaries of state, serving first under Hedges, who belonged to the Tory section of the Government, and afterwards under Lord Sunderland, Marlborough's son-in-law, and a zealous follower of Addison's early patron, Somers. The work of this office, however, like that of the commissionership, must often have admitted of performance by deputy. For in 1707, the Whigs having become stronger, Lord Halifax was sent on a mission to the Elector of Hanover; and, besides taking Vanbrugh the dramatist with him as king-at-arms, he selected Addison as his secretary. In 1708 he entered Parliament, sitting at first for Lostwithiel, but afterwards for Malmesbury, which, being six times elected, he represented from 1710 till his death. Here unquestionably he did fail. What part he may have taken in the details of business we are not informed; but he was always a silent member, unless it be true that he once attempted to speak and sat down in confusion. In 1709 Lord Wharton, the father of the notorious duke, having been named lord-lieutenant of Ireland, Addison became his

secretary, receiving also an appointment as keeper of records. This event happened only about a year and a half before the dismissal of the ministry; and the Irish secretary would seem to have transacted the business of his office chiefly in London. But there are letters showing him to have made himself acceptable to some of the best and most distinguished persons in Dublin; and he escaped without having any quarrel with Swift, his acquaintance with whom had begun some time before. In the literary history of Addison those seven years of official service are almost a blank, till we approach their close. He defended the Government in an anonymous pamphlet on *The Present State of the War;* he united compliments to the all-powerful Marlborough with indifferent attempts at lyrical poetry in his opera of *Rosamond;* and, besides furnishing a prologue to Steele's comedy of *The Tender Husband,* he perhaps gave some assistance in the composition of the play. Irish administration, however, allowed it would seem more leisure than might have been expected. During the last few months of his tenure of office Addison contributed largely to the *Tatler*. But his entrance on this new field does nearly coincide with the beginning of a new section in his history.

Even the coalition-ministry of Godolphin was too Whiggish for the taste of Queen Anne; and the Tories, the favourites of the court, gained, both in parliamentary power and in popularity out of doors, by a combination of lucky accidents, dexterous management, and divisions and double-dealing among their adversaries. The real failure of the prosecution of Addison's old friend Sacheverell, completed the ruin of the Whigs; and in August 1710 an entire revolution in the ministry had been completed. The Tory administration which succeeded kept its place till the queen's death in 1714, and Addison was thus left to devote four of the best years of his life, from his thirty-ninth year to his forty-third, to occupations less lucrative than those in which his time had recently been frittered away, but much more conducive to the extension of his own fame, and to the benefit of English literature. Although our information as to his pecuniary affairs is very scanty, we are entitled to believe that he was now independent of literary labour. He speaks, in an extant paper, of having had (but lost) property in the West Indies; and he is understood to have inherited several thousand pounds from a younger brother, who was governor of Madras. In 1711 he purchased, for £10,000, the estate of Bilton, near Rugby,—the place which afterwards became the residence of Mr Apperley, better known by his assumed name of "Nimrod."

During those four years he produced a few political writings. Soon after the fall of the ministry, he contributed five numbers to the *Whig Examiner*, a paper set up in opposition to the Tory periodical of the same name, which was then conducted by the poet Prior, and afterwards became the vehicle of Swift's most vehement invectives against the party he had once belonged to. These are certainly the most ill-natured of Addison's writings, but they are neither lively nor vigorous. There is more spirit in his allegorical pamphlet, the *Trial and Conviction of Count Tariff.*

But from the autumn of 1710 till the end of 1714 his principal employment was the composition of his celebrated Periodical Essays. The honour of inventing the plan of such compositions, as well as that of first carrying the idea into execution, belongs to Richard Steele, who had been a school-fellow of Addison at the Charter-house, continued to be on intimate terms with him afterwards, and attached himself with his characteristic ardour to the same political party. When, in April 1709, Steele published the first number of the *Tatler*, Addison was in Dublin, and knew nothing of the design. He is said to have detected his friend's authorship only by recognising, in one of the early papers, a critical remark which he remembered having himself communicated to Steele. He began to furnish essays in a few weeks, assisted occasionally while he held office, and afterwards wrote oftener than Steele himself. He thus contributed in all, if his literary executor selected his contributions correctly, more than 60 of the 271 essays which the work contains. The *Tatler* exhibited, in more ways than one, symptoms of being an experiment. The projector, imitating the news-sheets in form, thought it prudent to give, in each number, news in addition to the essay; and there was a want, both of unity and of correct finishing, in the putting together of the literary materials. Addison's contributions, in particular, are in many places as lively as anything he ever wrote; and his style, in its more familiar moods at least, had been fully formed before he returned from the Continent. But, as compared with his later pieces, these are only what the painter's loose studies and sketches are to the landscapes which he afterwards constructs out of them. In his invention of incidents and characters, one thought after another is hastily used and hastily dismissed, as if he were putting his own powers to the test, or trying the effect of various kinds of objects on his readers; his most ambitious flights, in the shape of allegories and the like, are stiff and inanimate; and his favourite field of literary criticism is touched so slightly, as to show that he still wanted confidence in the taste and knowledge of the public.

The *Tatler* was dropped at the beginning of 1711, but only to be followed by the *Spectator*, which was begun on the 1st day of March, and appeared every week-day till the 6th day of December 1712. It had then completed the 555 numbers usually collected in its first seven volumes. Addison, now in London and unemployed, co-operated with Steele constantly from the very opening of the series; and the two, contributing almost equally, seem together to have written not very much less than five hundred of the papers. Emboldened by the success of their former adventure, they devoted their whole space to the essays. They relied, with a confidence which the extraordinary popularity of the work fully justified, on their power of exciting the interest of a wide audience by pictures and reflections drawn from a field which embraced the whole compass of ordinary life and ordinary knowledge, no kind of practical themes being positively excluded except such as were political, and all literary topics being held admissible, for which it seemed possible to command attention from persons of average taste and information. A seeming unity was given to the undertaking, and curiosity and interest awakened on behalf of the conductors, by the happy invention of the Spectator's Club, in which Steele is believed to have drawn all the characters. The figure of Sir Roger de Coverley, however, the best even in the opening group, is the only one that was afterwards elaborately depicted; and Addison was the author of all the papers in which his oddities and amiabilities are so admirably delineated. To him, also, the *Spectator* owed a very large share of its highest excellences. His were many, and these the most natural and elegant, if not the most original, of its humorous sketches of human character and social eccentricities, its good-humoured satires on ridiculous features in manners, and on corrupt symptoms in public taste; these topics, however, making up a department in which Steele was fairly on a level with his more famous coadjutor. But Steele had neither learning, nor taste, nor critical acuteness sufficient to qualify him for enriching the series with such literary disquisitions as those which Addison insinuated so often into the lighter matter of his essays, and of which he gave an elaborate specimen in his celebrated and agreeable criticism on *Paradise Lost.* Still further beyond the powers of Steele were those speculations on the theory of literature and of the processes of

thought analogous to it, which, in the essays "On the Pleasures of the Imagination," Addison prosecuted, not, indeed, with much of philosophical depth, but with a sagacity and comprehensiveness which we shall undervalue much unless we remember how little of philosophy was to be found in any critical views previously propounded in England. To Addison, further, belong those essays which (most frequently introduced in regular alternation in the papers of Saturday) rise into the region of moral and religious meditation, and tread the elevated ground with a step so graceful as to allure the reader irresistibly to follow; sometimes, as in the "Walk through Westminster Abbey," enlivening solemn thought by gentle sportiveness; sometimes flowing on with an uninterrupted sedateness of didactic eloquence; and sometimes shrouding sacred truths in the veil of ingenious allegory, as in the majestic "Vision of Mirza." While, in a word, the *Spectator*, if Addison had not taken part in it, would probably have been as lively and humorous as it was, and not less popular in its own day, it would have wanted some of its strongest claims on the respect of posterity, by being at once lower in its moral tone, far less abundant in literary knowledge, and much less vigorous and expanded in thinking. In point of style, again, the two friends resemble each other so closely as to be hardly distinguishable, when both are dealing with familiar objects, and writing in a key not rising above that of conversation. But in the higher tones of thought and composition, Addison showed a mastery of language raising him very decisively, not above Steele only, but above all his contemporaries. Indeed, it may safely be said, that no one, in any age of our literature, has united, so strikingly as he did, the colloquial grace and ease which mark the style of an accomplished gentleman, with the power of soaring into a strain of expression nobly and eloquently dignified.

On the cessation of the *Spectator*, Steele set on foot the *Guardian*, which, started in March 1713, came to an end in October, with its 175th number. To this series Addison gave 53 papers, being a very frequent writer during the latter half of its progress. None of his essays here aim so high as the best of those in the *Spectator;* but he often exhibits both his cheerful and well-balanced humour, and his earnest desire to inculcate sound principles of literary judgment. In the last six months of the year 1714, the *Spectator* received its eighth and last volume; for which Steele appears not to have written at all, and Addison to have contributed 24 of the 80 papers. Most of these form, in the unbroken seriousness both of their topics and of their manner, a contrast to the majority of his essays in the earlier volumes; but several of them, both in this vein and in one less lofty, are among the best known, if not the finest, of all his essays. Such are the "Mountain of Miseries;" the antediluvian novel of "Shallum and Hilpa;" the "Reflections by Moonlight on the Divine Perfections."

In April 1713 Addison brought on the stage, very reluctantly, as we are assured, and can easily believe, his tragedy of *Cato*. Its success was dazzling; but this issue was mainly owing to the concern which the politicians took in the exhibition. The Whigs hailed it as a brilliant manifesto in favour of constitutional freedom. The Tories echoed the applause, to show themselves enemies of despotism, and professed to find in Julius Cæsar a parallel to the formidable Marlborough. Even with such extrinsic aids, and the advantage derived from the established fame of the author, *Cato* could never have been esteemed a good dramatic work, unless in an age in which dramatic power and insight were almost extinct. It is poor even in its poetical elements, and is redeemed only by the finely solemn tone of its moral reflections, and the singular refinement and equable smoothness of its diction.

The literary career of Addison might almost be held as closed soon after the death of Queen Anne, which occurred in August 1714, when he had lately completed his 42d year. His own life extended only five years longer; and this closing portion of it offers little that is pleasing or instructive. We see him attaining the summit of his ambition, only to totter for a little and sink into an early grave. We are reminded of his more vigorous days by nothing but a few happy inventions interspersed in political pamphlets, and the gay fancy of a trifling poem on Kneller's portrait of George I.

The lord justices who, previously chosen secretly by the Elector of Hanover, assumed the government on the Queen's demise, were, as a matter of course, the leading Whigs. They appointed Addison to act as their secretary. He next held, for a very short time, his former office under the Irish lord-lieutenant; and, early in 1715, he was made one of the lords of trade. In the course of the same year occurred the first of the only two quarrels with friends, into which the prudent, good-tempered, and modest Addison is said to have ever been betrayed. His adversary on this occasion was Pope, who, only three years before, had received, with an appearance of humble thankfulness, Addison's friendly remarks on his *Essay on Criticism;* but who, though still very young, was already very famous, and beginning to show incessantly his literary jealousies, and his personal and party hatreds. Several little misunderstandings had paved the way for a breach, when, at the same time with the first volume of Pope's *Iliad*, there appeared a translation of the first book of the poem, bearing the name of Thomas Tickell. Tickell, in his preface, disclaimed all rivalry with Pope, and declared that he wished only to bespeak favourable attention for his contemplated version of the *Odyssey*. But the simultaneous publication was awkward; and Tickell, though not so good a versifier as Pope, was a dangerous rival, as being a good Greek scholar. Further, he was Addison's under-secretary and confidential friend; and Addison, cautious though he was, does appear to have said (quite truly) that Tickell's translation was more faithful than the other. Pope's anger could not be restrained. He wrote those famous lines in which he describes Addison under the name of Atticus; and, as if to make reconciliation impossible, he not only circulated these among his friends, but sent a copy to Addison himself. Afterwards, he went so far as to profess a belief that the rival translation was really Addison's own. It is pleasant to observe that, after the insult had been perpetrated, Addison was at the pains, in his *Freeholder*, to express hearty approbation of the *Iliad* of Pope; who, on the contrary, after Addison's death, deliberately printed the striking but malignant lines in the Epistle to Dr Arbuthnot. In 1715 there was acted, with little success, the comedy of *The Drummer, or the Haunted House*, which, though it appeared under the name of Steele, was certainly not his, and was probably written in whole or chiefly by Addison. It contributes very little to his fame. From September 1715 to June 1716, he defended the Hanoverian succession, and the proceedings of the Government in regard to the rebellion, in a paper called the *Freeholder*, which he wrote entirely himself, dropping it with the fifty-fifth number. It is much better tempered, not less spirited, and much more able in thinking, than his *Examiner*. The finical man of taste does indeed show himself to be sometimes weary of discussing constitutional questions; but he aims many enlivening thrusts at weak points of social life and manners; and the character of the Fox-hunting Squire, who is introduced as the representative of the Jacobites, is drawn with so much humour and force that we regret not being allowed to see more of him.

In August 1716, when he had completed his 44th year, Addison married the Countess-Dowager of Warwick, a

widow of fifteen years' standing. She seems to have forfeited her jointure by the marriage, and to have brought her husband nothing but the occupancy of Holland House at Kensington. We know hardly anything positively in regard to the affair, or as to the origin or duration of his acquaintance with the lady or her family. But the current assertion that the courtship was a long one is very probably erroneous. There are better grounds for believing the assertion, transmitted from Addison's own time, that the marriage was unhappy. The countess is said to have been proud as well as violent, and to have supposed that, in contracting the alliance, she conferred honour instead of receiving it. To the uneasiness caused by domestic discomfort, the most friendly critics of Addison's character have attributed those habits of intemperance, which are said to have grown on him in his later years to such an extent as to have broken his health and accelerated his death. His biographer, Miss Aikin, who disbelieves his alleged want of matrimonial quiet, has called in question, with much ingenuity, the whole story of his sottishness; and it must at any rate be allowed that all the assertions which tend to fix such charges on him in the earlier parts of his life, rest on no evidence that is worthy of credit, and are in themselves highly improbable. Sobriety was not the virtue of the day; and the constant frequenting of coffee-houses, which figures so often in the *Spectator* and elsewhere, and which was really practised among literary men as well as others, cannot have had good effects. Addison, however, really appears to have had no genuine relish for this mode of life; and there are curious notices, especially in Steele's correspondence, of his having lodgings out of town, to which he retired for study and composition. But, whatever the cause may have been, his health was shattered before he took that which was the last, and certainly the most unwise step, in his ascent to political power.

For a considerable time dissensions had existed in the ministry; and these came to a crisis in April 1717, when those who had been the real chiefs passed into the ranks of the opposition. Townshend was dismissed, and Walpole anticipated dismissal by resignation. There was now formed, under the leadership of General Stanhope and Lord Sunderland, an administration which, as resting on court-influence, was nicknamed the "German ministry." Sunderland, Addison's former superior, became one of the two principal secretaries of state; and Addison himself was appointed as the other. His elevation to such a post had been contemplated on the accession of George I., and prevented, we are told, by his own refusal; and it is asserted, on the authority of Pope, that his acceptance now was owing only to the influence of his wife. Even if there is no ground, as there probably is not, for the allegation of Addison's inefficiency in the details of business, his unfitness for such an office in such circumstances was undeniable and glaring. It was impossible that a Government, whose secretary of state could not open his lips in debate, should long face an opposition headed by Robert Walpole. The decay of Addison's health, too, was going on rapidly, being, we may readily conjecture, precipitated by anxiety, if no worse causes were at work. Ill health was the reason assigned for retirement, in the letter of resignation which he laid before the king in March 1718, eleven months after his appointment. He received a pension of £1500 a year.

Not long afterwards the divisions in the Whig party alienated him from his oldest friend. The Peerage Bill, introduced in February 1719, was attacked, on behalf of the opposition, in a weekly paper, which was called the *Plebeian*, and written by Steele. Addison answered it temperately enough in the *Old Whig*; provocation from the *Plebeian* brought forth angry retort from the *Whig*; Steele charged Addison with being so old a Whig as to have forgotten his principles; and Addison sneered at Grub Street, and called his friend "Little Dicky."[1] How Addison felt after this painful quarrel we are not told directly; but the *Old Whig* was excluded from that posthumous collection of his works for which his executor Tickell had received from him authority and directions. In that collection was inserted a treatise on the evidences of the faith, entitled *Of the Christian Religion*. Its theological value is very small; but it is pleasant to regard it as the last effort of one who, amidst all weaknesses, was a man of real goodness as well as of eminent genius.

The disease under which Addison laboured appears to have been asthma. It became more violent after his retirement from office, and was now accompanied by dropsy. His deathbed was placid and resigned, and comforted by those religious hopes which he had so often suggested to others, and the value of which he is said, in an anecdote of doubtful authority, to have now inculcated in a parting interview with his stepson. He died at Holland House on the 17th day of June 1719, six weeks after having completed his 47th year. His body, after lying in state, was interred in the Poets' Corner of Westminster Abbey.

The *Biographia Britannica* gives an elaborate memoir of him; particulars are well collected in the article under his name in the *Biographical Dictionary of the Society for the Diffusion of Useful Knowledge;* and a good many new materials, especially letters, will be found in *The Life of Joseph Addison*, by Lucy Aikin, 1843. (W. S.)

An edition of Addison's works, in four volumes quarto, was published by Baskerville at Birmingham in 1761. Dibdin characterises this as a "glorious performance." A complete edition in six volumes, with notes, by Richard Hurd, appeared in 1811. An American edition (New York, 1854), in six volumes, with notes, by G. W. Greene, contains several pieces collected for the first time. An edition of the *Spectator*, with valuable notes by Henry Morley, appeared in 1871.

ADEL or SOMAULI, an extensive tract of country, stretching eastward from the neighbourhood of Tajurrah to Cape Guardafui, between 43° and 51° E. long., with a breadth not accurately ascertained. Zeila and Berbera are the chief ports on the coast, and have some trade with the opposite shores of Arabia, exporting spices, ivory, gold dust, cattle, and horses, and receiving Indian commodities in exchange. The country, which is marshy and unhealthy, is inhabited by the Somauli, who are governed by an Iman, and are Mahometans.

ADELAAR, CORT SIVARTSEN, surnamed the Eagle, a famous naval commander, was born at Brevig in Norway in 1622. At the age of fifteen he became a cadet in the Dutch fleet under Van Tromp, and after a few years entered the service of the Venetian Republic, which was engaged at the time in a war with Turkey. In 1645 he had risen to the rank of captain; and after sharing in various victories as commander of a squadron, he achieved his most brilliant success at the Dardanelles, on the 13th May 1654, when, with his own vessel alone, he broke through a line of 37 Turkish ships, sank 15 of them, and burned others, causing a loss to the enemy of 5000 men. The following day he entered Tenedos, and compelled the complete surrender of the Turks. On returning to Venice he was crowned with honours, and became admiral-lieutenant in 1660. Numerous tempting offers were made to him by other naval powers, and in 1661 he left Venice to return to the Netherlands. Next year he was induced, by the offer of a title and an enormous salary, to accept the command of the Danish fleet from Frederick III. Under Christian V. he took the command of the combined Danish fleets against Sweden, but died suddenly (5th November

[1] On this point, however, see Macaulay's Essay on *The Life and Writings of Addison*.

1675) at Copenhagen, before the expedition set out. When in the Venetian service, Adelaar was known by the name of Curzio Suffrido Adelborst.

ADELAIDE, the capital of the British colony of South Australia and of the county of the same name, situated on the Torrens, seven miles from Port Adelaide, with which it is connected by railway. The river, which is spanned at this point by several bridges, divides the city into two parts —North Adelaide, the smaller of the two, but containing the chief private houses, occupying a gentle slope on the right bank; and South Adelaide, the commercial centre of the town, lying on a very level plain on the left. The streets of Adelaide are broad, and regularly laid out. Among its public buildings are the Government offices and the governor's house, the post office, the jail, five banks, the railway station, and a theatre. It is the seat of a Protestant Episcopal and also of a Roman Catholic bishop, and contains places of worship belonging to these bodies, as well as to the Presbyterians, the Methodists, the Unitarians, the Baptists, and other denominations. Adelaide possesses a botanical garden, and is surrounded by extensive public grounds, known as the "Park Lands," containing over 1900 acres. It is lighted with gas, and is supplied with water from a reservoir some miles up the Torrens. The corporation consists of a mayor and eight councillors, two from each of the four wards; and there are also two auditors, a town clerk, and other officials. The chief manufactures are woollen, starch, soap, beer, flour, leather, earthenware, and iron goods. There is a good retail trade in European produce; and in the vicinity are iron and copper mines. Adelaide was founded in 1836, and incorporated in 1842. It received its name in honour of Queen Adelaide. Population, 27,208. Lat. 34° 55′ S., long. 138° 38′ E.

Port Adelaide is situated in a low marshy position, on a small inlet of the Gulf of St Vincent. Its harbour is safe and commodious; but a bar at the mouth, where the depth of water varies with the tide from 8 to 16 feet, prevents large vessels from entering. It is a free port, and has good wharfs and warehouse accommodation. In 1867, 364 vessels of 119,654 tons arrived at, and 376 of 125,559 tons departed from, Port Adelaide. The chief imports were drapery, iron goods and machinery, beer, wine, spirits, and paper; and the exports, grain, copper and lead ores, wool, tallow, and other native products. Population, 2482.

ADELSBERG, a market town of Austria, in the province of Carniola, 26 miles SW. of Laibach, and about the same distance E. of Trieste. About a mile from the town is the entrance to the famous stalactite cavern of Adelsberg, the largest and most magnificent in Europe. The cavern is divided into four grottoes, with two lateral ramifications which reach to the distance of about a mile and a half from the entrance. The river Poik enters the cavern 60 feet below its mouth, and is heard murmuring in its recesses. In the Kaiser-Ferdinand grotto, the third of the chain, a great ball is annually held on Whitmonday, when the chamber is brilliantly illuminated. The Franz-Joseph-Elisabeth grotto, the largest of the four, and the farthest from the entrance, is 665 feet in length, 640 feet in breadth, and more than 100 feet high. Besides the imposing proportions of its chambers, the cavern is remarkable for the variegated beauty of its stalactite formations, some resembling transparent drapery, others waterfalls, trees, animals, or human beings, the more grotesque being called by various fanciful appellations. These subterranean wonders were known in the Middle Ages, but the cavern remained undiscovered in modern times until 1816, and it is only in still more recent times that its vast extent has been fully ascertained and explored.

ADELUNG, Friedrich von, a distinguished philologist, nephew of John Christoph Adelung, was born at Stettin on the 25th February 1768. After studying philosophy and jurisprudence at Leipsic he accompanied a family to Italy, where he remained for several years. At Rome he obtained access to the Vatican library, a privilege which he utilised by collating and editing some valuable old German MSS. that had been taken from Heidelberg. On his return he became private secretary to Count Pahlen, whom he accompanied from Riga to St Petersburg. In 1803 he became instructor to the younger brothers of the Czar, the arch-dukes Nicholas and Michael, and gave such satisfaction to the empress-mother that she entrusted him with the care of her private library. In 1824 he became director of the Oriental Institute in connection with the foreign office, and in the year following president of the Academy of Sciences. He died on the 30th January 1843. Adelung's chief literary works were—a *Biography of Baron Herberstein* (St Petersburg, 1817), a *Biography of Baron de Meyerberg* (1827), a treatise on the *Relations between the Sanscrit and the Russian Languages* (1815), and an *Essay on Sanscrit Literature* (1830), a second edition of which appeared in 1837, under the title *Bibliotheca Sanscrita*.

ADELUNG, Johann Christoph, a very eminent German grammarian, philologist, and general scholar, was born at Spantekow, in Pomerania, on the 8th August 1732, and educated at the public schools of Anclam and Closterbergen, and the university of Halle. In the year 1759 he was appointed professor at the gymnasium of Erfurt, but relinquished this situation two years after, and went to reside in a private capacity at Leipsic, where he continued to devote himself for a long period to the cultivation of letters, and particularly to those extensive and laborious philological researches which proved so useful to the language and literature of his native country. In 1787 he received the appointment of principal librarian to the elector of Saxony at Dresden, with the honorary title of Aulic Counsellor. Here he continued to reside during the remainder of his life, discharging with diligence and integrity the duties of his situation, and prosecuting his laborious studies to the last with indefatigable industry and unabated zeal. Possessing a naturally robust constitution, he was able to devote, it has been said, fourteen hours daily to literary toil, down even to the period of his death. He died at Dresden on the 10th of September 1806. The life of a mere scholar is generally destitute of interest; and that of Adelung, which was spent entirely in literary seclusion, presents no variety of incident to the pen of the biographer. Of his private character and habits few memorials have been preserved, but in these few he is represented as the man of an amiable disposition. He was a lover of good cheer, and spared neither pains nor expense in procuring a variety of foreign wines, of which his cellar, which he facetiously denominated his *Bibliotheca Selectissima*, is said to have contained no less than forty different kinds. His manners were easy and affable, and the habitual cheerfulness of his disposition rendered his society most acceptable to a numerous circle of friends. The writings of Adelung are very voluminous, and there is not one of them, perhaps, which does not exhibit some proofs of the genius, industry, and erudition of the author. But although his pen was usefully employed upon a variety of subjects in different departments of literature and science, it is to his philological labours that he is principally indebted for his great reputation; and no man ever devoted himself with more zeal and assiduity, or with greater success, to the improvement of his native language. In a country subdivided into so many distinct sovereign states, possessing no common political centre, and no national institution whose authority could command deference in matters of taste,—in a country whose indigenous literature was but of recent growth, and where the dialect

of the people was held in contempt at the several courts, it was no easy task for a single writer to undertake to fix the standard of a language which had branched out into a variety of idioms, depending in a great measure upon principles altogether arbitrary. Adelung effected as much in this respect as could well be accomplished by the persevering labours of an individual. By means of his excellent grammars, dictionary, and various works on German style, he contributed greatly towards rectifying the orthography, refining the idiom, and fixing the standard of his native tongue.[1] Of all the different dialects he gave a decided preference to that of the margraviate of Misnia, in Upper Saxony, and positively rejected everything that was contrary to the phraseology in use among the best society of that province, and in the writings of those authors whom it had produced. In adopting this narrow principle he is generally thought to have been too fastidious. The dialect of Misnia was undoubtedly the richest, as it was the earliest cultivated of any in Germany; but Adelung probably went too far in restraining the language within the limits of this single idiom, to the exclusion of others from which it might have, and really has, acquired additional richness, flexibility, and force. His German dictionary has been generally regarded as superior to the English one of Johnson, and certainly far surpasses it in etymology. Indeed, the patient spirit of investigation which Adelung possessed in so remarkable a degree, together with his intimate knowledge of the ancient history and progressive revolutions of the different dialects on which the modern German is based, peculiarly qualified him for the duties of a lexicographer. No man before Jacob Grimm did so much for the language of Germany. Shortly before his death he issued the very learned work, at which he had been labouring quietly for years, entitled *Mithridates; or, a General History of Languages, with the Lord's Prayer, as a specimen, in nearly five hundred languages and dialects.* The hint of this work appears to have been taken from a publication, with a similar title, published by the celebrated Conrad Gesner in 1555; but the plan of Adelung is much more extensive. Unfortunately he did not live to finish what he had undertaken. The first volume, which contains the Asiatic languages, was published immediately after his death; the other three were issued under the superintendence of Professor Vater (1809–17). Of the very numerous works by Adelung, in addition to translations, the following are of greatest importance:—

Geschichte der Streitigkeiten zwischen Dänemark und den Herzogen von Holstein-Gottorp. Frankf., Leipsic, 1762, 4to.—*Pragmatische Staatsgeschichte Europens von dem Ableben Kaiser Karls des 6ten an.* Vols. i.–ix. Gotha, 1762–9, 4to.—*Mineralogische Belustigungen.* Vols. i.–vi. Copenhagen and Leipsic, 1767–71, 8vo.—*Glossarium Manuale ad Scriptores mediæ et infimæ Latinitatis, ex magnis Glossariis Caroli du Fresne Domini Ducange et Carpentarii, in compendium redactum.* Tomi vi. Halle, 1772–84.—*Versuch eines vollständigen grammatisch-kritischen Wörterbuchs der Hoch Teutschen Mundart.* 1774–86, 5 vols. 4to.—*Ueber die Geschichte der Teutschen Sprache, über Teutsche Mundarten und Teutsche Sprachlehre.* Leipsic, 1781, 8vo.—*Ueber den Ursprung der Sprache und den Bau der Wörter. Ibid.* 1781, 8vo.—*Teutsche Sprachlehre, zum Gebrauch der Schulen in den Königl. Preuss. Landen.* Berlin, 1781.—*Lehrgebäude der Teutschen Sprache.*—*Versuch einer Geschichte der Cultur des Menschlichen Geschlechts.* 1782, 8vo.—*Beyträge zur Bürgerlichen Geschichte, zur Geschichte der Cultur, zur Naturgeschichte, Naturlehre, und dem Feldbaue.* Leipsic, 1783, 8vo.—*Fortsetzung und Ergänzungen zu Christ. Gottl. Jöchers allgemeinem Gelehrten Lexico.* Leipsic, 1784, 2 vols. 4to.—*Ueber den Teutschen Styl.* Berlin, 1785, 3 vols. 8vo.—*Vollständige Anweisung zur Teutschen Orthographie.* Leipsic, 1786, 2 vols.—*Auszug aus dem Grammatisch-kritischen Wörterbuch der Hohen Teutschen Mundart.* Leipsic, 1793, 1 vol.; 1795, 2 vols. 8vo.—*Mithridates, oder Allgemeine Sprachenkunde.* 3 vols. Berlin, 1806–1812.

[1] The period in which High German as a written language approached nearest perfection is, according to him, the short interval between 1740 and 1760.

ADEN, a town and seaport of Yemen in Arabia, belonging to Britain, situated on a peninsula of the same name, 100 miles east of the strait of Bab-el-Mandeb. The peninsula of Aden consists chiefly of a mass of barren and desolate volcanic rocks, extending five miles from east to west, and three from its northern shore to Ras Sanailah or Cape Aden, its most southerly point; it is connected with the mainland by a neck of flat sandy ground only a few feet high; and its greatest elevation is Jebel Shamshan, 1776 feet above the level of the sea. The town is built on the eastern coast, in what is probably the crater of an extinct volcano, and is surrounded by precipitous rocks that form an admirable natural defence. There are two harbours, an outer, facing the town, protected by the island of Sirah, but now partially choked with mud; and an inner, called Aden Back-bay, or, by the Arabs, Bander Tuwayyi, on the western side of the peninsula, which, at all periods of the year, admits vessels drawing less than 20 feet. On the whole, Aden is a healthy place, although it suffers considerably from the want of good water, and the heat is often very intense. From its admirable commercial and military position, Aden early became the chief entrepôt of the trade between Europe and Asia. It was known to the Romans as *Arabia Felix* and *Attanæ*, and was captured by them, probably in the year 24 B.C. At the commencement of the 16th century it fell into the hands of the Portuguese, who, however, were expelled by the Turks in 1538. In the following century the Turks themselves relinquished their conquests in Yemen, and the Sultan of Senna established a supremacy over Aden, which was maintained until the year 1730, when the Sheik of Lahej, throwing off his allegiance, founded a line of independent sultans. In 1837 a ship under British colours was wrecked near Aden, and the crew and passengers grievously maltreated by the Arabs. An explanation of the outrage being demanded by the Bombay Government, the Sultan undertook to make compensation for the plunder of the vessel, and also agreed to sell his town and port to the English. Captain Haines of the Indian navy was sent to complete these arrangements, but the Sultan's son, who now exercised the powers of government, refused to fulfil the promises that his father had made. A combined naval and military force was thereupon despatched, and the place was captured on the 16th January 1839. It became an outlying portion of the Presidency of Bombay. The withdrawal of the trade between Europe and the East, caused by the discovery of the passage round the Cape of Good Hope, and the misgovernment of the native rulers, had gradually reduced Aden to a state of comparative insignificance; but about the time of its capture by the British, the Red Sea route to India was re-opened, and commerce soon began to flow in its former channel. Aden was made a free port, and was chosen as one of the coaling stations of the Peninsular and Oriental Steamship Company; and at present its most valuable import is coal for the use of the steamers. It has, however, a considerable trade in the products of Arabia—coffee, gum, feathers, dyes, pearls, and ivory; and in return receives silk and cotton goods, grain, and provisions. In 1871–72 the value of its imports was £1,404,169; and of its exports, £885,919. In the same year 535 steamers (643,982 tons), 94 sailing vessels (90,516 tons), and 898 native craft visited the port. The town has been fortified and garrisoned by the British; and its magnificent water-tanks, which had been permitted to fall into ruins, have been partially restored. It contains nearly 30,000 inhabitants, as compared with less than 1000 in 1839. Lat. 12° 46′ N.; long. 45° 10′ E.

ADERNO, a city of Sicily, in the province of Catania, near the foot of Mount Etna, 17 miles N.W. of Catania. It is built on the site of the ancient *Adranum*, portions of the massive walls of which are still visible, and numerous

Roman sepulchres have been found in the vicinity. The modern city has a clean appearance, but the situation is unhealthy. It is remarkable for the number of its convents and nunneries, and has several churches, the chief of which is supported by beautiful pillars of polished lava. On the river Simeto, near the town, there is a series of beautiful cascades. Population, 12,999.

ADERSBACH ROCKS, a remarkable group of isolated columnar rocks in a valley of the Riesengebirge, on the frontier of Bohemia and Prussian Silesia, 9 miles W.N.W. of Braunau. The mountain, for several miles, appears divided into detached masses by perpendicular gaps, varying in depth from 600 to 1200 feet. These masses are from a few feet to several hundred yards in diameter. The part called the labyrinth consists of smaller masses of columnar form, confusedly piled on one another, and rising to heights of from 100 to 200 feet. From their fantastic shapes the rocks have received various fanciful appellations. Some geologists have supposed that their remarkable structure is the result of subterranean commotion; but the generally-received opinion is, that the whole area had once been a tabular mass of sandstone of unequal hardness, and that the soft parts, which formed perpendicular seams, have been worn away by water and atmospheric changes, leaving the harder portions in their natural position. The recesses of this wild region frequently afforded a place of refuge to the distressed inhabitants of the district during the Thirty Years' War.

ADHESION, a term used to denote the physical force in virtue of which one body or substance remains attached to the surface of another with which it has been brought into contact. It is to be distinguished from *cohesion*, which is the mutual attraction that the particles of the same body exert on each other; and it differs from *chemical attraction* or *affinity*, since the properties of the substances it affects remain unchanged after it takes place. It is a force that the molecules of the adhering bodies exert on each other, and must not be confounded with a contact which is due to mere mechanical pressure, such as that which a piece of caoutchouc tubing exerts by its elasticity on a body that distends it. A very familiar instance of adhesion occurs in the wetting of solid bodies. It often, indeed generally, happens that, when a solid and a liquid touch each other, a film of the latter adheres to the former, and neither falls nor can be shaken off. This arises from the adhesion of the liquid to the solid being a stronger force than the cohesion of the particles of the liquid. It is also stronger than the force of gravitation; and the liquid can only be removed by being forcibly rubbed off, or by the process of evaporation. The force of adhesion may be determined by poising a plate of metal on a balance, and afterwards ascertaining what additional force will be required to detach it from the surface of a liquid. But this can only be done in the few cases in which the liquid does not wet the solid (otherwise the measurement would be that of the cohesive force of the liquid), and does not act on it chemically. The phenomena of CAPILLARY ATTRACTION (*q.v.*) depend on adhesion. Sometimes, when a solid and a liquid are brought into contact, the adhesive force overcomes the cohesion of the particles of the solid, so that it loses its solid form, and is dissolved or held in solution. Solid bodies, too, as well as liquids, adhere to solids. Smooth surfaces (of lead, for instance, or of dissimilar metals) will adhere; and if two plates of polished glass be laid together, it will scarcely be possible to separate them without breaking them. If the solids are pressed together, the adhesive force is generally greater; but it has been shown to be dependent to a very slight extent only on the pressure of the atmosphere. To a looser kind of adhesion, whereby one body is prevented from moving smoothly on the surface of another, we give the name of *friction*. The force of this increases with pressure, which may be the effect of gravitation or the result of mechanical appliances. If it be desired that solids should adhere permanently, this is commonly effected by the intervention of other substances—the cements, mortars, and solders—in a liquid or viscid state, which, when they "set" or become solid, adhere closely to the bodies united by means of them. The principle of the processes of plating, gilding, &c., is similar to this. The adhesive force of cements, &c., is sometimes very great. The common experiment of splitting a thin sheet of paper into two is an illustration of it. The paper is pasted carefully between two pieces of cloth, which are pulled asunder after the paste has dried. The adhesion of the paste to the paper and to the cloth is so strong that the paper is thus separated into two sheets, which can easily be detached from the cloth by wetting it. Again, air and other gases adhere to solids. A dry needle, placed carefully on the surface of still water, will float, resting on a cushion of air; and when thermometers are filled with mercury, the liquid has to be boiled in them to expel the air that adheres to the glass.

ADIAPHORISTS (ἀδιάφορος, *indifferent*), a name applied to Melancthon and his supporters in a controversy which arose out of the so-called Leipsic Interim (1548), and raged until 1555. In 1547 Charles V. had drawn up the Augsburg Interim, with a view to provide for the temporary government of the Church until a general council could be called. This gave great dissatisfaction both to the more advanced and to the more moderate reformers; and the object of Melancthon's Leipsic Interim was to reconcile all parties, if possible, by declaring that certain rites and observances of the Roman Catholic Church and the jurisdiction of the Roman Catholic bishops being *adiaphora* (things indifferent), might be lawfully recognised. On the other hand, the Catholics were required to accept the Protestant formula of the doctrine of justification, leaving out the words *sola fide*, which, it was said, might belong to the *adiaphora*. In the controversy that followed, Melancthon's chief opponent was his former colleague, Matth. Flacius, on whose removal from Wittenburg to Magdeburg the latter place became the head-quarters of the extreme Lutherans.

ADIGE (German, *Etsch*), the ancient *Athesis*, a large river of Italy, formed by several rivulets which rise in the Rhætian Alps, and unite near Glarus. After flowing eastward to the neighbourhood of Botzen, it receives the Eisach, and becomes navigable. It then turns to the south, and leaving the Tyrol, enters Lombardy 13 miles S. of Roveredo. After traversing Northern Italy in a course first southerly, but then easterly, it falls into the Adriatic at Porto-Fossone, a few miles N. of the Po. The most considerable towns on its banks are Trent and Roveredo in the Tyrol, and Verona and Legnago in Italy. It is navigable from the heart of the Tyrol to the sea, and has in Lombardy a breadth of 200 yards and a depth of from 10 to 16 feet, but the strength of the current renders its navigation very difficult, and lessens its value as a means of transit between Germany and Northern Italy. The Adige has a course of about 220 miles.

ADIPOCERE (from *adeps*, fat, and *cera*, wax), a substance into which animal matter is sometimes converted, deriving its name from the resemblance it bears to both fat and wax. When the Cemetery of the Innocents at Paris was removed in 1786–87, great masses of this substance were found where the coffins containing the dead bodies had been placed very closely together. At the bottom of the coffin, in these cases, there appeared, loosely enveloped in linen, a shapeless mass, of a dingy white colour,

flattened as though it had undergone great pressure. The whole body had been converted into this fatty matter, except the bones, which remained, but were extremely brittle. Fourcroy, who had observed the substance before, and had given it the name of adipocere, read a paper on the subject before the Academy of Sciences in 1789. Chemically, adipocere is found to consist principally of margarate of ammonia. A similar substance, found in peat, is known as *bog-butter*.

ADIPOSE (*adeps*, fat), a term in *Anatomy*, signifying fatty; as adipose tissue, adipose cell, &c.

ADIRONDACK MOUNTAINS, a group of mountains in the N. of the state of New York, North America, lying between Lakes Champlain and Ontario. They rise from an extensive plateau about 2000 feet above the level of the sea, and are chiefly of granite formation. Mount Marcy, the highest summit, has an altitude of 5337 feet, and others of the group are from 4000 to 5000 feet high. The two principal streams which take their rise in this region—the Hudson flowing south, and the Richelieu flowing northwards from Lake Champlain—afford abundant means of conveying from the mountains the valuable timber, chiefly pine, maple, ash, and beech, with which they are covered. Extensive deposits of magnetic iron ore of great value were discovered about 1835, and a village, called Adirondack, sprang up, where smelting was for some time extensively prosecuted. The works were afterwards however abandoned as unprofitable.

ADIT (from *adire*, to go to), a passage or door. The doors of porticoes in ancient theatres were called adits. In mines the name is given to a gallery or passage, nearly horizontal, by which water is carried off. Ores also are sometimes removed by the adit. Some works of this kind are of great magnitude. The great Cornish adit at Gwennap, near Falmouth, extends, with its branches, to from 30 to 40 miles in length, and drains a tract of 5500 acres.

ADJUDICATION, in *Scottish Law*, the name of that action by which a creditor attaches the heritable, *i.e.*, the real, estate of his debtor, or his debtor's heir, in order to appropriate it to himself either in payment or security of his debt. The term is also applied to a proceeding of the same nature by which the holder of an heritable right, labouring under any defect in point of form, gets that defect supplied by decree of a court.

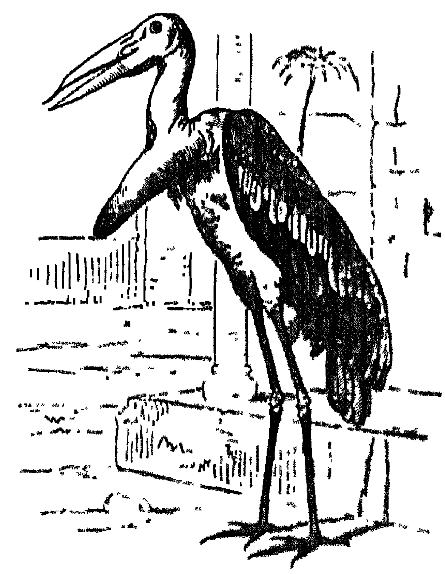
ADJUDICATION in Bankruptcy, in *English Law*, is equivalent to the Scotch award of sequestration.

ADJUSTMENT, in *Commerce*, the settlement of a loss incurred at sea on insured goods. If the policy be what is called an *open one*, and the loss of the goods be total, the insurer must pay for them at the value of prime cost, which includes not only the invoice price of the goods, but all duties paid, the premium of insurance, and all expenses incurred on them when put on board. If the policy be a *valued one*, and a total loss be incurred, then they are settled for at the valuation fixed at the time of the insurance, unless the insurers can prove that the insured had not a real interest in the goods, or that they were overvalued. In case of a partial loss, the value of the goods must be proved. (See Arnould *On Marine Insurance.*)

ADJUTAGE, a short tube or nozzle, inserted in an orifice, by means of which liquids flow from a vessel more freely.

ADJUTANT, a military officer whose duty it is to assist the commanding officer of a regiment or battalion. Every battalion of infantry, regiment of cavalry, and brigade of artillery, has an adjutant, who keeps the regimental books, records, and correspondence; acts as the commanding officer's representative in matters of regimental detail; superintends the drill of recruits; keeps the roster (*i.e.*, register of order of service) for all duties; details the guards, piquets, detachments, &c., that are furnished by the regiment; and is responsible for the receipt of the daily divisional or brigade order from the superior staff-officer, and the preparation and issue of regimental orders. The *Adjutant-General* is the staff-officer specially charged with all matters relating to the discipline and drill of the army.

ADJUTANT, the *Ciconia Argala*, or *Leptoptilos Argala*, a species of stork found in tropical India. It is of great size, sometimes six or even seven feet in height, the body and legs bearing nearly the same proportion as in the common stork. The bill is long and large; while the head, neck, and pouch are bare, or covered only with a few scattered hairs. At the back of its neck there is a second pouch-like appendage, which the bird inflates during flight. The general colour of the body is an ashen gray above and white below. The adjutant is extremely voracious, and, feeding on offal, reptiles, and other vermin, acts the part of a scavenger. It is often to be seen in camps and parade-grounds; hence its name. A similar bird, which, however, has been differentiated as *Ciconia Marabou*, occurs in different parts of Africa—*Marabou* being the native Senegal name. The brilliant white marabou feathers of commerce are the under feathers of the tail and wings of both species, but those of the *C. Argala* are the most valuable.



ADJYGURH, a town and fort of India, in the presidency of Bengal, 130 miles S.W. of Allahabad. The fort is situated on a very steep hill, more than 800 feet above the town; and contains the ruins of temples adorned with elaborately-carved sculptures. It was captured by the British in 1809. The town is a neatly-built place, but subject to malaria. Population, 5000.

ADMINISTRATOR, in *English Law*, he to whom the ordinary or judge of the ecclesiastical court, now the Court of Probate, acting in the queen's name, commits the administration of the goods of a person deceased, in default of an executor. The origin of administrators is derived from the civil law. Their establishment in England is owing to a statute made in the 31st year of Edward III. Till then no office of this kind was known besides that of executor; in default of whom, the ordinary had the disposal of goods of persons intestate, &c.

ADMINISTRATOR, in *Scottish Law*, a person legally empowered to act for another whom the law presumes incapable of acting for himself, as a father for a pupil child.

ADMIRAL, a great officer or magistrate, who has the government of a navy and the hearing of all maritime causes.

There can be little doubt of the Asiatic origin of the name given to this officer, which does not appear to have been known in the languages of Europe before the time of the Holy Wars. *Amir*, in Arabic, is a chief or commander of forces; it is the same word as the *ameer* of the peninsula of India (as *ameer al omrah*, the chief of lords or princes), and the *emir* of the Turks or Saracens, who had and still have their *emir* or *ameer'l durea*, commander

of the sea, *amir'l asker dureea*, commander of the naval armament. The incorporation of the article with the noun appears, we believe, for the first time in the Annals of Eutychius, patriarch of Alexandria, in the 10th century, who calls the Caliph Omar *Amirol munumim*, i.e., *Imperator fidelium.* Spelman says, "In regno Saracenorum quatuor prætores statuit, qui *admiralli* vocabantur." The *d* is evidently superfluous, and is omitted by the French, who say *Amiral.* The Spanish write *Almirante;* the Portuguese the same. Milton would seem to have been aware of the origin of the word when he speaks of "the mast of some great ammiral." It is obvious, then, that the supposed derivations of ἅλμυρος from the Greek, *aumer* from the French, and *aen mereal* from the Saxon, are fanciful and unauthorised etymologies.

Anciently there were three or four admirals appointed for the English seas, all of them holding the office *durante beneplacito*, and each of them having particular limits under his charge and government, as admiral of the fleet of ships from the mouth of the Thames, northward, southward, or westward. Besides these, there were admirals of the Cinque Ports. We sometimes find that one person had been admiral of all the fleets—Sir John de Beauchamp, 34 Edw. III., being the first who held the post; but the title of *Admiralis Angliæ* does not occur till the reign of Henry IV., when the king's half-brother, Sir Thomas Beaufort (created Earl of Dorset 5th July 1411), a natural son of John of Gaunt, was made admiral of the fleet for life, and admiral of England, Ireland, and Aquitaine for life. It may be observed that there was a title above that of admiral of England, which was *locum tenens regis super mare*, the king's lieutenant-general of the sea. This title is first mentioned in the reign of Richard II. Before the use of the word *admiral* was known, the title of *custos maris* was made use of.

Of the rank of admiral there are three degrees—admiral, vice-admiral, rear-admiral. Each of these degrees formerly comprised three grades, distinguished by red, white, and blue flags—the red being the highest degree in each rank of admiral, vice-admiral, and rear-admiral.

It may be remarked that for nearly a century there was no admiral of the red squadron. According to a vulgar error, that flag had been taken from us by the Dutch in one of those arduous struggles for naval superiority which that nation was once able to maintain against the naval power of England. But the fact is, the red flag was laid aside on the union of the two crowns of England and Scotland, when the union flag was adopted in its place, and was usually hoisted by the admiral commanding in chief. The red flag was revived on the occasion of the promotion of naval officers in November 1805, in consequence of the memorable victory off Trafalgar. The three degrees of red, white, and blue flag-officers were abolished by order in council on 5th August 1864, and the white ensign was thenceforward adopted as the sole flag for the ships of the royal navy proper. Captains are now promoted to be rear-admirals, rear-admirals to be vice-admirals, and vice-admirals to be admirals *simpliciter*—the numbers of each rank being regulated by orders in council passed on and subsequently to 22d February 1870. (See NAVY.) For biographical information, see Campbell's *Lives of the British Admirals*, 8 vols. 8vo, 1817; O'Byrne's *Naval Biographical Dictionary*, 8vo, 1849.

ADMIRAL OF THE FLEET is a mere honorary distinction, which gives no command, but merely an increase of half-pay, his being £3, 7s. a-day, and that of an admiral £2, 2s. The title has been sometimes conferred on the senior admiral on the list of naval officers, and was a short time held by the Duke of Clarence, afterwards William IV. In 1851 were appointed, for the first time, two admirals of the fleet, Sir Thomas Byam Martin, G.C.B., and Sir George Cockburn, G.C.B., the last having been appointed for his long and highly-distinguished services. The number of admirals of the fleet now (1874) authorised to be borne is three. If the admiral of the fleet should happen to serve afloat, he is authorised to carry the union flag at the main-top-gallant-mast head, which was the case when the Duke of Clarence escorted Louis XVIII. across the Channel to take possession of the throne of France.

The comparative rank of flag-officers and officers in the army has been settled as follows by his Majesty's order in council, in the reign of George IV:—

The admiral and commander-in-chief of the fleet has the rank of a field-marshal in the army; admirals with flags at the main take rank with generals of horse and foot; vice-admirals with lieutenant-generals; rear-admirals with major-generals; commodores of the first and second class with broad pendants with brigadier-generals.

On the active list of admirals there were in 1873 three admirals of the fleet, thirteen admirals, fifteen vice-admirals, and twenty-five rear-admirals.

In addition to these, there were on the reserved list forty admirals and thirty-four vice-admirals; on the retired list forty-three admirals, fifty-five vice-admirals, and sixty-two rear-admirals. As to the numbers to be borne permanently on these lists, and the regulations according to which admirals are retired and reserved, under Mr Childers' retirement scheme, see NAVY.

ADMIRAL (THE LORD HIGH) OF ENGLAND, an ancient officer of high rank in the state, who not only is vested with the government of the navy, but who, long before any regular navy existed in England, presided over a sovereign court, with authority to hear and determine all causes relating to the sea, and to take cognizance of all offences committed thereon

The period about which this officer first makes his appearance in the governments of European nations corroborates the supposition of the office having been adopted in imitation of the Mediterranean powers at the return of the Christian heroes from the Holy Wars. According to Moreri, Florent de Varenne, in the year 1270, was the first admiral known in France; but by the most approved writers of that nation the title was unknown till, in 1284, Enguerand de Coussy was constituted admiral. The first admiral by name that we know of in England was W. de Leybourne, who was appointed to that office by Edward I. in the year 1286, under the title of *Admiral de la mer du Roy d'Angleterre.* Mariana, in his *History of Spain*, says that Don Sancho, having resolved to make war on the barbarians (Moors), prepared a great fleet; and as the Genoese were at that time very powerful by sea, and experienced and dexterous sailors, he sent to Genoa to invite, with great offers, Benito Zacharias into his service; that he accepted those offers, and brought with him twelve ships; that the king named him his admiral (*almirante*), and conferred on him the office for a limited time. This happened in the year 1284. Several Portuguese authors observe that their office of *almirante* was derived from the Genoese, who had it from the Sicilians, and these from the Saracens; and it appears from Souza's *Historia Genealogica da Caza Real*, that in 1322 Micer Manuel Piçagow was invited from Genoa into Portugal, and appointed to the office of *almirante*, with a salary of 3000 pounds (*livras*) a year, and certain lands, &c., on condition that he should furnish on his part twenty men of Genoa, all experienced in sea affairs, and qualified to be *alcaidis* (captains) and *arraises* (masters) of ships: all of which terms, *almirante*, *alcaidi*, and *arrais*, are obviously of Arabic derivation.

Edward I., who began his reign in 1272, went to the Holy Land, and visited Sicily on his return. He must therefore have had an opportunity of informing himself concerning the military and naval science of the various countries bordering on the Mediterranean—an opportunity which so able and warlike a prince would not neglect, but whether the title and office of admiral existed in England before his time, as some are inclined to think, or whether W. de Leybourne was first created to that office in 1286, as before mentioned, we believe there is no authentic record to enable us to decide. Supposing him, however, to be the first, Edward may either have adopted the office and title from the Genoese, or the Sicilians, or the Spaniards, or the French; or even had it directly from the Saracens, against whom he had fought, and with whom he had afterwards much amicable intercourse. It would seem, however,

that the office was in Edward's time to some extent honorary; for that monarch, in 1307, orders the lord mayor of London, at his peril and without delay, to provide a good ship, well equipped, to carry his pavilions and tents; and in the same year another order is addressed to the *Viceccomes Kantiæ* to provide for immediate passage across the seas *tot et tales pontes et claias*, as the constable of Dover Castle should demand, without one word being mentioned of the admiral. (Rymer, vol. iii. p. 32.) It is to be observed, however, that at this time the royal fleets were made up of royal and private ships, and that the admiral would not be charged with the transport of such things as those mentioned unless the fleet was intended to co-operate with the land forces.

From the 34th Edward II. we have a regular and uninterrupted succession of admirals. In that year Edward Charles was appointed admiral of the north, from the mouth of the river Thames northward, and Gervase Allard admiral of the west, from the mouth of the Thames westward; and these two admirals of the north and the west were continued down to the 34th Edward III., when Sir John de Beauchamp, lord warden of the Cinque Ports, constable of the Tower of London and of the Castle of Dover, was constituted *High Admiral of England*. Nine years afterwards the office was again divided into north and west, and so continued until the 10th Richard II., when Richard, son of Alain, Earl of Arundel, was appointed Admiral of England. Two years after this it was again divided as before; and in the 15th year of the same reign, Edward, Earl of Rutland and Cork, afterwards Duke of Albemarle, was constituted *High Admiral of the North and West;* and after him the Marquis of Dorset and Earl of Somerset, son of John of Gaunt, Duke of Lancaster. Percy, Earl of Winchester, next succeeded to the same title, which once more was dropped in the 2d of Henry IV., and divided as before. Sir Thomas Beaufort was twice appointed by Henry IV. admiral of England; and on the accession of Henry V. he was reappointed by letters patent dated 3d June 1413. In the 14th Henry VI., John Holland, Duke of Exeter, was created admiral of England, Ireland, and Aquitaine, for life; and in the third year of Edward VI., John Dudley, Earl of Warwick, was constituted high admiral of England, Ireland, Wales, Calais, Boulogne, the marches of the same, Normandy, Gascony, and Aquitaine, also captain-general of the navy and seas of the king, &c. In the 27th Elizabeth, Charles, Lord Howard, had all the aforesaid titles, with the addition of captain-general of the navy and seas of the said kingdoms.

On the 20th November 1632 the office of high admiral was for the first time put in commission, all the great officers of state being the commissioners. During the Commonwealth a committee of Parliament managed the affairs of the Admiralty. At the Restoration, in 1660, the Duke of York was constituted *Lord High Admiral of England*. The commission was revoked in 1673, and King Charles II. held the Admiralty in his own hands, and managed it by the great officers of his privy council till 1684, when the Duke of York was re-instated. Charles took this occasion of reserving for his own use all the droits and perquisites claimed by the lord high admiral.

Annexed is a list of lord high admirals and first lords of the Admiralty from the time of Charles the Second to the year 1874:—

FIRST LORDS OF THE ADMIRALTY FROM 1660.

	Date of Appointment
James Duke of York,*	June 6, 1660.
King Charles the Second,	June 14, 1673.
Prince Rupert,	July 9, 1673.
Sir Henry Capell, Kt.,	May 14, 1679.
Daniel Finch, Esq.,	Feb. 14, 1680.
Daniel Lord Finch,	Jan. 20, 1681.
Daniel Earl of Nottingham,	April 17, 1684.
James Duke of York (and as James II.),†	May 17, 1684.
Arthur Herbert, Esq.,	March 8, 1689.
Thomas Earl of Pembroke and Montgomery,	Jan. 20, 1690.
Charles Lord Cornwallis,	March 10, 1692.
Anthony Viscount Falkland,	April 15, 1693.
Edward Russell, Esq.,	May 2, 1694.
Edward Earl of Orford,	June 5, 1697.
John Earl of Bridgewater,	May 31, 1699.
Thomas Earl of Pembroke and Montgomery,	April 4, 1701.
George Prince of Denmark,‡	May 20, 1702.
Thomas Earl of Pembroke and Montgomery,‡	Nov. 29, 1708.
Edward Earl of Orford,	Nov. 8, 1709.
Sir John Leake, Kt.,	Oct. 4, 1710.
Thomas Earl of Strafford,	Sept. 30, 1712.
Edward Earl of Orford,	Oct. 14, 1714.
James Earl of Berkeley,	March 19, 1717.
Lord Viscount Torrington,	Aug. 2, 1727.
Sir Charles Wager, Kt.,	June 21, 1733.
Daniel Earl of Winchelsea and Nottingham,	March 19, 1741.
John Duke of Bedford,	Dec. 27, 1744.
John Earl of Sandwich,	Feb. 16, 1748.
George Lord Anson,	June 22, 1751.
Richard Earl Temple,	Nov. 17, 1756.
Daniel Earl of Winchelsea and Nottingham,	April 6, 1757.
George Lord Anson,	July 2, 1757.
George Dank Earl of Halifax,	June 17, 1762.
George Grenville, Esq.,	Oct. 18, 1762.
John Earl of Sandwich,	April 20, 1763.
John Earl of Egmont,	Sept. 16, 1763.
Sir Charles Saunders, K.B.,	Sept. 15, 1766.
Sir Edward Hawke, K.B.,	Dec. 11, 1766.
John Earl of Sandwich,	Jan. 12, 1771.
Hon. Augustus Keppel,	April 1, 1782.
Augustus Viscount Keppel,	July 18, 1782.
Richard Viscount Howe,	Jan. 30, 1783.
Augustus Viscount Keppel,	April 10, 1783.
Richard Viscount Howe,	Dec. 31, 1783.
John Earl of Chatham,	July 16, 1788.
George John Earl Spencer,	Dec. 19, 1794.
John Earl of St Vincent, K.B.,	Feb. 19, 1801.
Henry Lord Viscount Melville,	May 15, 1804.
Charles Lord Bartram,	May 2, 1805.
Charles Grey, Esq.,	Feb. 10, 1806.
Thomas Grenville, Esq.,	Sept. 29, 1806.
Henry Lord Mulgrave,	April 6, 1807.
Right Hon. Charles Yorke,	Nov. 24, 1809.
Right Hon. Robert Viscount Melville,	March 25, 1812.
H. R. H. William Henry Duke of Clarence,‡	May 2, 1827.
Right Hon. Robert Viscount Melville, K.T.,	Sept. 19, 1828.
Right Hon. Sir James R. G. Graham, Bart.,	Nov. 25, 1830.
Right Hon. George Baron Auckland,	June 11, 1834.
Thomas Philip Earl de Grey,	Dec. 23, 1834.
Right Hon. George Baron Auckland,	April 25, 1835.
Gilbert Earl of Minto, G.C.B.,	Sept. 19, 1835.
Thomas Earl of Haddington,	Sept. 8, 1841.
Right Hon. Edward Earl of Ellenborough,	Jan. 13, 1846.
Right Hon. George Earl of Auckland (died 1st January 1849),	July 24, 1846.
Right Hon. Sir Francis T. Baring, Bart.,	Jan. 18, 1849.
Algernon Percy Duke of Northumberland, K.G.,	Feb. 28, 1852.
Right Hon. Sir James R. G. Graham, Bart.,	Jan. 5, 1853.
Right Hon. Sir Charles Wood, Bart.,	March 8, 1855.
Right Hon. Sir John Pakington, Bart.,	March 8, 1858.
Edward A. St Maur Duke of Somerset, K.G.,	June 28, 1859.
Right Hon. Sir J. S. Pakington, Bart., G.C.B.,	July 13, 1866.
Right Hon. Henry Thomas Lowry Corry,	March 8, 1867.
Right Hon. Hugh Culling Eardley Childers,	Dec. 18, 1868.
Right Hon. George Joachim Goschen,	March 13, 1871.

* Lord High Admiral of England.
† Lord High Admiral and Lord General.
‡ Lord High Admirals of Great Britain.

Prince George of Denmark, when lord high admiral, having surrendered, by a formal instrument, all the rights, profits, perquisites, and advantages whatsoever, appertaining to the office, for the benefit and use of the public, with the exception of the sum of £2500 a-year, to be disposed of in such manner and for such particular uses as her Majesty, under her sign manual, should direct; and the salary of the lord high admiral, which had hitherto been no more than 300 marks, was now fixed, by warrant under privy seal, at £7000 a-year. This sum, by 1st George II., was divided equally among seven commissioners, an arrangement which continued from that time, except that the pay of the commissioner who stood first in the patent was made up from other funds to £3000 a-year, and in the year 1806 was further increased to £5000 a-year. Since the surrender above mentioned, all the *droits of admiralty*, as they are called, with all the fees, emoluments, and perquisites whatsoever, have been taken from the admiral and applied to public purposes.

These droits and perquisites are by no means inconsiderable. As enumerated in the patent, they consist of flotsam, jetsam, ligan, treasure, deodands, derelicts, found within the admiral's jurisdiction; all goods picked up at sea; all fines, forfeitures, ransoms, recognisances, and pecuniary punishments; all sturgeons, whales, porpoises, dolphins, and

grampuses and all such large fishes; all ships and goods of the enemy coming into any creek, road, or port, by stress of weather, mistake, or ignorance of the war; all ships seized at sea, salvage, &c., together with his shares of prizes; which shares were afterwards called *tenths*, in imitation probably of the French, who gave their admiral, for supporting the dignity of his office, *son droit de dixième*. All prizes are now wholly given up by the crown to the captors, and such share of the *droits* as from circumstances may be thought proper The lord high admiral also claimed and enjoyed as his due the cast ships; and the subordinate officers of the navy, as their perquisites, all other decayed and unserviceable stores.

Though by Act of 2 William and Mary, stat. 2, c. 2 (extended by the 1 Geo. IV. c. 90, and 7 and 8 Geo. IV. c. 65), the lords commissioners of the admiralty are vested with all and singular authorities, jurisdictions, and powers which have been and are vested, settled, and placed in the lord high admiral of England for the time being, to all intents and purposes as if the said commissioners were lord high admiral of England, yet there is this remarkable difference in the two patents by which they are constituted, that the patent of the lord high admiral mentions very little of the military part of his office, but chiefly details his judicial duties as a magistrate; whilst, on the contrary, the patent to the lords commissioners of the admiralty is very particular in directing them to govern the affairs of the navy, and is almost wholly silent as to their judicial powers.

These powers, as set forth in the patent to the Earl of Pembroke in 1701, are, the power to act by deputy; to take cognisance of all causes, civil and maritime, within his jurisdiction; to arrest goods and persons; to preserve public streams, ports, rivers, fresh waters, and creeks whatsoever within his jurisdiction, as well for the preservation of the ships as of the fishes; to reform too strait nets and unlawful engines, and punish offenders; to arrest ships, mariners, pilots, masters, gunners, bombardiers, and any other persons whatsoever able and fit for the service of the ships, as often as occasion shall require, and wheresoever they shall be met with; to appoint vice-admirals, judges, and other officers, *durante beneplacito;* to remove, suspend, or expel them, and put others in their places, as he shall see occasion; to take cognisance of civil and maritime laws, and of death, murder, and mayhem.

It was by no means necessary that the lord high admiral should be a professional man. Henry VIII. made his natural son, the Duke of Richmond, lord high admiral of England when he was but six years old. When the high admiral, however, went to sea in person, he had usually a commission under the great seal appointing him admiral and captain-general of the fleet, sometimes with powers to confer knighthood, and generally to punish with life and limb. Such a commission was granted by Henry VIII. to Sir Edward Howard, who executed indenture with the king to furnish 3000 men, 18 captains, 1750 soldiers, 1232 mariners and gunners; his own pay to be 10s. and that of a captain 1s. 6d. a-day. The rest had 5s. per mensem as wages, and 5s. for victuals each man, together with certain dead shares.

It appears, from Mr Pepys' *Naval Collections*, that the lord high admiral did anciently wear, on solemn occasions, a gold whistle, set with precious stones, hanging at the end of a gold chain.

The salary of the first lord commissioner is £4500 a-year, and of each of the naval lords £1500, in addition to the half-pay of their rank. The civil lord gets £1000, and the parliamentary secretary £2000 a-year.

The opening paragraph of the *Black Book of the Admiralty* has the following noteworthy instruction as regards the deputies and officers to be chosen by the lord high admiral:—

"When one is made admirall, hee must first ordaine and substitute for his lieutenants, deputies, and other officers under him, some of the most loyall, wise, and discreete persons in the maritime law and auncient customes of the seas which hee can any where find, to the end that by the helpe of God and their good and just government, the office may be executed to the honour and good of the realme."

Had this precept been always acted on, there would probably have been less occasion than has presented itself for the many reorganisations which the administration of the lord high admiral's administrative office has undergone. As it has been, the necessity for periodical changes has been urgent and unavoidable. From the time of which Macaulay wrote, that the king (James II.) was the only honest man in his dockyards, down to the present date, the need has been incumbent on successive first lords and high admirals to lay the axe to the root of a tree which, in some shape or other, has not ceased to bring forth evil fruit. The soil favoured corruption, and no efficient means were employed to prevent its growth. A root and branch reformation was urgently needed, though it was not applied except in particular instances. Till the great French war of 1793–1815 led to the formation of a navy board of commissioners to superintend the work and management of the dockyards; of a victualling board, to see to the provisioning of the fleet; and of sick and hurt commissioners, to look after the sick and wounded —the administrative departments of the navy were left to nominees of the lord high admiral or first lord, the said nominees deriving "no small advantage" from the arrangement. Under the departmental boards things certainly improved from what they were in the time of Charles II.; but they fell far short of what was desirable, and, by the vagueness of their administrative principle, opened a door for irresponsible wrongdoing, which in the end made them exceedingly bad instruments of government. These boards continued till 1832, when Sir James Graham, then first lord of the admiralty, introduced sweeping changes. He abolished the several intangible boards which administered under the shelter of the board of admiralty, and appointed in their stead five principal officers of the navy, who were afterwards included in the admiralty patent. These officers were—a surveyor or architect and constructor of the navy; a storekeeper-general, charged with oversight and purchase of the material for dockyards and ships; an accountant-general, charged with the duty of seeing that all wages and cash paid were duly brought to account; a comptroller of victualling and transport services, charged with the maintenance of the victualling establishments of the navy, and of sufficient supplies of provisions and clothing for the fleet, and with the oversight of the transport arrangements for men and stores; and a physician of the navy, afterwards called medical director-general, charged with the oversight of all hospitals and of all sanitary arrangements of the navy. Each of these officers administered the department entrusted to him in every particular, not only in respect of stock, but of replenishment and account of stock. A lord of the admiralty was told off to supervise the permanent head and to represent his department at the board. These alterations were in many respects very beneficial. Altered circumstances required some modification of the original scheme of duties; and the addition of three principal officers—the director of works, the director of transports (who, after the Crimean war, relieved the comptroller of victualling of his transport duties), and the registrar of contracts. In 1860 the office of surveyor of the navy was abolished, and that of controller of the navy, with larger powers over dockyard management, was revived. In 1869, Mr Childers, first lord of the admiralty, made changes which tended

to subordinate the members of the board of admiralty more effectually to the first lord, constituting him in effect minister of marine; and to render departmental officers at once more individually responsible and more intimate with the controlling members of the board. He increased the power and functions of the controller of the navy, giving him a seat at the board, and charging him with the stock-keeping attributes of the storekeeper-general, whose purchasing functions were transferred to a new officer—the superintendent of contracts, the head of the contract and purchase department, and his accounting functions to the accountant-general. The office of storekeeper-general was abolished. The office of comptroller of victualling was also abolished—the storekeeping functions being transferred to a new officer, the superintendent of victualling—the purchasing function to the head of the purchase department, the accounts to the accountant-general. The other officers remained; but in the case of each this modification of business ensued, viz., that all stores whatever required by any of them were to be obtained through the agency of one supply or purchase department; that all accounts whatever were to be rendered to the accountant-general. The departmental officers of the admiralty at the present time (1874) are—the controller of the navy, without a seat at the board (who has on his staff a chief naval architect, a chief engineer, a surveyor of dockyards, a superintendent of naval stores, and a director of ordnance)—the director-general of the medical department, the director of works, the director of transports, the hydrographer, the superintendent of contracts, the superintendent of victualling. The department of the two permanent secretaries of the admiralty (one a naval officer, the other a civilian) undertakes the conduct of all business relating to the *personnel* of the navy and the ordering of the fleets.

To control the departmental officers, and to advise the responsible first lord, there are the following members of the board of admiralty, viz., the parliamentary or financial secretary, who has oversight of all business relating to finance, estimates, expenditure, and accounts, and who is the *alter ego* of the first lord in Parliament; the first naval lord, who, assisted by two other naval "lords," takes oversight of the *personnel* and of all executive functions of the fleet; and a civilian lord, who assists the financial secretary, and has particular oversight also of naval civil establishments and of the works department.

A list of secretaries of the admiralty from 1684 to the present time is given below:—

FIRST SECRETARIES TO THE ADMIRALTY.

	From	To
Samuel Pepys, Esq., . . .	May 1684	Feb. 1689.
Phineas Bowles, Esq., . . .	March 1689	Dec. 1689.
James Sotherne, Esq., . . .	Dec. 25, 1689	Sept. 24, 1694.
Josiah Barchett, Esq., . . .	Sept. 25, 1694	Oct. 10, 1741.
Thomas Corbet, Esq., . . .	Oct. 10, 1741	...
John Cleveland, Esq., . . .	...	...
Philip Stevens, Esq. (then one of the Board), ...	June 18, 1763	March 3, 1795.
Evan Nepean, Esq., ...	March 3, 1795	Jan. 21, 1804.
William Marsden, Esq., . .	Jan. 21, 1804	June 24, 1807.
Hon. W. W. Pole, ...	June 24, 1807	Oct. 8, 1809.
John Wilson Croker, Esq., .	Oct. 9, 1809	Nov. 29, 1830.
Captain the Hon. George Elliott,	Nov. 29, 1830	Dec. 24, 1834.
Right Hon. George R. Dawson,	Dec. 24, 1834	April 27, 1835.
Charles Wood, Esq., M.P., .	April 27, 1835	Oct. 4, 1839.
R. More O'Ferrall, Esq., . .	Oct. 4, 1839	June 9, 1841.
John Parker, Esq., M.P., . .	June 9, 1841	Sept. 10, 1841.
Hon. Sidney Herbert, . . .	Sept. 10, 1841	Feb. 1845.
Right Hon. H. T. L. Corry, M.P.,	Feb. 1845	July 13, 1846.
Henry G. Ward, Esq., M.P., .	July 13, 1846	May 1, 1849.
John Parker, Esq., M.P., . .	May 21, 1849	March 3, 1852.
Augustus Stafford, Esq., . .	March 3, 1852	Jan. 6, 1853.
Bernal Osborne, Esq., M.P., .	Jan. 6, 1853	March 8, 1858.
Right Hon. H. T. L. Corry, M.P.,	March 9, 1858	June 30, 1859.
Rear-Admiral Lord C. G. Paget, C.B., M.P., ...	June 30, 1859	April 29, 1866.
Hon. Thomas G. Baring, M.P.,	April 30, 1866	July 15, 1866.
Lord Henry G. Lennox, M.P.,	July 16, 1866	Dec. 17, 1868.
W. E. Baxter, Esq., M.P., .	Dec. 18, 1868	March 16, 1871.
Geo. J. Shaw Lefevre, Esq., M.P.,	March 17, 1871	...

As regards the navies of foreign countries, their government is in the hands of ministers or departments variously constituted. The Russian Admiralty is a highly-organised bureau, divided into departments after the English manner, and under the supreme control of a high admiral, usually a Grand Duke of the Imperial House. The German Admiralty was, till 1872, a branch of the War Office, though governed by a vice-admiral under a naval prince of the reigning family. In 1872 it was severed from the War Office, though remaining an appanage thereof, and a general of the army was placed at its head. The French minister of marine, assisted by a permanent staff, controls the navy of France on a highly centralised system of administration; but the departments are well organised, and work well. The Italian fleet is governed on principles analogous to the French, but with a large admixture of the English representative element. The American navy is governed by a secretary of the navy, a cabinet minister, to whom the departmental heads are responsible, and under whose orders they work. (F. W. R.)

ADMIRALTY, HIGH COURT OF. This is a court of law, in which the authority of the lord high admiral is exercised in his *judicial* capacity. Very little has been left on record of the ancient prerogative of the admirals of England. For some time after the first institution of the office they judged all matters relating to merchants and mariners, which happened on the main sea, in a summary way, according to the laws of Oleron (so called because promulgated by Richard I. at that place). These laws, which were little more than a transcript of the Rhodian laws, became the universally-received customs of the western part of the world. "All the seafaring nations," says Sir Leoline Jenkins, "soon after their promulgation, received and entertained these laws from the English, by way of deference to the sovereignty of our kings in the British ocean, and to the judgment of our countrymen in sea affairs."

In the patents granted to the early admirals between the latter years of the reign of Henry III. and the close of that of Edward III., no mention is made of marine perquisites or of civil power, nor does it appear that the admirals enjoyed either; but after the death of the latter, new and extraordinary powers were granted to them, and it would appear that they usurped others. The preamble to the 13 Richard II. stat. 1, c. 5, sets forth that "a great and common clamour and complaint hath been oftentimes made before this time, and yet is, for that the admirals and their deputies hold their sessions within divers places of this realm, as well within the franchise as without, accroaching to them greater authority than belongeth to their office, in prejudice of our lord the king and the common law of the realm, and in diminishing of divers franchises, and in destruction and impoverishing of the common people;" and the statute therefore directs that the admirals and their deputies shall not meddle from henceforth of any thing done within the realm, but only of a thing done upon the sea. Two years afterwards (15 Rich. II. c. 3), in consequence, as stated in the preamble of the statute, "of the great and grievous complaint of all the commons," it was ordained that the admiral's court should have no cognisance of any contracts, pleas, or quarrels, or of any thing done or arising within the bodies of counties, whether by land or by water, nor of wreck of the sea; but that the admiral should have cognisance of the death of a man, and of mayhem done in great ships being and hovering in the main stream of great rivers, yet only beneath the bridges of the same rivers nigh to the sea. He may also arrest ships in the great flotes for the great voyages of the king and of the realm, saving always to the king all manner of forfeitures and profits thereof coming, and have jurisdiction over the said flotes, but during the said voyages only. But if the admiral or his lieutenant exceed that jurisdiction, then, by 2 Henry IV. c. 11, the statute and the common law may be holden against them; and if a man pursues wrongfully in the admiralty court, his adversary may recover double damages at common law,

and the pursuant, if attainted, shall incur the penalty of £10 to the king.

The place which, according to Spelman, is absolutely subject to the jurisdiction of the admiral is the sea; which, however, comprehends public rivers, fresh waters, creeks, and all places whatsoever, within the ebbing and flowing of the sea, at the highest water, the shores or banks adjoining, from all the first bridges to the seaward; and in these, he observes, the admiralty hath full jurisdiction in all causes, criminal and civil, except treasons and the right of wreck. Lord Coke observes (5 Rep. 107), that between the high-water mark and the low-water mark the admiral hath jurisdiction *super aquam, ad plenitudinem maris*, and as long as it flows, though the land be *infra corpus comitatus* at the reflow, so as of one place there is *divisum imperium* interchangeably.

But though the statute restraineth the lord high admiral that he shall not hold plea of a thing rising in the body of a county, he is not restrained from making execution upon the land, but is empowered to take either body or goods upon the land; otherwise his jurisdiction would often prove a dead letter. He also can and does hold his court in the body of a county. So, likewise, the civil power may apprehend and try persons who may have been guilty of offences cognisable at common law, though committed in the fleet, in any port or harbour of Great Britain, or at sea, provided such persons have not already been tried for such offences either by court-martial or in the admiralty court; and in all ports, harbours, creeks, &c., lying in any county, the high admiral and the sheriff, or coroner, as the case may be, have concurrent jurisdiction.

By the 6 and 7 Will. IV. c. 53 the admiralty jurisdiction is extended to Prince of Wales' Island, Singapore, and Malacca; and under the 3 and 4 Vict. c. 65, the court has jurisdiction in the following cases:—

Whenever a vessel is arrested by process issuing from the said court, or the proceeds of any vessel are brought into the registry, to take cognisance of all claims in respect of any mortgage of such vessel.

To decide all questions as to the title to, or ownership of, such vessel, or the proceeds thereof remaining in the registry, arising in any cause of possession, salvage, damage, wages, or bottomry, instituted in the said court.

To decide all claims and demands whatsoever in the nature of salvage, or in the nature of towage, or for necessaries supplied to any foreign vessel, and enforce the payment of the same, whether such vessel may have been in the body of the county or upon the high seas at the time when the service was rendered, or damage received, or necessaries furnished, in respect of which claim is made.

To decide all matters and questions concerning booty of war on shore, or the distribution thereof, which it shall please her Majesty, by the advice of the privy council, to refer to the judgment of the said court, who shall proceed therein as in cases of prize of war.

And under § 40 of the 9 and 10 Vict. c. 99, to decide on all claims and demands whatsoever in the nature of salvage for services performed, whether on sea or land.

The high court of Admiralty has jurisdiction upon the high seas all over the world. It has an instance jurisdiction which is civil, and a prize jurisdiction in time of war. The latter jurisdiction does not extend to the admiralty courts of Ireland or Scotland, which never had prize commissions sent to them. It is of the highest importance in war time, when questions of seizure or detention of neutral ships arise, to have but one court of which to inquire concerning all causes, so as to expedite the action of the Foreign Office in dealing with representations from neutral powers. The causes which arise in time of peace are causes of collisions, of seamen's wages, bottomry, wearing unlawful colours, salvage, and causes of possession, where one part owner or minor claims to have security from those other owners who are going to send the ship on a foreign voyage that the ship shall return again. Causes under the Slave Act treaties are also cognisable here. The evidence is all documentary. In 1803 there were 1125 prize cases before the court; in 1804, 1144; in 1806, 2286; in 1807, 2789; and so on, above 1000 causes each year, down to the year 1811.

The criminal jurisdiction, which formerly comprehended all crimes whatever committed at sea, from larceny to homicide, which were triable at common law at the assizes if committed on shore, was much modified upon the report of the select committee on the high court of admiralty in 1833. Such offences are now triable at common law on surrender to the jurisdiction; but the judge of the admiralty court may still sit with other commissioners of oyer and terminer. He has no longer any independent criminal jurisdiction.

The instance jurisdiction is permanent; the prize jurisdiction is by virtue of a special commission, *pro re natâ*. Its issue is one of the first acts done on the outbreak of war. Appeals formerly lay from the civil decisions to the high court of delegates or specially-appointed commissioners; from the prize decisions to the prize commissioners. By the Acts 2 and 3 Will. IV. c. 92, and 3 and 4 Will. IV. c. 41, all appeals from admiralty court decisions of any kind lie to the sovereign, who is authorised to refer them to the judicial committee of the privy council.

The lord high admiral was assisted in his *judicial* functions by the following principal officers:—1. The vice-admiral; 2. The judge; 3. The registrar; 4. The advocate-general; 5. The counsel and judge-advocate; 6. The solicitor; 7. The procurator; 8. The marshal,—which officers are continued.

1. *The Vice-Admiral.* This officer is the admiral's deputy or lieutenant mentioned in the statutes of 13th and 15th Richard II., and was the person, most probably, who presided in the court. At present the office of vice-admiral of England is a perfect sinecure, generally conferred on some naval officer of high rank and distinguished character in the service. The salary of £434, 1s. 9d. per annum, attached to it in addition to half-pay, was abolished by order in council, 22d February 1870. The salary and office of rear-admiral of England were abolished by the same order in council. The salary was £342, 9s. per annum. Each county of England has its vice-admiral, which is little more than an honorary distinction, though the patent gives to the holder all the powers vested in the admiral himself. Similar powers were also granted to the judges of the admiralty county courts; but this was found so inconvenient and prejudicial to those who had suits to commence or defend before them, that the Duke of York, when lord high admiral, in 1663 caused instructions to be drawn up in order to assign to each his province, whereby the whole judicial power remained with the judge, and the upholding of the rights of the admiral, and levying and receiving the perquisites, &c., appertained to the vice-admiral.

Each of the four provinces of Ireland has its vice-admiral. There is one vice-admiral for all Scotland, and one for the Shetland and Orkney Islands. The governor of most of our colonies had a commission of vice-admiral granted to him by the lord high admiral or lords commissioners of the admiralty, and generally a commission from the king under the great seal, grounded on the 11 and 12 William III. c. 7, and further confirmed by 46 Geo. III. c. 54, by which he was authorised to try all treasons, piracies, felonies, robberies, murders, conspiracies, and other offences, of what nature or kind soever, committed on the seas, where the parties were taken into custody in places remote from England. The court consisted of seven persons at the least, of whom the governor, the lieutenant-governor, the vice-admiral, the flag-officer, or commander-in-chief of the squadron, the members of the council, the chief-justice, judge of the vice-admiralty court, captains of men-of-war, and secretary of the colony, were specially named in the commission; but any three of these, with four others selected from known merchants, factors, or planters, captains, lieutenants, or warrant officers of men-of-war, or captains, masters, or mates of merchant ships, constituted a legal court of piracy. By the 12 and 13 Vict. c. 96, all persons charged in any colony with offences committed on the sea may be dealt with in the same manner as if the offences had been committed on waters within the local jurisdiction of the courts of the colony.

The vice-admiralty courts in the colonies are of two descriptions. The one has power to inquire into the causes of detention of enemies or neutral vessels, to try and condemn the same for the benefit of the captors, as well as to take cognisance of all matters relating to the office of the lord high admiral. The other has only power to institute inquiries into misdemeanours committed in merchant vessels, and to determine petty suits, &c., and to guard the privileges of the admiral. The former are usually known by the name of *prize courts*, the latter by that of *instance courts*. Appeals from vice-admiralty courts abroad lay formerly to the high court of admiralty in England, and from that, if need were, to the high court of delegates, or in prize cases to the prize commissioners. By an Act of her present Majesty, all such appeals lie direct to the sovereign, who refers them to the judicial committee of the privy council.

The following are the colonies and foreign possessions in which vice-admiralty courts are now (1874) established. Others are constituted as occasion may require, in case of war:—

Aden. (*Slave trade jurisdiction only.*)
Antigua, Montserrat, and Barbuda.
Australia, South.
Australia, West.
Bahamas.
Barbadoes.
Bermuda.
Bombay.
British Columbia.
British Guiana.
Calcutta.
Canada.
Cape of Good Hope.
Ceylon.
Dominica.
Falkland Islands.
Gambia.
Gibraltar.
Gold Coast.
Grenada.
Halifax, Nova Scotia.
Honduras.
Hong Kong.
Jamaica.
Labuan.
Lagos.
Madras.
Malta.
Mauritius.
Montserrat.
Natal.
Nevis.
New Brunswick.
Newfoundland.
New South Wales.
New Zealand.
Prince Edward's Island.
Quebec.
Queensland.
St Christopher.
St Helena.
St Lucia.
St Vincent.
Sierra Leone.
The Straits Settlements. (*Prince of Wales' Island, Singapore, and Malacca.*)
Tasmania.
Tobago.
Tortola and Virgin Islands.
Trinidad.
Vancouver's Island.
Victoria.
Zanzibar. (*Limited slave trade jurisdiction only.*)

By the provisions of the Vice-admiralty Courts Act of 1863, The governor of a colony is *ex officio* vice-admiral, and the chief-justice *ex officio* judge of the vice-admiralty court.

In none of the patents to the lord high admiral, vice-admiral, or judge, is any mention made of prize jurisdiction. Lord Mansfield had occasion to search into the records of the court of admiralty in Doctors' Commons, to ascertain on what foundation this jurisdiction was exercised by the judge of the admiralty; but he could not discover any prize-act books farther back than 1643; no sentences farther back than 1648. The registrar could go no farther back than 1690. "The prior records," says his lordship, "are in confusion, illegible, and without index." The prize jurisdiction may therefore be considered as of modern authority, and distinct altogether from the ancient powers given to the admiral. To constitute the authority for trying prize causes, a commission under the great seal issues to the lord high admiral at the commencement of every war, to will and require the court of admiralty, and the lieutenant and judge of the said court, his surrogate or surrogates, to proceed upon all manner of captures, seizures, and reprisals, of all ships and goods that are or shall be taken; and to hear and determine according to the course of the admiralty, or the law of nations; and a warrant issues to the judge of the admiralty accordingly.

The admiralty court being in this respect a court in which foreigners of all nations may become suitors, an appeal may be had from its decisions to a committee of the lords of the privy council, who hear and determine according to the established laws of nations.

At the breaking out of a war, the lord high admiral also receives a special commission from the crown, under the great seal, to empower him to grant letters of marque and reprisals against the enemy, he having no such power by his patent. These letters are either general or special: general, when granted to private men to fit out ships at their own charge to annoy the enemy; special, when in the case of any of our merchants being robbed of their estates or property by foreigners, the king grants them letters of reprisal against that nation, though we may be in amity with it. Before the latter can be sued for, the complainant must have gone through the prosecution of his suit in the courts of the state whose subjects have wronged him; where, if justice be denied, or vexatiously delayed, he must first make proof of his loses and charges in the admiralty court here; whereupon, if the Crown is satisfied he has pursued all lawful means to obtain redress, and his own interceding should produce no better effect, special letters of reprisal are granted; not, however, as must be evident, until a very strong case has been made out. This custom, which we may now consider as obsolete, seems to be a remnant of the law of ancient Greece, called *androlepsia*, by which, if a man was slain, the friends and relations of the deceased might seize on any three citizens of the place where the murderer took refuge, and make them slaves, unless he was delivered up. Both Oliver Cromwell and King Charles II. granted letters of reprisal. In 1638 the Duc d'Epernon seized on the ship "Amity" of London, for the service of the French king against the Spaniards, promising full satisfaction; but none being made, the owners obtained letters of reprisal from the Protector, and afterwards, in 1665, from Charles II. In 1666 Captain Butler Barnes had letters of reprisal against the Danes. The Dutch having burnt six English merchant vessels in the Elbe, within the territories of Hamburg, which city, instead of giving any assistance or protection, hindered the English from defending themselves, letters of reprisal were granted to the sufferers against that city. Lastly, one Justiniani, a noble Genoese, being indebted in a large sum to Joseph Como, a merchant in London, which he had several years solicited for without obtaining satisfaction, Captain Scott, commander of his Majesty's ship the "Dragon," stationed at that time in the Mediterranean, received orders to make reprisals upon the ships of that republic; upon which the debt was paid.

2. *The Judge.*—The patents to the judge of the admiralty and vice-admiralty courts run pretty nearly in the same manner as those of the lord high admiral, and point out the several matters of which he can take cognisance. The Parliament of 1640 established the office of judge of the admiralty court in three persons, with a salary of £500 a-year to each. At the Restoration there were two judges of the high court of admiralty, which sometimes proved inconvenient; for when they differed in opinion, no judgment could be had. These judges, before the Revolution, held their appointment only during pleasure. At that period, and under the provisions of the Bill of Rights, Sir Charles Hedges was constituted judge under the great seal of England, *quamdiu se bene gesserit*, with a salary of £400 a-year, and an additional £400 out of the proceeds of prizes and perquisites of the admiralty; but in the year 1725 the latter sum was diminished from the ordinary estimate by the House of Commons. The salary of Sir James Marriott, from 1778 to 1782, during the American war, was £800 a year, and £3700 added for fees. From 1794 to 1798, the salary was £1780, and £2500 for fees. During the sixteen years that Sir William Scott (Lord Stowell) was judge,

from 1798 to 1814, the salary was £2500, and the fees averaged £2800 a-year. Under the 3 and 4 Vict. c. 66, § 1, the salary is fixed at £4000 per annum. All fees of whatever kind, formerly payable to the judge, are now paid to the consolidated fund.

The court of admiralty is at present (1873), and pending the erection of the new law courts, held in Westminster. In the time of Henry IV. it was held in Southwark, either at a quay on the south side of the Thames, or in the erewhile church of St Margaret-on-Hill, most likely the former. Stow, in his *Survey* (A.D. 1598), says—"A part of this parish church of St Margaret is now a court, wherein the assizes and sessions be kept; and the court of admiralty is also there kept." Pepys also, in his *Diary* (17th March 1663), describes the court as sitting there. But it is probable that the sittings in St Margaret's Church were commenced shortly before Stow's time; for in the Rolls of Parliament, 11 Hen. IV. No. 61, the Commons complain that people are summoned by the officers of the admiral *à Loundres à le Key de William Horton, Suthwerke.* Further, it would appear from an appeal made to the king, Henry IV., that the rule then was for the admiral's court to be held upon some wharf or quay within the flux and reflux of the tide. In the reign of Henry VIII., Horton's Quay, near London Bridge, is mentioned in the records of the high court of admiralty (3d Nov. 1541) as its usual place of sitting.

The judges of the vice-admiralty courts in certain of the colonies, limited by 41 George III. c. 96, are allowed a salary not exceeding to each the sum of £2000 a-year, to be paid out of the consolidated fund of Great Britain; together with profits and emoluments not exceeding to each the further sum of £2000 per annum, out of the fees to be taken by the said judges, of which a table is directed to be hung up in some conspicuous place in the court; and no judge is to take any fee beyond those specified, directly or indirectly, on pain of forfeiture of his office, and being proceeded against for extortion; and on his retirement from office after six years' service, or from some permanent infirmity, the Crown may, by authority of the Act above mentioned, grant unto such judge an annuity for the term of his life not exceeding £1000 per annum. This liberal provision puts the judges of the colonial courts of vice-admiralty above all suspicion of their decisions being influenced by unworthy motives—a suspicion they were not entirely free from when their emoluments depended mainly on their fees.

During the war of 1793–1815 a session of oyer and terminer to try admiralty causes was held at the Old Bailey, now the central criminal court, twice a-year. The commission for this purpose was of the same nature with those which are granted to the judges when they go on circuit; that is to say, to determine and punish all crimes, offences, and misdemeanours, and abuses; the *end* of both being the same, their *limits* different; the one relating to things done upon the land, the other to things done upon the water. The lords commissioners of the admiralty, all the members of the privy council, the chancellor and all the judges, the lords of the treasury, the secretary of the admiralty, the treasurer and commissioners of the navy, some of the aldermen of London, and several doctors of the civil law, were the members of this commission; any four of whom made a court.

The proceedings of the court, now probably obsolete, were continued *de die in diem*, or, as the style of the court was, from tide to tide.

3. *The Registrar of the Admiralty* formerly held his place by patent from the Crown. The patent was issued under the great seal of the court of admiralty, and the appointment was afterwards confirmed by patent under the great seal of the United Kingdom. The appointment was for life, and was often granted in reversion. The registrar had no salary, the amount of his emoluments depending on the captures, droits, &c., condemned by the court, which during the war of 1793–1815 were so enormous that in 1810 an Act was passed for regulating the offices of registrars of admiralty and prize courts, by which it is enacted "that no office of registrar of the high court of admiralty, or of the high court of appeals for prizes, or high court of delegates in Great Britain, shall, after the expiration of the interest now vested in possession or reversion therein, be granted for a longer term than during pleasure, nor be executed by deputy; that an account be kept in the said offices respectively of all the fees, dues, perquisites, emoluments, and profits received by and on account of the said registrars, out of which all the expenses of their offices are to be paid; that one-third of the surplus shall belong to the registrar and to his assistant (if an assistant should be necessary), and the remaining two-thirds to the consolidated fund of Great Britain, to be paid quarterly into the exchequer; the account of such surplus to be presented to the court at least fourteen days before each quarter-day, and verified on oath." Under the 3 and 4 Vict. c. 66, § 2, a yearly salary of £1400 is substituted for "all fees, dues, perquisites, emoluments, and profits," and which may be increased in time of war to £2000. The duties of the registrar are—1. To keep a public registry, to give attendance therein, and to preserve in a regular manner the registers, acts, records, and documents belonging to the office; 2. To attend all sittings of the court of admiralty, and to attend the judge at chambers; 3. To draw and sign all warrants, monitions, commissions, &c., issuing from the court; to attend other courts with minutes, &c., of the admiralty court when required; 4. To have the custody of all moneys paid into court or paid out of court.

4. *The Advocate-General.*—This officer is appointed by warrant of the lords commissioners of the admiralty. His duties are—to appear for the lord high admiral in his court of admiralty, court of delegates, and other courts; to move and debate in all causes wherein the rights of the admiral are concerned; for which he had anciently a salary of 20 marks (£13, 6s. 8d.) a-year. In May 1803, Dr William Battine, who was appointed in 1791, had an addition of £200 to his salary, "for his extraordinary trouble and attendance during the present hostilities." His salary was continued to him and his successor, Dr Arnold, till 1816; since that time the allowance has been reduced to its original amount of £13, 6s. 8d. Formerly the admiral's advocate was always retained as leading counsel, but after the droits were transferred to the crown, he was gradually supplanted by the king's advocate, who was generally retained in all cases, the admiralty advocate acting only as junior counsel; and while the former during the war made sometimes from £15,000 to £20,000 a-year, the latter rarely received from his professional duties more than from £1500 to £2000 a-year.

5. *The Counsel and Judge-Advocate for the affairs of the Admiralty and Navy* is the law officer who is chiefly consulted on matters connected with the military duties of the lord high admiral. He advises also on all legal questions. His salary is £100 a-year, besides his fees, which in time of war may be reckoned to amount to from £1200 to £1800 a-year. Till the present reign the offices of counsel of the admiralty and judge-advocate of the fleet were separate and distinct, the latter being a sinecure appointment, with a salary of £182, 10s. attached to it. The salary is now abolished. The duties are very light, the veritable work of the office being discharged by deputy judges-advocate appointed on each occasion of a court-martial, and by resident law agents at Portsmouth and Plymouth, who receive salaries in lieu of all fees and charges.

6. *The Solicitor to the Admiralty* is also an officer ap-

pointed during pleasure by the lords of the admiralty. He is the general legal adviser, in the first instance, of the lords commissioners; and since 1869 there have been added to his other functions those of registrar of public securities and custodian of all public securities and bonds belonging to the admiralty. His salary is £1600 a-year in lieu of all fees, bills, and disbursements, with an allowance of £1300 a-year for assistance of clerks. His office is provided for him.

7. *The Procurator.*—The admiralty's proctor stands precisely in the same situation to the queen's proctor that his advocate does to that of the queen, though there is not quite so great a difference in their emoluments. They act as the attorneys or solicitors in all causes concerning the queen's and the lord high admiral's affairs in the high court of admiralty and other courts. All prize causes are conducted by the queen's proctor. It is supposed that in some years of war, in the early part of the century, the proctor did not receive less than £20,000 a-year.

8. *The Marshal.*—This officer receives his appointment from the lord high admiral or lords commissioners of the admiralty. His appointment is under the seal of the high court of admiralty during pleasure, and is confirmed by letters patent from the Crown. His duties are to arrest ships and persons; to execute all processes or orders issuing from the court; to attend, in person or by deputy, the judge with the silver oar (the ancient emblem of maritime jurisdiction); and formerly also to attend executions. It is also the duty of the marshal or his deputy to arrest, under warrant from the admiralty, any officer not beneath the rank of post captain who may be ordered for trial by court-martial; and to see to the delivery of sentenced prisoners to their place of punishment. His emoluments formerly depended on the number of prizes brought into port for condemnation, and the number of ships embargoed, and might probably be reckoned in time of war, *communibus annis*, from £1500 to £2000 a-year, out of which he had to pay about £400 a-year to a deputy. He had no salary. The office can, however, be no longer performed by deputy, except in case of illness, § 9 of the 3 and 4 Vict. c. 66. The marshal is now paid by a salary of £500, in addition to his travelling expenses.

(See *Orders in Council* since February 1870; Campbell's *Lives of the British Admirals;* O'Byrne's *Naval Biographical Dictionary;* Rymer's *Fœdera;* Pepys' *Naval Collections,* and Pepys' *Diary; The Black Book of the Admiralty* (republished by the Master of the Rolls); Stephen's *Commentaries on the Laws of England;* Stow's *Survey of London; Rolls of Parliament;* Report of Committee appointed by the Treasury in 1836 to inquire into the fees and emoluments of public offices; Sir Harris Nicolas's *History of British Navy*). (F. W. R.)

ADMIRALTY, IRELAND.—For all executive functions Ireland is subject to the jurisdiction and orders of the lord high admiral, or lords commissioners for executing the office, of Great Britain. For judicial purposes, however, an admiralty court sits in the Four Courts, Dublin, having a judge, a registrar, a marshal, and other officers. In peace time and war time alike it exercises only an instance jurisdiction. No prize commission has ever issued to it.

ADMIRALTY, SCOTLAND. At the Union, while the national functions of the lord high admiral were merged in the English office, there remained a separate court of admiralty, with subsidiary local courts, having civil and criminal jurisdictions in maritime questions. The separate courts were abolished in 1831, and their powers merged in the courts of session and justiciary, and the local courts.

ADMIRALTY CHARTS. These useful aids to navigation are constructed in the hydrographic department of the British Admiralty, by specially-appointed surveyors and draughtsmen, and they are issued to the public by order of the lords commissioners of the admiralty. They are divided into various sections as follows:—1. English and Irish Channels and coasts of the United Kingdom; 2. North Sea and adjacent coasts; 3. Baltic Sea; 4. North and west coasts of France, Spain, and Portugal; 5. Mediterranean, Black Sea, and Sea of Azov; 6. Atlantic Ocean and Islands; 7. Arctic Sea and north and east coasts of America; 8. West Indies, Gulf of Mexico, &c.; 9. South America, east coast; 10. West coasts of South and North America; 11. Africa, Madagascar, Mauritius, Red Sea, &c.; 12. East Indies, Arabian coast, &c.; 13. Indian Archipelago, China Sea, Japan, &c.; 14. Australia, New Zealand, &c.; 15. Pacific Ocean islands. They are about 3000 in number, of various sizes and scales, and the prices vary from 6d. to 10s. Accompanying the charts there are books of sailing directions, tables, and lists of lights. Similar charts as those of the British Admiralty are issued by the United States Coast Survey, as well as by the Russian and French governments. The superintendent of the United States Coast Survey issues an annual report, showing the progress of the survey, and containing much valuable information.

ADMIRALTY ISLAND, an island belonging to the United States, about 90 miles long from N. to S., and 25 miles broad, lying between King George III. Archipelago and the mainland, in 58° N. lat., 134° W. long. Its coasts, which are generally steep and rocky, are indented with several accessible and commodious bays. The island has abundance of good water, and is covered with pines, which grow there to a very large size.

ADMIRALTY ISLANDS, a group of about forty islands lying to the N.E. of New Guinea, between 2° and 3° S. lat., and 146° 18′ and 147° 46′ E. long. The largest is about 50 miles in length; the others are very small, and all rise but little above the sea-level. Their exuberant vegetation, and in particular the groves of cocoa nut trees, give them a very beautiful appearance. The islands were discovered by the Dutch in 1616, but have seldom been visited, access being difficult on account of the surrounding reefs. The natives are tall, and of a tawny colour.

ADOLPHUS, JOHN, historian and barrister, was born in London on the 7th August 1768. He was educated under the care of a grand-uncle, and after making a voyage to the West Indies was enrolled as an attorney about the year 1790. Called to the bar in 1807, he devoted himself to practice in criminal causes, and in a few years attained a leading position among Old Bailey counsel. His masterly defence of Thistlewood and the Cato Street conspirators, for which he had been retained only a few hours before the trial, did much to extend his reputation. He was very skilful in the management of his cases, but his hastiness of temper frequently led to unseemly altercations with other counsel. He held a good position in society, and was on terms of intimacy with the leading literary men of the day. *The History of England from the Accession of George III. to* 1783, which he published in 1802, was favourably noticed in the *Edinburgh Review* for its impartiality and accuracy. A new and enlarged edition of this work, in eight volumes, was in preparation, but only seven volumes were completed when the author died, 16th July 1845. His other literary works were—*Biographical Memoirs of the French Revolution* (1799); *The British Cabinet* (1799); *History of France from* 1790 *to* 1802 (1803); *Memoirs of John Bannister.*

ADOLPHUS, JOHN LEYCESTER, son of the above, also a distinguished barrister (died 1862), was the first to pierce the mask of the author of *Waverley*, in a series of critical letters addressed to Richard Heber, which he published in 1821.

ADONIS, according to some authors, the son of Theias, king of Assyria, and his daughter Smyrna [Myrrha], was the favourite of Venus. He was fond of hunting; and Venus often warned him not to attack the larger wild beasts; but neglecting the advice, he was killed by a wild boar he had rashly wounded. Venus was inconsolable, and turned him into a flower of a blood colour, supposed by some to be an anemone. Adonis had to spend half the year in the lower regions, but during the other half he was permitted to revisit the upper world, and pass the time with Venus. No grief was ever more celebrated than that of Venus for Adonis, most nations round the Mediterranean having perpetuated the memory of it by anniversary ceremonies. "The tale of Adonis (Keightley's *Mythology*) is evidently an eastern myth. His own name and those of his parents refer to that part of the world. He appears to be the same with the Thammuz mentioned by the prophet Ezekiel (viii. 14), and to be a Phœnician personification of the sun, who during part of the year is absent, or, as the legend expresses it, with the goddess of the under world; during the remainder with Astarte, the regent of heaven." Among the Egyptians, Adonis is supposed to have been adored under the name of Osiris, the husband of Isis; but he was sometimes called by the name of Ammuz or Thammuz, *the concealed*, to denote probably his death or burial. It has been thought it is he the Hebrews call *the dead* (Ps. cvi. 28, and Lev. xix. 28), because his worshippers wept for him, and represented him as one dead; and at other times they call him the *image of jealousy* (Ezek. viii. 3, 5), because he was an object of jealousy to other gods. The Syrians, Phœnicians, and Cyprians worshipped Adonis; and Calmet was of opinion that this worship may be identified with that of the Moabitish Baal-peor. Modern critics plausibly connect the divine honours paid to Adonis with the mysterious rites of phallic worship, which, in some shape or other, prevailed so extensively in the ancient world.

ADONIS, in *Ancient Geography*, a small river rising in Mount Lebanon, and falling into the sea at Byblus. When in flood its waters exhibit a deep red tinge; hence the legend that connects it with the wound of Adonis.

> "While smooth Adonis from his native rock,
> Ran purple to the sea, suppos'd with blood
> Of Thammuz yearly wounded."—MILTON.

ADONIS, a genus of ranunculaceous plants, known commonly by the names of Pheasant's Eye and *Flos Adonis*. There are ten or twelve species given by authors, but they may be probably reduced to three or four. There are two indigenous species, *Adonis autumnalis* and *Adonis æstivalis*. They are commonly cultivated. An early flowering species, *Adonis vernalis*, is well worthy of cultivation.

ADOPTIAN CONTROVERSY, a controversy relating to the sonship of Christ, raised in Spain by Elipandus, archbishop of Toledo, and Felix, bishop of Urgel, towards the close of the 8th century. By a modification of the doctrine of Nestorius they maintained that Christ was really the Son of God in his divine nature alone, and that in his human nature he was only the Son of God by adoption. It was hoped that this view would prove more acceptable to the Mahometans than the orthodox doctrine, and Elipandus especially was very diligent in propagating it. Felix was instrumental in introducing it into that part of Spain which belonged to the Franks, and Charlemagne thought it necessary to assemble a synod at Ratisbon (792), before which the bishop was summoned to explain and justify the new doctrine. Instead of this he renounced it, and confirmed his renunciation by a solemn oath to Pope Adrian, to whom the synod sent him. The recantation was probably insincere, for on returning to his diocese he taught adoptianism as before. Another synod was held at Frankfort in 794, by which the new doctrine was again formally condemned, though neither Felix nor any of his followers appeared. A friendly letter from Alcuin, and a controversial pamphlet, to which Felix replied, were followed by the sending of several commissions of clergy to Spain to endeavour to put down the heresy. Archbishop Leidrad of Lyons being on one of these commissions, persuaded Felix to appear before a synod at Aix-la-Chapelle in 799. There, after six days' disputing with Alcuin, he again recanted his heresy. The rest of his life was spent under the supervision of the archbishop at Lyons, where he died in 816. Elipandus, secure in his see at Toledo, never swerved from the adoptian views, which, however, were almost universally abandoned after the two leaders died. The controversy was revived by solitary advocates of the heretical opinions more than once during the Middle Ages, and the questions on which it turns have, in one form or another, been the subject of frequent discussion.

ADOPTION, the act by which the relations of paternity and filiation are recognised as legally existing between persons not so related by nature. Cases of adoption were very frequent among the Greeks and Romans, and the custom was accordingly very strictly regulated in their laws. In Athens the power of adoption was allowed to all citizens who were of sound mind, and who possessed no male offspring of their own, and it could be exercised either during lifetime or by testament. The person adopted, who required to be himself a citizen, was enrolled in the family and *demus* of the adoptive father, whose name, however, he did not necessarily assume. In the interest of the next of kin, whose rights were affected by a case of adoption, it was provided that the registration should be attended with certain formalities, and that it should take place at a fixed time—the festival of the *Thargelia*. The rights and duties of adopted children were almost identical with those of natural offspring, and could not be renounced except in the case of one who had begotten children to take his place in the family of his adoptive father. Adopted into another family, children ceased to have any claim of kindred or inheritance through their natural father, though any rights they might have through their mother were not similarly affected. Among the Romans the existence of the *patria potestas* gave a peculiar significance to the custom of adoption. The motive to the act was not so generally childlessness, or the gratification of affection, as the desire to acquire those civil and agnate rights which were founded on the *patria potestas*. It was necessary, however, that the adopter should have no children of his own, and that he should be of such an age as to preclude reasonable expectation of any being born to him. Another limitation as to age was imposed by the maxim *adoptio imitatur naturam*, which required the adoptive father to be at least eighteen years older than the adopted children. According to the same maxim eunuchs were not permitted to adopt, as being impotent to beget children for themselves. Adoption was of two kinds according to the state of the person adopted, who might be either still under the *patria potestas* (*alieni juris*), or his own master (*sui juris*). In the former case the act was one of *adoption proper*, in the latter case it was styled *adrogation*, though the term adoption was also used in a general sense to describe both species. In adoption proper the natural father publicly sold his child to the adoptive father, and the sale being thrice repeated, the maxim of the Twelve Tables took effect, *Si pater filium ter venunduit, filius a patre liber esto*. The process was ratified and completed by a fictitious action of recovery brought by the adoptive father against the natural parent, which the latter did not defend, and which was therefore known as the *cessio in jure*. *Adrogation* could be accomplished originally only by the authority of the people assembled in the

Comitia, but from the time of Diocletian it was effected by an imperial rescript. Females could not be adrogated, and, as they did not possess the *patria potestas*, they could not exercise the right of adoption in either kind. The whole Roman law on the subject of adoption will be found in Justinian's *Institutes*, lib. i. tit. 11. In Hindoo law, as in nearly every ancient system, wills are almost unknown, and adoptions take their place. The strict law of adoption in India has been relaxed to the extent that a Hindoo widow may adopt when her deceased husband has not done so. Adoption is not recognised in the laws of England and Scotland, though there are legal means by which one may be enabled to assume the name and arms and to inherit the property of a stranger. In France and Germany, which may be said to have embodied the Roman law in their jurisprudence, adoption is regulated according to the principles of Justinian, though with several more or less important modifications, rendered necessary by the usages of these countries respectively. The part played by the legal fiction of adoption in the constitution of primitive society and the civilisation of the race is so important, that Sir Henry S. Maine, in his valuable work on *Ancient Law*, expresses the opinion that, had it never existed, the primitive groups of mankind could not have coalesced except on terms of absolute superiority on the one side, and absolute subjection on the other. With the institution of adoption, however, one people might *feign itself* as descended from the same stock as the people to whose *sacra gentilicia* it was admitted; and amicable relations were thus established between stocks which, but for this expedient, must have submitted to the arbitrament of the sword with all its consequences.

ADOPTION, as a Biblical term, occurs only in the *New Testament*. In Old Testament history the practice was unknown, though cases approximating to it have been pointed out. In the New Testament υἱοθεσία occurs in several passages, on which is founded one of the leading doctrines of theology.

ADORATION (from *os, oris*, the mouth, or from *oro*, to pray), an act of homage or worship which, among the Romans, was performed by raising the hand to the mouth, kissing it, and then waving it in the direction of the adored object. The devotee had his head covered, and after the act turned himself round from left to right. Sometimes he kissed the feet or knees of the images of the gods themselves, and Saturn and Hercules were adored with the head bare. By a natural transition the homage that was at first paid to divine beings alone came to be paid to men in token of extraordinary respect. Those who approached the Greek and Roman emperors adored by bowing or kneeling, laying hold of the imperial robe, and presently withdrawing the hand and pressing it to the lips. In eastern countries adoration was performed in an attitude still more lowly. The Persian method, introduced by Cyrus, was to bend the knee and fall on the face at the prince's feet, striking the earth with the forehead, and kissing the ground. Homage in this form was refused by Conon to Artaxerxes, and by Callisthenes to Alexander the Great. In England the ceremony of kissing the king's or queen's hand, and some other acts which are performed kneeling, may be described as forms of adoration. Adoration is applied in the court of Rome to the ceremony of kissing the Pope's foot, a custom which is said to have been introduced by the popes after the example of the Emperor Diocletian. In the Romish Church a distinction is made between *Latria*, a worship due to God alone, and *Dulia* or *Hyperdulia*, the adoration paid to the Virgin, saints, martyrs, crucifixes, the host, &c.

ADOUR, the ancient *Aturus*, a river of France which rises near Barége, in the department of Upper Pyrenees, and, flowing first northwards, then with a circuit to the west, passes through the departments of Gers and Landes, and falls into the Bay of Biscay 3 miles below Bayonne. Its length is about 180 miles, and it is navigable for about 70 miles, as far as St Séver. Bagnères-de-Bigorre, Tarbes, and Dax are the other important towns on its banks.

ADOWA, the capital of Tigré, in Abyssinia, is situated in 14° 12′ N. lat., 39° 3′ E. long., on the left bank of the River Hasam, 145 miles N.E. of Gondar. It is built on the eastern declivity of a hill overlooking a small plain, and has regular streets, ornamented with trees and gardens. The town derives its chief importance from its situation on the route between Massowah and Gondar, which has caused it to become the great entrepôt of traffic between the extensive table-land of Tigré and the coast. Gold and ivory are included in its transit trade, and hardware is manufactured, as well as the coarse cotton cloth which circulates in Abyssinia as the medium of exchange in place of money. Population about 6000.

ADRA, the ancient *Abdera*, a seaport of Spain on the Mediterranean, in the province of Almeria, 60 miles S.E. of Grenada. Lead is extensively wrought in the neighbourhood, and exported to Marseilles. The other exports include wheat and sugar. Population, 7400.

ADRASTUS, in *Legendary History*, was the son of Talaus, king of Argos, and Lysianassa, daughter of Polybus, king of Sicyon. Being driven from Argos by Amphiaraus, Adrastus repaired to Sicyon, where he became king on the death of Polybus. After a time he was reconciled to Amphiaraus, to whom he gave his sister in marriage, returned to Argos, and occupied the throne. He acquired great honour in the famous war against Thebes, which he undertook for the restoration of his son-in-law Polynices, who had been deprived of his rights by his brother Eteocles, notwithstanding the agreement between them. Adrastus, followed by Polynices and Lydeus, his two sons-in-law, Amphiaraus, his brother-in-law, Capaneus, Hippomedon, and Parthenopaeus, marched against the city of Thebes, and on his way is said to have founded the Nemean games. This is the expedition of the *Seven Worthies against Thebes* which the poets have made nearly as famous as the siege of Troy. As Amphiaraus had foretold, they all lost their lives in this war except Adrastus, who was saved by the speed of his horse Arion. Ten years after, at the instigation of Adrastus, the war was renewed by the sons of the chiefs that had fallen. This expedition was called the *War of the Epigoni*, and ended in the taking and destruction of Thebes. None of the followers of Adrastus perished in it except his son Ægialeus. The death of this son affected Adrastus so much that he died of grief at Megara, as he was leading back his victorious army.

ADRIA, a city of Italy, in the province of Rovigo, between the rivers Po and Adige. It is a place of great antiquity, and was at an early period a seaport of such importance and celebrity as to give name to the sea on which it stood. Originally an Etruscan colony, it enjoyed for a time remarkable prosperity; but under the Romans it appears never to have been of much importance, and after the fall of the Western Empire it rapidly declined. The dykes which protected the surrounding country from inundation were neglected, the canals became choked, and the mud and other deposits brought down by the waters of the Po and Adige caused a gradual extension of the land into the Adriatic, so that Adria ceased to be a seaport, and is now 16 miles from the sea, on whose shores it formerly stood. By the draining of the neighbouring lands, the modern town has been much improved. It has some trade in grain, cattle, fish, wine, and earthenware, is the seat of a bishopric, and has a museum of Greek and Roman antiquities. A little to the south, extensive remains of the

ancient city have been discovered deeply imbedded in the accumulated soil. The population of Adria is 10,000.

ADRIA (ὁ Ἀδρίας—Acts xxvii. 27) in St Paul's time meant all that part of the Mediterranean between Crete and Sicily. This fact is of importance, as it relieves us from the necessity of finding the island of Melita, on which Paul was shipwrecked, in the present Adriatic Gulf.

ADRIAN, a town of the United States, capital of Lenawee co., Michigan, situated on a branch of the Raisin river, and on the Michigan Southern Railway, 73 miles W.S.W. of Detroit. Adrian is the centre of trade for the surrounding district, which is chiefly grain-producing. Its extensive water-power is employed in mills of various kinds. It has several fine churches and other public buildings. Population in 1870, 8438.

ADRIAN, Publius Ælius, Roman emperor. See Hadrian and Roman History.

ADRIAN (sometimes written Hadrian) was the name of six popes:—

Adrian I., son of Theodore, a Roman nobleman, occupied the pontifical chair from 772 to 795. Soon after his accession the territory that had been bestowed on the popes by Pepin was invaded by Desiderius, king of the Longobards, and Adrian found it necessary to invoke the aid of Charlemagne, who entered Italy with a large army, and repelled the enemy. The pope acknowledged the obligation by conferring upon the emperor the title of Patrician of Rome, and Charlemagne made a fresh grant of the territories orginally bestowed by his father, with the addition of Ancona and Benevento. The friendly relations thus established between pope and emperor continued unbroken, though a serious difference arose between them on the question of the worship of images, to which Charlemagne and the Gallican Church were strongly opposed, while Adrian favoured the views of the Eastern Church, and approved the decree of the Council of Nicæa (787), confirming the practice and excommunicating the iconoclasts. It was in connection with this controversy that Charlemagne wrote the so-called *Libri Carolini*, to which Adrian replied by letter, anathematising all who refused to worship the images of Christ, or the Virgin, or saints. Notwithstanding this, a synod, held at Frankfort in 794, anew condemned the practice, and the dispute remained unsettled at Adrian's death. An epitaph written by Charlemagne in verse, in which he styles Adrian "father," proves that his friendship with the pontiff was not disturbed by the controversy in which they were so long engaged.

Adrian II., born at Rome, became pope in 867, at the age of seventy-six. He faithfully adhered to the ambitious policy of his immediate predecessor, Nicholas I., and used every means to extend his authority. His persistent endeavours to induce Charles the Bald to resign the kingdom of Lorraine to the emperor were unsuccessful. Hincmar, archbishop of Rheims, who had crowned Charles, denied the pope's right to interfere in the matter, and maintained that the threatened excommunication of the king's adherents would have no validity. Adrian was for the time more successful in his contest with the patriarch of Constantinople—the sentence of deposition he passed upon Photius being confirmed by a council of the Eastern Church held in 869–70. His arrogant measures were, however, the immediate occasion of the schism between the Greek and Latin churches. Adrian had himself been married, but put away his wife on ascending the papal throne, and a council called by him at Worms in 868 decreed the celibacy of the clergy. He died in 872.

Adrian III., born at Rome, succeeded Martin II. in 884, and died in 885 on a journey to Worms.

Adrian IV. whose name was Nicholas Breakspeare, was born before 1100 A.D. at Langley, near St Albans, in Hertfordshire, and is the only Englishman who has occupied the papal chair. His request to be allowed to take the habit of the monastery of St Albans having been refused by Abbot Richard, he proceeded to Paris, where he studied with diligence, and soon attained great proficiency, especially in theology. Being admitted, after a period of probation, a regular clerk in the monastery of St Rufus, in Provence, he distinguished himself so much by his learning and strict observance of the monastic discipline that he was chosen abbot when the office fell vacant. His merit became known to Pope Eugenius III., who created him cardinal-bishop of Alba in 1146, and sent him two years later as his legate to Denmark and Norway. On this mission he converted many of the inhabitants to Christianity, and erected Upsal into an archiepiscopal see. Soon after his return to Rome, Anastasius, successor of Eugenius, died, and Nicholas was unanimously chosen pope, against his own inclination, in Nov. 1154. On hearing of the election, Henry II. of England sent the abbot of St Albans and three bishops to Rome with his congratulations, which Adrian acknowledged by granting considerable privileges to the monastery of St Albans, including exemption from all episcopal jurisdiction except that of Rome. The bestowal by Adrian of the sovereignty of Ireland upon the English monarch was a practical assertion of the papal claim to dispose of kingdoms. The act, besides facilitating and hastening the subjection of Ireland to England, was also the means of inducing Henry to yield the long-contested point of lay investiture to ecclesiastical offices. The beginning of Adrian's pontificate was signalised by the energetic attempts of the Roman people to recover their ancient liberty under the consuls, but the pope took strong measures to maintain his authority, compelling the magistrates to abdicate, laying the city under an interdict, and procuring the execution of Arnold of Brescia (1155). In the same year he excommunicated William, king of Sicily, who had ravaged the territories of the church, but the ban was removed and the title of King of the Two Sicilies conferred on William in the following year, on the promise of a yearly tribute to the Holy See. With Adrian commenced the long and bitter conflict between the papal power and the house of Hohenstaufen which ended in the humiliation of the latter. Frederick Barbarossa having entered Italy at the head of a large army for the purpose of obtaining the crown of Germany from the hands of the pope, Adrian met him at Sutri. The demand that he should hold the pope's stirrup as a mark of respect was at first refused by Frederick, whereupon the pope on his part withheld from the emperor the *osculum pacis*, and the cardinals ran away in terror. After two days' negotiation, Frederick was induced to yield the desired homage, on the representation that the same thing had been done by his predecessors. His holiness then conducted the emperor to Rome, where the ceremony of coronation took place in the Church of St Peter's. It was in these transactions that the quarrel originated. A letter addressed by the pope to Frederick and the German bishops in 1157 asserted, on the ground of the ceremonies that had taken place, that the emperor held his dominions as a *beneficium*. The expression, being interpreted as denoting feudal tenure, stirred up the fiercest indignation of Frederick and the Germans, and though explanations were afterwards given with the view of showing that the word had not been used in an offensive sense, the breach could not be healed. Adrian was about to pronounce the sentence of excommunication upon Frederick when he died at Anagni on the 1st Sept. 1159.

Adrian V., a Genoese, whose name was Ottoboni Fiesci, occupied the papal throne for only five weeks in 1276. When congratulated on his accession he replied in the

well-known words, "I wish you had found me a healthy cardinal rather than a dying pope."

ADRIAN VI., born of humble parentage at Utrecht in 1459, studied at the university of Louvain, of which he became vice-chancellor. He was chosen by the Emperor Maximilian to be tutor to his grandson, the Archduke Charles, through whose interest as Charles V. he was afterwards raised to the papal throne. In 1517 he received the cardinal's hat from Leo X., and in 1519 he was made bishop of Tortosa. After the death of Ferdinand he was for a time regent of Spain. He was chosen pope Jan. 9, 1522; but the election was very displeasing to the people of Rome, as the new pope, in contrast with his predecessor Leo, was known to be very rigid in discipline and frugal in his mode of living. On his accession, contrary to the usual custom, he did not change his name, and he showed his dislike to ostentation in many other ways. In regard to the great fact with which he had to deal—the Reformation—Adrian's conduct showed that he did not fully estimate the gravity of the crisis. Acknowledging the corruptions of the church, he did his utmost to reform certain external abuses; but when his proposed measures failed to win back Luther and the other reformers, he immediately sought to suppress their doctrines by force. He died on the 14th September 1523. So little did the people care to conceal their joy at the event that they wrote on the door of his physician's house the words "the saviour of his country."

ADRIAN, CARDINAL, was born at Corneto, in Tuscany, and studied at Rome. He was sent by Innocent VIII. as nuncio to Britain, to endeavour to reconcile James III. of Scotland and his subjects. That king having died, Adrian remained in England, where Henry VII. presented him to the bishopric of Hereford, and afterwards to that of Bath and Wells; but he never resided in either of these dioceses. On his return to Rome he became secretary to Pope Alexander VI., who employed him in various missions, and subsequently invested him with the purple. It was Adrian in particular that Alexander is said to have meant to poison in order that he might seize on his great wealth, when, as is generally reported, he fell a victim to his own wickedness. Not long after the elevation of Leo X. to the papal chair he was implicated in the conspiracy of Cardinal Petrucci against that pontiff. He confessed his guilt; and pardon being offered only on condition of his payment of a fine of 25,000 ducats, he resolved to fly from Rome. It is supposed that he was murdered by a domestic who coveted his wealth. Adrian was one of the first who sought to restore the Latin tongue from its mediæval corruptions to classical purity. He wrote *De Vera Philosophia*, a religious treatise, printed at Cologne in 1548; *De Sermone Latino*, a learned work, published at Rome in 1515, and repeatedly since; a treatise, *De Venatione;* and some Latin verses.

ADRIANI, GIOVANNI BATTISTA, born of a patrician family of Florence about 1511, was secretary to the republic of Florence, and for thirty years professor of rhetoric at the university. He wrote a history of his own times, from 1536 to 1574, in Italian, which is generally, but according to Brunet erroneously, considered a continuation of Guicciardini. De Thou acknowledges himself greatly indebted to this history, praising it especially for its accuracy. Adriani composed funeral orations on the Emperor Charles V. and other noble personages, and was the author of a long letter on ancient painters and sculptors prefixed to the third volume of Vasari. He died at Florence in 1579.

ADRIANOPLE (called by the Turks EDRENEH), a city of European Turkey, in the province of Rumelia, 137 miles W.N.W. of Constantinople; 41° 41′ N. lat., 26° 35′ E. long. It is pleasantly situated partly on a hill and partly on the banks of the Tundja, near its confluence with the Maritza. Next to Constantinople, Adrianople is the most important city of the empire. It is the seat of a bishop of the Greek Church. The streets are narrow, crooked, and filthy; its ancient citadel, and the walls which formerly surrounded the town, are now in ruins. Of its public buildings the most distinguished are the *Eski-Serai*, the ancient palace of the sultans, now in a state of decay; the famous bazaar of Ali Pacha; and the mosque of the Sultan Selim II., a magnificent specimen of Turkish architecture, which ranks among the finest Mahometan temples. The city has numerous baths, caravanseries, and bazaars; and considerable manufactures of silk, leather, tapestry, woollens, linen, and cotton, and an active general trade. Besides fruits and agricultural produce, its exports include raw silk, cotton, opium, rose-water, attar of roses, wax, and the famous dye known as Turkey red. The surrounding country is extremely fertile, and its wines are the best produced in Turkey. The city is supplied with fresh water by means of a noble aqueduct carried by arches over an extensive valley. There is also a fine stone bridge here over the Tundja. During winter and spring the Maritza is navigable up to the town, but Enos, at the mouth of that river, is properly its seaport. Adrianople was called Uskadama previous to the time of the Emperor Hadrian, who improved and embellished the town, and changed its name to Hadrianopolis. In 1360 it was taken by the Turks, who, from 1366 till 1453, when they got possession of Constantinople, made it the seat of their government. In the campaign of 1829 Adrianople surrendered to the Russians without making any resistance, but was restored after the treaty of peace signed the same year. Population, 140,000.

ADRIATIC SEA, the *Adriaticum Mare* of the ancients, is an arm of the Mediterranean which separates Italy from Triest, Croatia, Dalmatia, and Albania. It extends from 40° to 45° 50′ N. lat. in a N.W. direction. Its extreme north-west portion forms the Gulf of Venice, and on the east side are the gulfs of Triest, Fiume, Cattaro, and Drino. Its greatest length is 450 miles, its mean breadth 90 miles, and its depth varies from 12 to 22 fathoms. The western or Italian coasts are generally low and marshy; but the eastern shores are steep and rocky, and the abounding creeks and inlets, with the numerous islands, afford to mariners many safe natural harbours. The ebbs and flows of the tide in the Adriatic are inconsiderable, though more observable than in the Mediterranean generally; and its saltness is a little greater than that of the ocean. The prevalence of sudden squalls from the N.E. and S.E. renders its navigation hazardous, especially in winter. Except the Po and Adige, no considerable rivers flow into the Adriatic. Its chief emporia of trade are Venice, Triest, and Ancona. The port of Brindisi, on the Italian coast, near the southern extremity of the Adriatic, is rapidly rising in importance as the point of arrival and departure of the Peninsular and Oriental Company's steamers conveying the overland mails between England and the East. The name Adriatic is derived from Adria, between the mouths of the Po and the Adige, and not from Adria in Picenum. (See *Highlands and Islands of the Adriatic*, by A. A. Paton, 2 vols. 8vo, 1849; *Shores of the Adriatic*, by Viscountess Strangford, 1864.)

ADULE or ADULIS, a town on the Red Sea. See ZULLA.

ADULLAM, in *Scripture Geography*, a city in the plain country of the tribe of Judah. The cave Adullam, in which David took refuge after escaping from Gath (1 Sam. xxii. 1), was probably situated among the mountains to the east of Judah, near the Dead Sea. From its being described as the resort of "every one that was in distress," or "in debt," or "discontented," it has often been humorously alluded to, as by the Baron of Bradwardine in *Waverley*, chap. 57.

ADULTERATION

ADULTERATION, the act of debasing a pure or genuine commodity for pecuniary profit, by adding to it an inferior or spurious article, or by taking from it one or more of its constituents. The term is derived from the Latin *adultero*, which in its various inflections signifies to defile, to debase, to corrupt, to sophisticate, to falsify, to counterfeit, &c. The objects of adulteration are fourfold, namely, to increase the bulk or weight of the article, to improve its appearance, to give it a false strength, or to rob it of its most valuable constituents. All these adulterations are manifestly of a designedly fraudulent character, and are therefore properly the subjects of judicial inquiry; but there may be accidental corruptions and adulterations of a commodity, arising from natural or unavoidable causes, as when darnel or ergot become mixed with grain in the fields of the slovenly farmer, or when an article becomes changed and deteriorated from spontaneous decay, or when mineral matters and other impurities are accidentally derived from the machinery or vessels in which the thing is prepared or kept. The recognition of such impurities, and the tracing of them to their source, is of prime importance in pursuing a charge of adulteration. Few articles of commerce, however, are exempt from fraudulent adulteration, and the practice of it has grown with the competition of trade, and the removal of those wholesome restrictions which in former times were so energetically opposed to all kinds of dishonest dealing; for the guilds and companies of all large cities had their corporate regulations for supervising and governing every description of trade and manufacture. The excise, too, including the customs, had until recently control over the quality of all exciseable articles; and although the prime object of this was to protect the revenue of the country, yet it also served to prevent adulteration. In addition to this there were in ancient times ordinances of assize for regulating the price and quality of the common necessaries of life. As far back as the reign of John (1203) there was a proclamation throughout the kingdom for enforcing the legal obligations of assize as regards bread; and in the following reign the statute (51 Hen. III. stat. 6), entitled the Pillory and Tumbrel, was framed for the express purpose of protecting the public from the dishonest dealings of bakers, vintners, brewers, butchers, and others. This statute is deserving of notice as the first in which the adulteration of human food is specially noticed and prohibited; and it seems to have been enforced with more or less of rigour until the time of Anne, when it was repealed (8 Anne, c. 19). According to *Liber Albus*, it was strictly observed in the days of Edward I., for it states that "if any default shall be found in the bread of a baker in the city, the first time, let him be drawn upon a hurdle from the Guildhall to his own house through the great street where there be most people assembled, and through the great streets which are most dirty, with the faulty loaf hanging from his neck; if a second time he shall be found committing the same offence, let him be drawn from the Guildhall through the great street of Cheepe, in the manner aforesaid, to the pillory, and let him be put upon the pillory, and remain there at least one hour in the day; and the third time that such default shall be found, he shall be drawn, and the oven shall be pulled down, and the baker made to forswear the trade in the city for ever." Vintners, spicers, grocers, butchers, regrators, and others, were subject to the like punishment for dishonesty in their commercial dealings—it being thought that the pillory, by appealing to the sense of shame, was far more deterrent of such crimes than fine or imprisonment. But all this has given way to the force of free trade, and now the practice of adulteration has become an art, in which the knowledge of science and the ingenuity of trade are freely exercised. Fifty years ago it attracted the attention of one of the most expert chemists of the day, Mr Accum, who, in his *Treatise on Adulterations of Food, and Culinary Poisons,* declared it to be an "art and mystery." Subsequently to that, in 1851 and the three following years, articles on the adulteration of food appeared in the *Lancet*, and the effect of those articles was to call for a Parliamentary inquiry, which resulted in the Adulteration of Food Act of 1860. That Act of Parliament gave power to certain local authorities in England, Scotland, and Ireland to appoint analysts, having competent medical, chemical, and microscopical knowledge. The penalty for selling an adulterated article, knowing it to be so adulterated, was five pounds, and the costs of the proceedings. But as the statute was permissive, only a few analysts were appointed, and it soon became a dead letter. Attempts were subsequently made to improve the law, and to make it compulsory on local authorities to appoint analysts. One of these was the Bill of 1869, and another was that of 1871—both of which were abandoned by their promoters. In the year 1872, however, an Act was passed, entitled An Act to amend the Laws for the Prevention of Adulteration of Food, Drink, and Drugs. The main features of this Act are the following:—Local authorities in England, Scotland, and Ireland are bound to appoint analysts with competent medical, chemical, and microscopical knowledge. They must also appoint officers or inspectors to purchase articles of food, drink, and drugs within their respective districts, and take them to the analyst for examination. Other purchasers of such articles are permitted, under proper restrictions, to have suspected articles analysed. On receiving a certificate from the analyst, stating that any article is adulterated, the inspector must take the necessary legal proceedings for the purpose of bringing the offender to justice. The penalty on conviction of mixing anything whatever with a drug, with the view of adulterating it, or of mixing any injurious or poisonous ingredient with any article of food or drink, is a sum not exceeding fifty pounds, together with the costs; and for the second offence he shall be guilty of a misdemeanour, and be imprisoned for a period not exceeding six calendar months with hard labour. The penalty for selling an adulterated article with a guilty knowledge is a sum not exceeding twenty pounds, together with the costs; and for a second offence, the justice may order the offender's name, place of abode, and offence to be published in a newspaper, or in any manner he thinks fit, at the expense of the offender. Although the meaning of the term adulteration is not strictly defined in the Act, yet it is declared that the admixture of anything whatever with an article of food, drink, or drug, for the purpose of fraudulently increasing its weight or bulk, is an adulteration within the provisions of the Act. The adulteration of intoxicating liquors is provided for by the Licensing Act 1872 (35 and 36 Vict. c. 94); and in this Act there is a schedule of substances, called "*Deleterious Ingredients*," which are considered to be adulterations: they are *Cocculus indicus*, chloride of sodium or common salt, copperas, opium, Indian hemp, strychnine, tobacco, darnel seed, extract of logwood, salts of zinc or lead, alum, and any extract or compound of any of these. The execution of this Act rests with the police authorities and the Inland Revenue. The penalties for adulteration

are very severe, leaving it to the magistrate either to inflict a heavy fine or to send the offender to prison. In the year 1869 an Act was passed to prevent the adulteration of seeds, in fraud of Her Majesty's subjects, and to the great detriment of agriculture (32 and 33 Vict. c. 112), wherein it is declared that the killing of seeds, the dying of them, and the selling of such killed or dyed seeds, with intent to defraud, is punishable with a penalty not exceeding five pounds for the first offence, nor exceeding fifty pounds for a second or subsequent offence, together with the publication of the offender's name, place of abode, and offence in any manner that the justice thinks fit.

Adulteration in other countries is strictly prohibited under penal obligations. The Prussian penal code provides that any person selling adulterated or spoiled goods shall be liable to a penalty up to fifty dollars, or imprisonment for six weeks, with confiscation of goods; and it is not necessary to prove that the seller was aware of the adulteration. In Holland, the Dutch law is very similar to the code Napoleon, and inflicts a punishment of imprisonment for from six days to two years, with a fine of from 16 to 600 francs. The adulteration of bread with copperas or sulphate of zinc is dealt with by imprisonment of from two to five years, and a fine of from 200 to 500 florins. In Paris, malpractices connected with the adulteration of food are investigated by the Conseil de Salubrité and punished. Much valuable information concerning the adulteration of food, drink, and drugs in foreign countries has lately been obtained from the various British legations and consulates abroad, through a circular addressed to them from the Foreign Office. These investigations were commenced by the late Earl of Clarendon, and have been continued by Earl Granville. The results have been published in the *Food Journal* for 1870 and 1871; and they are epitomised at page 193 of the journal of the last mentioned date.

Among the adulterations which are practised for the purpose of fraudulently increasing the weight or bulk of an article are the following :—

1. *Adulterations of Milk.*—This is commonly effected by the addition of water—technically termed Simpson; and it is known by the appearance of the milk, the specific gravity of it, the quantity of cream which rises, and the chemical composition of the milk. Good milk has a rich appearance, and a full pleasant taste. Its specific gravity ranges from 1029 (water being 1000) to 1032—the average being 1030. If, therefore, the density of milk is above 1030, other conditions corresponding, the inference is that the sample is unusually good. Between 1028 and 1030 it is most probably genuine. At from 1026 to 1028 it is of doubtful quality, and below that, unless the amount of cream is enormously large, the sample is not genuine. An instrument, called a *galactometer*, has been constructed to show the specific gravity of milk at a glance; but it must always be remembered that while the addition of water tends to lower the gravity of milk, so also does the presence of much cream, and therefore a sample of skimmed milk may show a high gravity even when diluted with water. The percentage quantity of cream is ascertained by means of an instrument called a *lactometer*. It is a glass tube about 10 or 11 inches long and half an inch in diameter, graduated into 100 parts. Having shaken a sample of milk so as to diffuse the cream throughout its bulk, it is poured into the lactometer to the topmost division; and after standing for 12 hours, to allow the cream to rise, the proportion of it is read off from the divisions on the tube. Good milk shows a range of from 8 to 12 divisions. Conjoined with the preceding test, this affords reliable indication of the quality of the sample. After removing the cream, the gravity should be again taken, and this should not be lower than 1030. The chemical composition of milk varies to some extent with the breed of the cow, its age, the diet upon which it is fed, the time of calving, and the time of milking; for afternoon milk is generally richer than morning, and the last drawn than the first. But taking the results of a large number of analyses by different chemists, it may be said that the average percentage composition of milk is as follows :—Casein or cheese matter, 3·64; butter, 3·55; milk, sugar or lactose, 4·70; saline matter, 0·81; and water, 87·30. If, therefore, 1000 grains of milk be treated with a few drops of acetic acid, and then heated in a flask to about 120° Fahr., the casein of the milk will curdle, and enclose within it all the butter. When it is quite cold, it can easily be filtered, and when dry, the curd and butter should weigh from 75 to 85 grains; and the serum or whey should have a density of about 1029. The addition of mineral matter, as common salt or carbonate of soda, to milk is easily recognised by an examination of the ash or saline constitutents. 1000 grains of good milk evaporated to dryness will produce from 120 to 130 grains of solid matter, of which about 8 grains are mineral; and these are left in the platinum capsule, when the solid matter is incinerated or burnt to an ash. Of this ash about half is phosphate of lime, and 2·7 are alkaline chlorides, the rest being phosphates of magnesia and iron, with a little carbonate of soda. Any notable increase, therefore, in the proportion of ash, or any large diminution of it, will show adulteration. Colouring matter, as annatto, &c., is known by the peculiar tint of the milk; and starchy matters boiled to an emulsion will give their characteristic reactions with iodine, and will furnish a sediment which the microscope will reveal. Fatty emulsions, in imitation of milk, were used during the siege of Paris, on the recommendation of M. Dubrunfaut, who claims to have made a very perfect substitute by emulsifying fatty matter with an artificial whey or serum. This he did by dissolving from 40 to 50 grammes of saccharine matter (lactose, glucose, or cane sugar), and from 20 to 30 grammes of albumen (dried white of egg), and from 1 to 2 grammes of the crystals of carbonate of soda, in half a litre of water, and then emulsifying with from 50 to 60 grammes of olive oil or other fatty substance. This is best done at a temperature of from 120° to 140° Fahr.; and the liquid so prepared has the appearance of cream, and requires to be mixed with twice its volume of water to acquire the consistence of milk. Gelatine may be used instead of albumen, the mixture being even more nearly like rich cream than the former. M. Gaudin says that any kind of fat may be used for this purpose, provided it is purified with superheated steam; and M. Fan states that even horse grease may be so employed. M. Dumas, however, is of opinion that none of these substitutes can take the place of milk for any time as dietetical agents. Milk from diseased animals, especially those affected with pleuropneumonia, and the foot and mouth disease, is very unwholesome, and ought not to be drunk. The diseased product is recognised by the presence of abnormal inflammatory globules of the nature of pus, and by a large amount of epithelium cells. Preserved condensed milk is now so commonly used for food, that its properties when good should be known. 100 parts of the specimens at present in the market consist of from 14 to 18 parts of casein, from 12 to 14 of butter, from 44 to 52 of sugar, and from 2·4 to 2·7 of saline matter—making in all from 77 to 81 parts of solid matter—the rest, namely, from 23 to 19 parts, being water. It appears, therefore, that the concentration of the milk has been carried to about one third of its original bulk, and that sugar has then been added, so that when diluted with twice its volume of water, it makes a sweet-tasting milk of ordinary strength. Good cream should contain rom 25 to 34 parts of butter, about 5 of casein, 2 of sugar, 2 of saline matter, and from 62 to 56 parts of water.

2. *Coffee* has from very early times been the subject of sophistication. As far back as 1725, the Act 2 Geo. I. c. 30, took cognizance of the practice, and rendered it penal. In 1803 it was the object of very decisive measures, for by 43 Geo. III. c. 129, the officers of excise were empowered to search for, and to seize any burnt, scorched, or roasted peas, beans, or other grains or vegetable substance prepared in imitation of coffee; and any person manufacturing or selling the same was liable to a penalty of £100; gradually, however, it was found that use of torrefied vegetables in lieu of coffee, was becoming general in spite of these restrictions, and, therefore, in 1822, the Legislature (3 Geo. IV. c. 53) thought it expedient to allow the manufacture and sale of scorched or roasted corn, peas, beans, or turnips, by persons who were not dealers or sellers of coffee or cocoa, provided the same was sold under license in a whole or unground condition, and in its proper name. The penalty for infraction of the law was £100 in the case of a dealer in coffee or cocoa, and £50 in that of a licensed dealer. At that time the use of chicory was not generally known in England, although it had long before been introduced into France as a substitute for coffee; and its use was encouraged by the first Napoleon, who thought thus to strike a blow at English commerce. It was also used in Belgium and the Netherlands, so that travellers who visited Paris, Brussels, or Amsterdam, became acquainted with the substitute, and gradually acquired a taste for it. About the year 1820 the first parcels of chicory were imported into this country, and it would seem that the public demand for it gradually increased; for in 1832 there was a minute of the Treasury nullifying the Acts of George III. and George IV., by allowing grocers and other dealers in coffee and cocoa to sell chicory, provided they did not mix it with coffee. At a later period even this restriction was withdrawn; for by the Treasury minute of 1840, dealers in coffee were permitted to sell a mixture of chicory and coffee, provided a duty of 6d. per lb. was paid on all the chicory imported for home consumption. The use of it being thus legalised, it rapidly came into favour, and English farmers found it profitable to cultivate the root, and to send it into commerce duty free. This roused the attention of the Government, for the duties on chicory and coffee began seriously to fall off. Even the quality of the coffee imported underwent a change; for instead of demanding the fine flavoured varieties, orders were given for a coarse and strong description of plantation coffee, which would stand a good deal of chicory, as the grocers phrased it. All this was brought to the notice of the Lords of the Treasury, and in 1852 they revoked the order of 1840. But so strong was the influence of the trade upon Government, that in the following year the offensive minute was withdrawn, and grocers were again permitted to sell mixtures of coffee and chicory, provided the packet was distinctly labelled "mixture of chicory and coffee." The Treasury even went so far in 1858 as to direct the Commissioners of Inland Revenue, not to object to licensed dealers in coffee keeping and selling mangel-wurzel or beet-root mixed with coffee, provided they observed the same conditions as those laid down in the Treasury minute of 1853 as to chicory and coffee. Up to this time the duty on chicory had been merely nominal; but it was gradually increased until, in 1863, it was equivalent to that levied on coffee, and thus the revenue was protected, while adulteration was encouraged. The extent to which this was practised may be gathered from the Annual Reports of Mr Phillips, the principal chemist of the Inland Revenue Laboratory. During the years 1856 to 1862 inclusive, when the dealers in coffee and chicory were visited by the officers of Excise, the average number of samples of coffee annually examined was 3053, and of these 90, or nearly 3 per cent. were adulterated—the range being from 5·1 per cent. in 1856, to 1·8 per cent. in 1862; and the quantity of chicory in the mixture averaged 24 per cent. In 1860 it was 29 per cent. Now, in all these cases the coffee was sold as pure coffee, with no label upon the package; but when the mixtures of chicory and coffee were asked for, 7·3 per cent. were improperly labelled, and the average proportions of chicory ranged from 39·8 per cent. in 1859, to 22·3 per cent. in 1862—the average for the seven years, before the duties were equalised, being 30·7 per cent. In some cases, however, it reached to nearly 90 per cent.—40 to 50 per cent. being common proportions; and to neutralise the peculiar sweetness, and the earthy flavours which such quantities of chicory induced, it was, and still is the practice, to add more or less of the bitter material called "finings," which is a preparation of burnt sugar or caramel. Even chicory itself is now the subject of adulteration with roasted corn, beans, lupin seeds, acorns, horse-chesnuts, peas, pulse (called "Hambro' powder"), mustard husks, coffee husks (called "flights"), and even spent coffee, besides various roots, as carrots, parsnips, mangel-wurzel, beet-root, dandelion, &c. It is even said that spent tan and dried bullocks' livers have been employed for the purpose. The tests for these adulterations are the appearances presented by the tissues of the various vegetables when examined under the microscope, and by the fact that infusion of chicory does not become discoloured when it is treated with iodine, as it contains no starchy matters. Ground coffee, also, is of such a greasy nature, from the presence of volatile oil, that when it is thrown upon water, it floats, and does not readily discolour the water; whereas, all the adulterating agents quickly sink in water, and give it a brown porter-like appearance. It is not difficult indeed to separate, in a rough way, the coffee from its adulterating matters by merely stirring a given weight of the mixture in a tumbler of cold water; after a few minutes, the coffee will be found upon the surface of the water, and the other things at the bottom of it. Chemical analysis also readily discovers the fraud. It might be thought that there was safety in purchasing the coffee-berries entire, but a very ingenious machine has been patented for the manufacture of spurious berries out of common vegetable substances.

3. *Tea.*—Formerly, when the supply of tea to this country was entirely under the control of the East India Company, the adulteration of it in China was rarely practised, as every shipment of it was carefully examined by experienced officers at Canton, who rejected all teas of spurious or doubtful character. At that time, therefore, the adulteration of tea was carried on after it was imported into this country, and there were many legislative enactments prohibiting the practice. By the Act 2 Geo. I. c. 3, every tea dealer was subject to a penalty of £100, if he was convicted of counterfeiting, altering, fabricating, or manufacturing tea, or mixing it with other leaves. Later still, the statutes of 4 Geo. II. c. 14, and 17 Geo. III. c. 29, and 4 Geo. IV. c. 14, dealt more precisely with the subject, and imposed other penalties. At that time the adulterations of tea were effected in a wholesale manner; for according to Mr Phillips, of the Inland Revenue Office, there were in London alone, in 1843, as many as eight manufactories in which the exhausted leaves, obtained from hotels, coffee-houses, and elsewhere, were redried, and faced with rose-pink and blacklead, in imitation of genuine tea. More recently, however, the adulteration of tea has been practised by the Chinese, who find no difficulty in disposing of any kind of spurious tea to English merchants at Canton and Shanghai, who ship it to this country, and lodge it in the bonded warehouses with all the formalities of an honourable transaction, knowing that the difficulties of convicting them under the Adulteration of Food Acts and

Nuisances Removal Acts are almost insurmountable; for, in the first place, the local sanitary authorities have no means of obtaining direct information of the existence of unsound or spurious tea, or other article of food or drink in bonded warehouses; and secondly, if such information reaches them indirectly, they have no legal right of entry for the purpose of examining the tea and taking samples. But supposing both of these difficulties have been surmounted, and the tea has been found on analysis to be spurious, there yet remain the difficulties of obtaining a justice's order for its condemnation, an order from the customs for its removal, and an order which will satisfy the requirements of the wharfinger in whose custody it has been placed. But besides these, there are the difficulties of proving the ownership of the article, and the guilty knowledge of the broker who sells it. In illustration of this, we may refer to the proceedings of the sanitary authorities of the city of London in their endeavour to suppress the importation and sale of spurious tea. In the month of March 1870, Dr Letheby, the food analyst for the city, reported that a large quantity of spurious tea had arrived in London from China, and was lodged in the bonded warehouses of the city. It was described as "Fine Moning Congou" from Shanghai; and it consisted of the redried leaves of exhausted tea, much of which had become putrid before drying. It appears to have been called in China "Ma-loo mixture"—Maloo being the name of the street where it was prepared, and along the sides of which heaps of this trash might often be seen drying in the sun, with dogs and pigs walking over it. Proceedings were taken under the Nuisance Removal Amendment Act (26 and 27 Vict. c. 117), for the purpose of obtaining an order for the condemnation and destruction of the tea; but it was argued for the defence—1*st*, That "tea" was not named in the Act of Parliament; 2*d*, That it was not included under the term "vegetable;" 3*d*, That it was not "food;" and 4*th*, That being in a bonded warehouse, it was not "exposed for sale." The case, however, was so glaring that, after two days' hearing, an order was given by the justice for its destruction; but as a case was granted for the opinion of the Court of Queen's Bench, the order was suspended; and as the application to the Court was never made, the order is still in abeyance. In another case, where many chests of spurious "scented orange Pekoe siftings" were in bond, the order for its condemnation was refuted on the ground that there was not sufficient evidence of the so-called tea being unwholesome, notwithstanding that it was not above one-sixth its proper strength; that it had little or none of the active principles of tea; that it had an unpleasant odour and an acrid taste; that a great portion of it was not tea at all, and that the rest of it was composed of exhausted tea leaves, with just enough good tea to give it a flavour. A like failure of justice occurred in the city in 1866, when measures were taken by the sanitary authorities to prevent the sale of about 350,000 lbs. of rotten and charred tea which had been saved from a fire at Beal's wharf. The adulterations practised by the Chinese are numerous; exhausted tea is redried and glazed in a very deceptive manner. Millions of pounds of leaves of different plants, other than tea, are gathered and mixed with it. Mineral matter too, in the form of china clay, fine sand, and iron filings, are ingeniously incorporated with the leaf before curling, so that as much as from 20 to 40 per cent. of impurity is thus mixed with it. The tests, however, for these adulterations are very simple. In the first place, there is the usual trade test of infusion: a quantity of tea, amounting to the weight of a sixpence, is put into a small covered cup, and infused with about four ounces of boiling water for ten minutes. The infusion is then poured off from the leaves. and is examined for colour, taste, and odour—all of which are characteristic. The leaves, too, are examined for soundness, for colour, for size, and for special botanical properties. Impurities like iron filings, sand, or dirt, are easily seen among the leaves, or at the bottom of the cup; and when these are placed upon a coarse sieve and washed with water, the impurities pass through, and may be collected for examination. The leaves, too, betray by their coarseness and botanical characters, the nature and quality of the tea; for although the leaves of genuine tea differ much in size and form, yet their venation and general structure are very distinctive. Very young leaves are narrow, convoluted, and downy; those next in size and age have their edges delicately serrated, and the venation is scarcely perceptible; while those of larger size have the venation well marked, there being a series of loops along each side of the leaf extending from the mid-rib to the edge: the serrations also are stronger and deeper, beginning a short distance from the stem and running up the side of the leaf to the apex. In addition to this, the microscopic characters of the surface of the leaf are very characteristic. Further investigations of a chemical nature are sometimes needed to determine the question of adulteration; and these depend on the well-known composition of good tea. In different cases, according to the age of the leaf and its mode of treatment, the proportions of its chief constituents may vary; but in a general way it may be said that the average composition of tea is as follows:—Moisture from 6 to 10 per cent.; astringent matter (tannin), from 25 to 35; gum, from 6 to 7; albuminous matters, from 2 to 3; thein, from 2 to 3; mineral matters (ash), from 5 to 6; and ligneous or woody tissue, from 50 to 60 per cent. Green tea, which is generally made out of young leaves, contains the largest quantity of soluble matters; and these, when fully exhausted from the leaves by successive boiling in water, amount to from 25 to 35 per cent. of the weight of the tea. In ordinary cases, when the tea is merely infused in boiling water, it does not yield above 25 per cent. of extractive. Again, the ash of tea is very characteristic of its quality—old and spurious leaves, as well as tea adulterated with mineral matter, yielding more than 6 per cent. of ash. The chief constituents of the ash of good tea are potash and phosphoric acid, with a little lime, silica, and oxide of iron —there being but a trace of chlorine and sulphuric acid; whereas the ash of old and exhausted leaves contains but little potash and phosphoric acid, in proportion to the lime and silica; and in those cases where tea has been damaged by sea water, the amount of chloride is considerable. Iron filings in tea are easily discovered by means of a magnet, there being in some cases as much as 20 or 30 per cent. of this impurity. Even when incorporated with the leaf before rolling and glazing, the fraud is detected by the attraction of the tea to the magnet.

4. *Cocoa* in its natural state contains so much fatty matter (amounting to rather more than half its weight), that it has long been the practice to reduce it by means of sugar or farinaceous substances. The first of these preparations is called chocolate, and the latter is known by such names as granulated, flake, rock, soluble cocoa, &c. In some cases the mixture is adulterated with mineral matters, as oxide of iron, to give colour. These adulterations are recognised by the appearance and taste of the preparation, by its microscopic characters, by the colour and reaction of its solution, and by the proportions of fat and mineral matters in it.

5. *Bread.*—Especial care has been taken at all times to protect the public from the dishonest dealing of bakers. The assize of bread, for example, is a very ancient institution; for it was the subject of a proclamation in 1202, and it was the chief matter referred to in the notable statute of

the Pillory and Tumbrel (51 Henry III. stat. 16) already mentioned. In the city of London, according to "*Liber Albus*," the assize of bread was an important institution. It was always made immediately after the feast of St Michael in each year, and very specific instructions were given for the guidance of the four discreet men who were to perform it; for their decision regulated the business of the baker in respect of the price and quality of bread, &c., for the current year; and woe to him if he disregarded it—there being numerous instances in "*Liber Albus*" of the pillory and the thew in cases where bread had been found adulterated or of short weight. In the time of Anne, the assize of bread was still further regulated (8 Anne, c. 19), and in the year 1815 it was abolished by the statute 55 Geo. III. c. 99. Especial provision, however, was made to guard against the frauds of adulteration, for several Acts of Parliament, especially 31 Geo. II. c. 29 and 1 and 2 Geo. IV. c. 50, prohibited the use of alum and other spurious articles in bread under severe penalties. At the present time, the chief adulterations of bread are with alum or sulphate of copper for the purpose of giving solidity to the gluten of damaged or inferior flour, or with chalk or carbonate of soda to correct the acidity of such flour, or with boiled rice or potatoes to enable the bread to carry more water, and thus to produce a large number of loaves per sack of flour. In practice 100 lbs. of flour will make from 133 to 137 lbs. of bread, a good average being 136 lbs.; so that a sack of flour of 280 lbs. should yield 95 four-pound loaves. But the art of the baker is exercised to increase the number, and this is accomplished by hardening the gluten in the way already mentioned, or by means of a gummy mess of boiled rice, three or four pounds of which, when boiled for two or three hours in as many gallons of water, will make a sack of flour yield at least 100 four-pound loaves. Such bread, however, is always dropsical, and gets soft and sodden at the base on standing, and quickly becomes mouldy. A good loaf should have kindness of structure, being neither chaffy, nor flaky, nor crummy, nor sodden. It should also be sweet and agreeable to the palate and the nose, being neither sour nor mouldy. It should keep well, and be easily restored to freshness by heating it in a closed vessel. And a slice of it, subjected to a temperature of from 260° to 280° Fahr. should hardly be discoloured, and should not lose more than 37 or 38 per cent. of its weight. When steeped in water, it should give a milky sweet solution, and not a ropy acid liquid. The recognition of alum and sulphate of copper in bread requires practice and skilful manipulation, it being surrounded with difficulties. The most easily applied process is that described by Mr Horsley. He makes a tincture of logwood, by digesting a quarter of an ounce of the freshly cut chips in five ounces of methylated spirit for eight hours, and filters. A teaspoonful of this tincture is put with a like quantity of a saturated solution of carbonate of ammonia into a wine-glassful of water; and the mixed solutions, which are of a pink colour, are then poured into a white-ware plate or dish. A slice of the suspected bread is allowed to soak in it for five minutes, after which it is placed upon a clear plate to drain, and, if alum be present, it will, in the course of an hour or two, acquire a *blue* colour; if the tint be *greenish*, it is a sign of sulphate of copper; whereas pure bread gradually loses its pink colour, but never becomes blue or green. The ash of bread will also furnish evidences of the presence of mineral impurities.

6. *Flour and other Farinaceous Matters.*—The tests for good flour are its sweetness and freedom from acidity and musty flavour. A given weight of the flour, say 500 grains, made into a stiff dough with water, and then carefully kneaded under a small stream of water, will yield a tough elastic gluten, which, when baked in an oven, expands into a clean-looking ball of a rich brown colour, that weighs, when perfectly dry, not less than 50 grains. Bad flour makes a ropy-looking gluten, which is very difficult of manipulation, and is of a dirty brown colour when baked. The ash of flour should not exceed 2 per cent. Other farinaceous matters are recognised under the microscope by the peculiar form, and size, and marking of the individual granules. In this way, the adulterations of oat-meal with barley-meal, and of arrow-root with inferior starches, may be easily detected.

7. *Fatty Matters and Oils* are the subjects of frequent adulteration. Butter and lard, for example, are mixed with inferior fats, and with water, salt, and farina. Most of these impurities are seen when the sample of butter or lard is melted in a glass, and allowed to stand in a warm place for a few hours, when the pure fat will float as a transparent oil, while the water, salt, farina, &c., will subside to the bottom of the glass. Fresh butter generally contains a notable quantity of water, as from 12 to 13 per cent., and sometimes a little salt, and a trace of curd; but these should never exceed two per cent. in the aggregate. Foreign fats are recognised by the granular look of the butter, by its gritty feel, by its taste, and by its odour when warmed. Other tests for these impurities are the melting-point of the sample, and its solubility in a fixed quantity of ether at a temperature of 65° Fahr. 20 grains of the sample, treated with a fluid drachm of ether, in a closed test tube, will look slighty flocculent, and be almost entirely dissolved in the case of good butter; but it will be mealy and liniment-like with lard, granular with dripping, and almost solid with mutton fat. The melting point of different fats is as follows:—Horse grease, 140°; calf fat, 136°; mutton fat, 130°; beef fat, 99°; hog's lard, 81°; and butter, 80°.

Oils are adulterated with inferior kinds, and the fraud is detected by means of the specific gravity of the oil, and its chemical reactions when tested upon a white plate with a drop of concentrated sulphuric acid—the colour and its time of development being the indications of the quality of the oil. The specific gravity of the animal oils are as follows:—Neat's-foot oil, 880; tallow oil, 900; dolphin oil, 918; cod-liver oil, 921 to 926; whale oil, 927; seal oil, 934; porpoise oil, 937. Among the vegetable oils the following are the most important:—Rape or colza oil, 913 to 916; olive oil, 918; filbert oil, 916; beech-nut, 922; walnut, 923; cotton-seed, 923 to 928; poppy, 924; sweet almond, 918 to 922; hazel-nut and hemp-seed, 926; and linseed, 634 to 936.

8. *Isinglass* is often adulterated with gelatine, the fraud being ingeniously contrived so as to retain to a large extent the well-known characters of genuine isinglass; but it may be recognised in the following way: immersed in cold water, the shreds of genuine isinglass become white and opaque like cotton threads, and they swell equally in all directions, whereas those of gelatine become transparent and ribbon-like. Isinglass dissolves completely in boiling water, and makes a slightly turbid solution, which has a faint fishy smell, and is without action on litmus paper; whereas gelatine leaves a quantity of insoluble matter, and the solution smells of glue, and has an acid reaction. Strong acetic acid swells up the shreds of isinglass, and renders them soft and gelatinous; but it hardens gelatine. And, lastly, the ash of genuine isinglass is very small in quantity, and has a reddish colour; whereas that of gelatine is bulky (weighing from 2 to 3 per cent.), and has a perfectly white appearance from the presence of calcareous salts. Genuine isinglass is produced from the swimming-bladder or sound of the sturgeon, but gelatine is a sort of clarified glue obtained from bones, clippings of hides, &c. Boussingault states that the Bouxwiller glue, which is prepared from the

bones of horses slaughtered at that establishment, is transparent, and nearly colourless, and is on that account much sought after by restaurateurs for making jellies. It enters largely, too, into the composition of French gelatine.

9. *Sugar.*—During the last ten or twelve years the manufacture of sugar from starch has been an important branch of industry. The product is sent into commerce under the names of glucose, saccharum, and British sugar; and although it is chiefly used for brewing purposes, it is also employed for adulterating brown sugar, and for making confectionery, jams, marmalades, and fruit jellies. In the year 1870, as much as 25,737 cwt. of this sugar was manufactured for home consumption, and since then the quantity has been increasing. It is produced from rice or other starch, by submitting it to the action of very dilute sulphuric acid at a boiling temperature—the acid being afterwards neutralised with lime, and the solution evaporated to the setting point. The crystals of grape sugar are very small, and are entirely without that sparkling character which distinguishes cane sugar. They are less soluble in water, but more so in alcohol, than cane sugar, and they have only about one-third the sweetening power. Boiled with a solution of caustic potash, they quickly produce a deep brown liquid, and they have the power of reducing the hydrated oxide of copper, when heated therewith in an alkaline solution. These characters are distinctive of it, and will serve to recognise it in the brown sugars of commerce.

10. *Mustard* is generally so acrid and powerful in its flavour that it is commonly diluted with flour, or other farinaceous matter, turmeric being added to improve its appearance. The mixture is recognised by means of the microscope, when the granules of starch and the colouring matters of turmeric are easily seen. Genuine mustard does not contain starch, and therefore does not become blue when it is treated with a solution of iodine.

11. *Spices*, as pepper, cinnamon, curry powder, ginger, cayenne, &c., are more or less the subjects of fraudulent adulteration, which can readily be detected by the microscope, and by an examination of the mineral constituents. Formerly, pepper was ground by the retail dealer, and then there was no excuse for the presence of adulterating agents; but in 1856, the wholesale dealer undertook the business of grinding, and from that time adulteration has been on the increase. In some cases, the article does not contain a trace of pepper, but is made up of gypsum, mustard husk, and a little starch. In the *Ninth Report of the Commissioners of Inland Revenue*, there is a statement by Mr Phillips, the chief chemist of the Excise, that he found a sample of so-called pepper containing 25 per cent. gypsum, the rest being mustard husks and a little cereal starch, without a trace of pepper. Another sample consisted of 16 per cent. gypsum, 44 mustard husks, a little cereal starch, and the rest pepper. Four other samples, closely resembling pepper, so as to deceive an inexperienced eye, were found to contain about 22 per cent. of gypsum, with sand, starch, and mustard husk. Linseed meal and powdered capsicums are likewise used for adulterating pepper. The chief sophistications of ginger powder are sago-meal, ground rice, and turmeric; while the colouring agents of curry powders and cayenne are ferruginous earths, brick dust, and even vermilion and red-lead. Spices, too, are sometimes exhausted of their active properties before they are ground and sold to the public.

12. *Beer, Ale, and Porter.*—The assize of ale is contemporaneous with that of bread, being described as the "*Assisæ Panis et Cervesiæ,*" in old documents. In the statute 51 Henry III. c. 16 (1266), they are spoken of as ancient and well-known institutions, the object of them being to regulate the quality and price of these articles. The officers appointed to determine the goodness of ale were called "ale conners," or "ale tasters" (*gustatores cervisiæ*), and were elected annually in the court-leet of each manor, and in the city of London at the ward-mote, according to the advice and assent of the alderman and other reputable men of the ward. Very specific instructions are given in *Liber Albus* of the business of the brewer, and of the penalties for any default thereof—it being ordained that no ale should be sold without having been tasted and approved by the ale conners of the district. Even now these officers are elected in the city of London with the old formalities, but the real duty of examining the quality of ale, beer, and porter has for many years been in the hands of the Excise. As far back as the time of Anne there was a law prohibiting the use of *Cocculus indicus* or any unwholesome ingredient in the brewing of beer, under severe penalties, the brewer being restricted to the use of malt and hops alone; but gradually, as the taste for porter came into fashion (since 1730), and during the French war, when the price of malt was very high, certain colouring matters prepared from burnt sugar were allowed to be used, and this at last became so necessary to the trade, that it was legalised by the Act 51 Geo. III. c. 51. Five years after, however, it was prohibited by the statute 56 Geo. III. c. 58, which declared that after the 5th of July 1817, no brewer, or dealer, or retailer of beer, shall receive, or use, or have in his possession or custody, any liquor, extract, or other material or preparation, for the purpose of darkening the colour of worts or beer, other than brown malt. He was also prohibited from using molasses, honey, liquorice, vitriol, quassia, *Cocculus indicus*, grains of paradise, guinea pepper, or opium, or any extract or preparation of the same, or any substitute for malt or hops, under a penalty of £200; and no chemist or vendor of drugs was permitted to sell, send, or deliver any such things to a brewer or retailer of beer under a penalty of £500. Later still, in 1830, the Act for permitting the general sale of beer and cider by retail in England (1 Will. IV. c. 64), declares that if any person so licensed shall knowingly sell any beer, ale, or porter, made otherwise than from malt and hops, or shall mix, or cause to be admixed, any drugs or other pernicious ingredients with any beer sold in his house or premises, or shall fraudulently dilute or in any way adulterate any such beer, &c., shall for the first offence forfeit and pay a sum of from £10 to £20, and for the second offence shall be adjudged disqualified from selling beer, ale, or porter for two years, or forfeit a sum of from £20 to £50; and the same regulations applied to cider and perry. The execution of these acts rested with the Excise, and it would seem that three classes of adulterations were practised, namely, 1*st*, Those which gave fictitious strength to the beer, as *Cocculus indicus*, tobacco, opium, &c.; 2*d*, Those which improved the flavour and body of the beer, as grains of paradise, capsicum pods, ground ginger, coriander seeds, caraway seeds, sweet flag, liquorice, molasses, and salt; and, 3*d*, Those which gave bitterness, as quassia, chiretta, horehound, gentian, &c. In London the publicans were not in the habit of practising the first kind of adulteration, but confined themselves to the second and third. In the country, however, according to Mr Phillips, it was quite otherwise, especially with brewers who retailed their own beer; for he found that they frequently used tobacco and *Cocculus indicus*. He even thinks that the cases of brutal and purposeless violence which were so often recorded were referable to the maddening influence of these ingredients. By the Act 24 and 25 Vict. c. 22 (1863), when the duty on hops was relieved, these bitters and substitutes were permitted, and so also was sugar, provided the full duty of 12s. 8d. per cwt. was paid upon it. Later still, by the Licensing Act 1872 (35

and 36 Vict. c. 94), provision is made to protect the public from the adulteration of beer; for it prohibits the possession, sale, or use of beer adulterated with *Cocculus indicus*, chloride of sodium (otherwise common salt), copperas, opium, Indian hemp, strychnine, tobacco, darnel-seed, extract of logwood, salts of zinc or lead, alum, and any extract or compound thereof, under a penalty of £20 for the first offence, and £100 for the second offence, together with disqualification of both the dealer and the house for a certain period. The police and the officers of Inland Revenue are empowered to search for and obtain samples of such beer, and the analyst is a person appointed by the Excise. The tests for the adulteration of beer, ale, and porter, are not easily applied except by a skilled chemist; but it may be said that the chief qualities of good beer are its density, sweetness, spirituosity, piquancy, flavour, and frothiness. The density of ale and beer ranges from 1008 to 1020 (water being 1000)—the average being 1015; and in the case of porter it ranges from 1015 to 1020. The amount of alcohol in these beverages ranges from 5 to 9 per cent., the average being about 7. The solid extract is from 4 to 6 per cent., and the ash or mineral matter is from 0·2 to 0·3 per cent. very little of which should be common salt.

13. *Malt.*—The Excise do not permit malt to be adulterated with ungerminated grain; but it is very difficult to determine whether the presence of these grains is accidental or otherwise, as in some wet seasons when barley is badly stacked it will heat or become mouldy, and the grains will lose their vitality. Even if the grain is dried artificially at a temperature of from 140° to 150° Fahr., the vitality of the seed will be destroyed. In some seasons as much as from 34 to 70 per cent. of the grain will be killed. Roasted unmalted grain, instead of the malted, is prohibited by 19 and 20 Vict. c. 34, but there is no doubt that the substitution is largely practised.

14. *Wine and Spirits.*—The denunciations in the Scripture against the use of mixed wine have reference, in all probability, to wines which were fortified or adulterated with stimulating and intoxicating herbs. In this country measures were taken at a very early period to prevent the sale of unsound and unwholesome wine. The Vintners' Company, for example, which was incorporated in the reign of Edward the Third, under the name of the "*Wine Tonners*," had control over the price and purity of the article, there being chosen every year "persons of the most sufficient, most true, and most cunning of the craft (that hold no taverns)," who were to see to the condition of all wines sold by retail, and who were to govern the taverners in all their proceedings. Bad or adulterated wine was thrown into the gutters, and the possessors thereof were set in the pillory. It would seem that the wine which was most adulterated was that called Gascoign; for in the tenth year of the reign of Henry the Sixth (1432), there was a petition to the king on the subject, praying him to amend the same. Stowe, in fact, says "that in the 6th of Henry VI., the Lombardes currupting their sweete wines, when the knowledge thereof came to John Ranwell, maior of London, he, in divers places of the citie, commanded the heades of the buts and other vessels in the open streetes to be broken, to the number of fifty, so that the liquor running forth passed through the citie like a stream of raine water, in the sight of all the people, from whence there issued a most loathsome savour." In modern times the art of adulterating wine has been brought to great perfection; for it consists not merely in the blending of wines of different countries and vintages, but in the use of materials which are entirely foreign to the grape. Port wine, for example, is manufactured from Beni Carlos, Figueras, and red Cape, with a touch of Mountain to soften the mixture and give it richness—the body and flavour being produced by gum-dragon, and the colour by "*berry-dye*," which is a preparation of German bilberries. To this is added the washings of brandy casks ("*brandy cowe*") and a little salt of tartar to form a crust. Sherry of the brown kind and of low price is mingled with Cape and cheap brandy, and is flavoured with "brandy-cowe," sugar-candy, and bitter almonds. If the colour be too high it is lowered by means of blood, and softness is imparted to it by gum-benzoin. Pale sherries are produced by means of plaster of Paris or gypsum, by a process called "plastering," and the effect of it is to remove the natural acids (tartaric and malic), as well as the colour of the wine. In this way a pale, dry, bitter, and sub-acid wine is produced, charged with the sulphates of lime and potash. Large quantities of what are called clarets are manufactured in this country from inferior French wine and rough cider, the colour being imparted to it by turnsol or cochineal. Madeira is produced from Vidonia with a little Mountain and Cape, to which are added bitter almonds and sugar. Even Vidonia and Cape are adulterated with cider and rum—carbonate of soda being used to correct the acidity. Common Sicilian wine is transformed into Tokay, Malaga, and Lachryma Christi. Champagne is produced from rhubarb stalks, gooseberries, and sugar, the product being largely consumed at balls, races, masquerades, and public dinners. Of late, too, since the investigations of Petiot, Thenard, Gall, Hussman, and others, the manufacture of wine from sugar and the refuse husk or mark of the grape has been largely practised, insomuch that a great part of the wine of France and Germany has ceased to be the juice of the grape at all. In point of fact, the processes of blending, softening, fortifying, sweetening, plastering, &c., &c., are carried on to such an extent that it is hardly possible to obtain a sample of genuine wine, even at first hand; and books are written on the subject, in which the plainest directions are given for the fabrication of every kind of wine, there being druggists called "brewers' druggists," who supply the agents of adulteration. These are as follow:—Elderberry, logwood, brazil-wood, red saunders-wood, cudbear, red beet-root, &c., for colour; litharge, lime or carbonate of lime, carbonate of soda, and carbonate of potash, to correct acidity; catechu, logwood, sloe-leaves, and oak-bark, for astringency; sulphate of lime, gypsum, or Spanish earth, and alum for removing colour; cane sugar for giving sweetness and body; glucose or starch sugar for artificial wine; alcohol for fortifying; and ether, especially acetic ether, for giving bouquet and flavour. The tests for these agents are not readily applied, except by the professional chemist; but they are promptly recognised by the stomach and the brain, for good wine, though it may intoxicate, rarely leaves a disagreeable impression. In a general way, it may be said that the specific gravity of genuine wine ranges from 991 to 997; and the amount of alcohol in it never exceeds 20 per cent. by volume. The solid residue in it, when evaporated to perfect dryness, amounts to from 1·33 to 2·15 per cent. in Rhine wines, and in the light wines of France; to from 2·85 to 3·73 per cent. in Teneriffe and Cape; to from 3·49 to 4·54 per cent. in sherry and Madeira; and to from 3·75 to 5·24 in port. Sweet wines, as Lachryma Christi, Muscat, Malaga, Tokay, Bergerac, champagne, and the wines of the Palatinate, contain a much larger percentage of solid matter in them. The ash, or involatile constituents of wine, should range between 0·19 and 0·5 per cent. It should be strongly alkaline, and should consist of carbonate, sulphate, and phosphate of potash, chloride of sodium, carbonate of lime, and a little alumina. As a distinctive mark of genuine wine, the ash is of the greatest value. Again, pure wine gives but slight precipitates with oxalate of ammonia, with acid nitrate of silver, and acid nitrate of baryta. The

colouring matters of wine may be separated and analysed by the process of Mulder, which is too elaborate for description in this place, and so also are the tests for recognising spurious colours, as the test of Vogel, Jacob, and others (solutions of acetate of lead), that of Pelouze and Frenny (basic acetate of lead); of Ness von Esenbeck (solutions of alum and of carbonate of potash); of Batilliat (ammonia); of Filhol (ammonia and sulphide of ammonium); and others. At present, the spectroscope has not furnished, as was expected, any very reliable indications of the nature of the colouring matters of wine. In fact, the whole subject requires fuller investigation. The adulteration of spirits consists mostly in the addition of water and in the use of inferior spirit, recipes being given in the *Publican's Guide*, and other such books, for what is called making up spirits for sale. The recognition of these frauds rests with the Excise, under the Act 35 and 36 Vict. c. 94.

15. *Tobacco and Snuff.*—The adulteration of these articles is prohibited and otherwise provided for by the statutes 5 and 6 Vict. c. 93, and 25 and 26 Vict. c. 7, and 30 and 31 Vict. c. 90, manufacturers of tobacco and snuff being prohibited from using or having in their possession sugar, honey, molasses, treacle, leaves, herbs, or plants, powdered wood, moss, weeds, sea-weeds, or any ground or unground roasted grain, chicory, lime, sand, umbre, ochre, or other earths, nor anything capable of being used to increase the weight of tobacco or snuff, under a penalty of £200—water alone being allowed in the manufacture of tobacco; and water, salt, and alkaline salts, as well as lime in the manufacture of snuffs, under a penalty of £300. But it appears from the reports of the Commissioners of Inland Revenue, that the adulteration of tobacco and snuff is still largely practised. Tobacco is adulterated with molasses, sugar, aloes, liquorice, gum, catechu, oil and lamp-black, alum, tannic acid and iron, logwood, and such leaves as rhubarb, chicory, cabbage, burdock, colts-foot, and excess of salt and water. In the year 1862 it was discovered that certain Irish manufacturers were adulterating their Cavendish and roll-tobacco with liquorice, in imitation of the sweetened Cavendish of North America, and therefore in 1863 the practice was legalised in the case of Cavendish and negro-head by the Manufactured Tobacco Act, 1863. Snuffs are adulterated with excess of alkaline salts, lime, sand, ferruginous earths, fustic, torrefied oatmeal, peat-moss, ground velonia cups, bichromate of potash, and chromate of lead. Mr Phillips states, in the *Fourth Report of the Commissioners of Inland Revenue*, that up to 1856 the practice of adulterating snuff was very prevalent, particularly in Ireland—52 per cent. of the samples analysed being found to be illicit; in 1858 and subsequently, however, the proportion has been much less. These adulterations are recognised by drying the sample, and noting the loss of weight, and by the amount and nature of the ash left on incineration. Foreign leaves, &c., are discovered by the aid of the microscope.

16. Among the adulterations which are practised for the purpose of improving the appearance of the article, and giving it a false strength, are the following:—The addition of *alum* or *sulphate of copper* to bread; the facing of black tea with *black lead*, and of green with a mixture of *indigo* or *Prussian blue* with *turmeric* and *china clay;* the treatment of pickles and preserved fruits with a *salt of copper*, which has the property of mordanting and brightening the green colouring matter of vegetables. In some cases the quantity of copper has been so large as to give a coppery appearance to a steel knife or fork kept in the pickle; but at all times the metal may be discovered by the pink colour of the ash, and by its becoming blue when treated with a little strong ammonia. *Ferruginous earths* are added to sauces, anchovies, potted meats, and the preparations of cocoa. This also is recognised by the amount and colour of the ash. *Mineral pigments*, as yellow and orange *chromate of lead*, green *arsenite of copper*, &c., are frequently used in colouring confectionery, and have produced serious results to those who have eaten it. Lastly, with a view of giving false strength to the article, *sulphuric acid* has been added to vinegar and lime-juice; *black jack* or *burnt sugar* to coffee and chicory; *catechu* or *terra japonica* to exhausted tea; *Cocculus indicus* to beer and porter; cayenne and mustard husks to pepper, &c.

17. Adulterations are also practised for the purpose of debasing the article, as when the cream is taken from milk by the process of skimming; or when the active principles of spices, &c., have been removed by distillation.

18. Accidental adulterations may occur from the admixture of darnel or ergot with flour; siliceous and earthy matters with substances that are ground in a mill; mould or acari with flour, sugar, cheese, &c.; and copper, zinc, or lead may be accidentally derived from the vessels in which any acid substance or liquid has been prepared or kept. In this manner cider and wine have become tainted with lead; sour milk with zinc; and jellies, jams, and preserves with copper.

19. *Adulteration of Cattle Foods.*—In a recent trial, where the question of adulteration was raised, a linseed-cake maker stated in evidence that his ordinary oil-cake consisted of 50 parts ground sesamé cake, 20 parts of bran, and 30 of linseed and linseed siftings. To prevent the detection of this fraud by an examination of the cake with the naked eye, it is customary to powder the materials very fine by means of a machine called a "Buffein machine," after which they are thoroughly mixed together and pressed into a cake. It would seem, indeed, that pure linseed cake is not saleable, except in a few localities, as in the neighbourhood of Gainsborough, and in the agricultural centres of Lincolnshire and Norfolk, where the genuine cake is appreciated. Elsewhere the adulterated article commands a ready sale, on account of its low price; and thus encouragement is given to the use of all sorts of adulterating agents, as earth-nut, cotton, beech, and sesamé bran, rice-husks, oat-dust, and other such worthless matter. Very recently this important subject has been treated by Dr Voelcker in a paper "On the Characters of Pure and Mixed Linseed Cakes," which was published in the *Journal of the Royal Agricultural Society of England* (vol. ix. part 1). Some of the impurities of linseed cake may be due to the accidental presence of the seeds of various weeds and wild plants, which the careless farmer has allowed to grow upon his land. Most of these, however, are easily removed by one or two siftings, as in the case with clean linseed; but the siftings are not thrown away; they are used for adulterating other samples of linseed—making the second, third, and even fourth qualities of Riga and St Petersburg seed. Occasionally the siftings are sent out to sea in barges to meet the vessels coming from the north with linseed on board; there the mixture is made; and when the vessels reach the port for which they are destined, the cargo is sold for genuine linseed "as imported." But besides these impurities, the linseed cake of commerce contains a large proportion of other cakes, as rape, earth-nut, decorticated and undecorticated cotton seed, beech-nut, hemp-seed, cocoa-nut, cocoa, palm-nut, palm-kernels, niger seed, sesamé or teal seed, poppy, castor oil, bassia, curcas, indigo seed, olive, &c., besides bran, acorns, careb-beans, and the husks or shades of earth-nut, oats, barley, rice, and other refuse. Some of these things are actually poisonous to cattle, as in the case of castor-oil cake, curcas bean, purging flax, wild mustard, wild radish, &c.; others are of doubtful quality, as corn cockle, darnel, indigo seed, earth-nut, &c.; and many are disagreeable to the taste, on

account of rancidity and other properties, as cocoa-nut cake, palm-nut cake, bassia cake, &c.; while many are so charged with woody matters as to be indigestible and irritating in their action, as cotton, olive, palm-nut, husks of rice, cocoa-nut fibre, saw-dust, &c. These impurities are sometimes easily recognised by the naked eye, or by a lens of low power. At other times the colour of the cake is an indication of its impurity. The taste of it also is frequently characteristic; for while linseed has a sweet mucilaginous taste, rape seed is turnipy, mustard acrid, dodder like garlic, bassia bitter, &c. Then, again, the action of a little warm water will develope the flavour of impurities—rape giving off a strong odour of turnip, mustard its well-known acrid flavour, wild radish and other impurities their characteristic smells. When examined chemically it is found that adulterated and dirty cakes show a deficiency of oil and albuminous matter, and a large excess of woody fibre and mineral substance. In good cake the moisture ranges from 10 to 14 per cent., the oil from 10 to 15, the albuminous matter from 25 to 35, the mucilage, sugar, and digestible fibre to from 20 to 30 per cent., the woody fibre to from 9 to 14, and the mineral matter or ash to from 6 to 8 per cent. Cake that has been shipped too fresh is apt to heat and become mouldy; in which case it will lose its fine aroma, and be of inferior quality: it may even be injurious to animals feeding on it.

20. *The Adulteration of Seeds*, in fraud of her Majesty's subjects, and to the great detriment of agriculture, has been provided for by the Act 32 and 33 Vict. c. 112, wherein it is prohibited to kill, dye, or to sulphur seeds, or any way to give them a false appearance, under a penalty of £5 for the first offence, and £50 for the second. But for all this extensive frauds are practised: turnip seed is adulterated with rape, wild mustard or charlock, the vitality of which has been destroyed by kiln-drying at a high temperature; old turnip seed (kiln-dried) is also used for diluting fresh seed; and it is notorious that such seed can be obtained in commerce by the ton. Again, clover seed is often killed and dyed—one of the commonest frauds being to dye trefoil, and to sell it for red clover; the pinkish or yellowish-brown tint and metallic look being given with a weak solution of logwood and alum, or with a strong solution of logwood alone, and then it is shaken up with a little black lead. Another trick is to dye white clover seed with a weak solution of indigo, and thus to make it look like hybrid clover which has a bluish-green colour. When trefoil and white clover seed have become changed by age and have lost their yellowish colour, they are dyed with infusion of turmeric, and then toned down with the fumes of burning sulphur; in fact, these fumes are used to brighten up all sorts of seeds that have become brown by keeping, but they destroy the vitality of the seed.

21. *Adulteration of Drugs*.—This at all times has been considered a serious offence. In the city of London, the president and censors of the College of Physicians have power to search for apothecaries' wares, drugs, and stuffs, and on finding them defective, corrupted, and not meet nor convenient to be ministered in any medicines for the health of man's body, they are to destroy them, and are to correct and punish the offenders by committing them to prison, and amercing them in a penalty not exceeding £20. These wholesome powers were granted to the college by the Acts 14 and 15 Hen. VIII. c. 5, and 32 Hen. VIII. c. 40, and 2 Mary, c. 9; but although they are still in force, and might be advantageously exercised, yet they have long since fallen into disuse; and if it had not been for the laudable efforts of the Pharmaceutical Society of Great Britain, there would have been no practical remedy for the adulteration of drugs. The Society was founded in 1841, for the purpose of advancing the status and education of those who were engaged in the preparation and sale of medicines, and it was incorporated by Royal Charter in 1843. A few years after, in 1852, the qualifications of pharmaceutical chemists were regulated by Act of Parliament (15 and 16 Vict. c. 56), and in 1868 it was further provided, by the 31 and 32 Vict. c. 121, that no person should be permitted to engage in the sale or dispensing of medicines, or to use the title of chemist and druggist, or dispensing chemist, or pharmaceutist, without being duly qualified, and registered as a pharmaceutical chemist. The adulteration of medicine was also prohibited by the incorporation of the Adulteration of Food and Drink Act 1860 (23 and 24 Vict. c. 84), it being declared that such adulteration should be deemed an admixture injurious to health. More recently, in 1872, the Act 35 and 36 Vict. c. 74, renders it penal for any one to adulterate a drug for sale, or to sell such drug. In the first case the penalty is a sum not exceeding £50, together with the costs of the conviction; and for a second offence he shall be guilty of a misdemeanour, and be imprisoned for a period not exceeding six calendar months, with hard labour. In the second case, the seller of an adulterated drug is subject to a penalty not exceeding £20, together with costs; and for a second offence he shall have his name, place of abode, and offence published in any manner that the justice thinks fit. The chief adulterations and debasing of drugs are the following:—In the case of vegetable substances, as jalap, opium, rhubarb, cinchona bark, &c., foreign substances are added to make up for the loss of weight in drying and powdering, there being in many cases a trade allowance of only four per cent. for such loss, whereas in almost all cases it exceeds this. Roots, seeds, and barks, for example, lose from 6 to 9 per cent., scammony 7 per cent., aloes 9, sarsaparilla 10, squills 12, and opium from 15 to 25 per cent. At other times foreign substances are added to assist the grinding, or to improve the appearance of the article. Occasionally the active principles are removed, or the medicine has become worthless from keeping or from faulty preparation. In the case of the alkaloids, inert substances, as sugar, starch, gum, &c., are mixed with them to increase their weight and bulk. Lastly, the activity of a vegetable drug may greatly depend on its mode and place of culture. With respect to mineral preparations, there is even a still larger field for adulteration, insomuch that the purity of the article is entirely regulated by the wholesale price of it. Again, directly after the Act of 1856 (18 and 19 Vict. c. 38), which permitted the sale of methylated spirit—that is, inferior spirit mixed with wood-naphtha, duty free for manufacturing purposes—advantage was taken of it by many chemists and druggists, and the cheap spirit was used for making tinctures and other medicinal preparations. This, however, came at last to be so serious and dangerous a practice, and was withal so great a fraud on the revenue, that means were taken to suppress it by the Act 29 and 30 Vict. c. 64, wherein it is provided that such spirit shall not be used in any medicinal preparation, except in the manufacture of chloroform, ether, and the vegetable alkaloids, or in the preparation of other things whereby the spirit was afterwards entirely dissipated. But Mr Phillips remarks, in the *Ninth Report of the Commissioners of Inland Revenue*, that a few instances have been discovered of the sale of drinks under the names of "Indianna brandee," "medicated whiskee," "pure Islay mountain," "Indian tincture," &c., the exciting principle of all of which was found to be hyponitrous ether prepared from methylated spirit. In the case of a drink called "Hollands whiskee," it was produced by distilling the methylated spirit with a little nitric acid, and then sweetening with treacle, and flavouring with rhubarb, chloroform,

fœnugreek, &c., so as to conceal its real character; and notwithstanding its disagreeable flavour, it got into public favour in some districts, especially in Ireland, and was largely sold as a cheap means of producing intoxication.

22. *The Adulteration of Textile Fabrics.*—Woollen goods have for years past been largely adulterated with refuse fibres called "shoddy" or "mingo." The practice was denounced by Latimer in one of his sermons at Paul's Cross, preached before king Edward in 1635, wherein he spoke of it as the devil's artifice, saying that they were wont to make beds of flock, but now they had turned it into dust, which he aptly called "Devil's dust," and that the cloth worker did so incorporate it to the cloth that it was wonderful to see. The practice is still in vogue, for there is hardly a piece of cheap cloth without it. Shoddy as originally used was merely the fluff or waste from the looms, but now it consists of any kind of woollen rubbish, as old blankets, stockings, &c., pulled to pieces in a machine called the "Devil." Mingo is even a shorter description of fibre, and is made in the same way from old rags. No less than forty millions of pounds of these are made annually in Yorkshire, at an estimated value of eight millions sterling, and all of it is used for adulterating woollen cloth. There is even another kind of refuse called "extract," which is employed for the same purpose. It consists of the wool obtained from the rags of mixed goods; that is, goods which have a cotton or linen warp blended with wool. The cotton is destroyed by chemical agency, chiefly by means of dilute sulphuric acid, and the wool is left intact.

The cotton fabrics and gray goods of Lancashire and Yorkshire are largely adulterated with size and china clay, the object being to give them increased weight and substance. Up to about twenty years ago the sizing of cotton goods was effected with a mixture of fermented flour, paste, and tallow, by which means the tenacity of the warp was increased and the friction of weaving was lessened. To effect this about 20 per cent. of size was used; but in 1854, when tallow became dear in consequence of the Russian war, a substitute was found in china clay. Later still in 1862, when the cotton famine began to be felt, and the long-fibred American cotton grew scarce, it was found necessary to give tenacity to the twist made from shorter fibre by using more size. In this manner as much as from 50 to 90 per cent. of size has got to be used, the greater part of it being china clay, with a certain proportion of hygroscopic matter, such as chloride of magnesium, to keep the material damp and supple. The impurity is easily detected by washing the cloth, and ascertaining the loss of weight before and after the operation. Cheap calicoes are also largely impregnated with lime, which has been used in the process of bleaching, and left in them. A cloud of dust flies out of such fabrics when they are torn. Silk also is made heavier and stouter by the incorporation of dye stuffs used expressly for the purpose. This is generally the case with dark-coloured silks, black and brown, as lighter shades will hardly admit of it; as much indeed as half the weight of the silk may be thus incorporated with it.

23. *Falsification of Coin and Precious Metals.*—In Anglo-Saxon times the debasing or counterfeiting of coin was punished by the loss of the hand. In later times it has been criminal in the highest degree. By the statute 24 and 25 Vict. c. 99, the counterfeiting of gold or silver coin is felony, and in Scotland is a high crime and offence. Hardly less severe is the punishment for debasing, diminishing, lightening, or impairing the value of the current coin of the realm; and very effectual means are taken to secure their standard value when put into circulation. In the first place, an officer is appointed by the Crown to superintend the coinage, and to be answerable for its goodness. (See MINT and COINAGE.) In the second place, the coin is tested, as to its weight and fineness, by persons skilled in the goldsmith's craft. (See ASSAY.) But notwithstanding this, the coins of the realm, as issued from the mint, have often been debased to a considerable extent; for, according to Lord Liverpool, the total debasement of the silver money of this country, from the time of the Conquest to the reign of Elizabeth, was not less than 65 per cent. It is notorious that in Spain, Austria, and Turkey the degradation of the silver coin, even at the present time, is carried to a serious extent. By the Coinage Act 1870 (33 and 34 Vict. c. 10) the composition and weight of all the coins of this country are strictly provided for; and in the case of gold coin, the limits or "remedy" of fineness and weight are exceedingly narrow. The composition of the coin is fixed at eleven-twelfths fine gold, and one twelfth alloy (copper); so that in 1000 parts of our gold coin there are 916·66 parts of fine gold. This is called its millesimal fineness, and the allowance for error in composition is limited to 0·002 per 1000 parts. The weight of the sovereign is fixed at 123·27447 grains, and the limit of error in weight is the 0·2 of a grain; and in proportion with all other gold coins. In the case of silver coins, the composition is thirty seven fortieths of fine silver, and three-fortieths of alloy (copper)—the millesimal fineness being therefore 925 parts of silver; the remedy or allowance of fineness is just twice that of gold—namely, 0·004 per 1000 parts. The weight of the silver coin is at the rate of 87·27272 grains per shilling of value; and the remedy or allowance of error is confined to 0·36363 of a grain per shilling. Lastly, the bronze coinage of the country consists of 95 parts copper, 4 tin, and 1 zinc: the weight of a penny being 145·83333 grains; and the allowance for error is 2·91666 grains per penny. The specific gravity of the several descriptions of coin is 17·53 for gold, 10·35 for silver, and 8·89 for bronze. So accurate are the composition and weight of the coins issued from the mint at the present time, that at the last trial of the "Pyx" in July 1871, the jury reported that every piece separately examined (representing many millions sterling) was found to be accurately coined in regard to weight and fineness. In the case of the gold coin, the fineness ranged from 916·2 to 917 parts per 1000. These, indeed, were the extremes of only 2·66 per cent. of the coins examined, the great bulk of them, namely 72·65 per cent. having a fineness of from 916·5 to 916·7 per 1000. Now, when it is considered that the composition of an alloy of gold and copper can be ascertained to the one-ten thousandth part, and that the delicacy of a balance is to the thousandth part of a grain, it must be evident that the accuracy and perfection of coining in this country are remarkably precise. As, however, the weight of gold and silver coin must become less by continual wear, the Acts 22 and 25 Vict. c. 99, and 33 and 34 Vict. c. 10 provide for it. It does not appear that the practice of debasing coin is carried on to any great extent in this country; for in the second Annual Report of the Deputy-Master of the Mint (1871), the chemist of the Mint (Mr W. Chandler Roberts) says that only two sovereigns were submitted to him, the weight of which had been fraudulently reduced by means of a solvent, aided by electricity. In former times, however, the process of "sweating" was very frequently employed.

The adulteration of precious metals was prohibited and provided for by the rules and regulations of the various guilds and corporations which took cognizance of the goldsmiths' craft. As early as the 26th of Henry II. (1180) the Goldsmiths' Company of London was founded, and in 1327, when it was incorporated, it was invested with the privilege and power of inspecting, trying, and regulating all gold and silver wares throughout the king-

dom, and of punishing all offenders who were found guilty of working adulterated gold or silver. The chief offenders appear to have been the cutlers, who were charged with covering base metal in such a manner that it could not easily be detected. It was therefore provided that all manner of vessels of gold and silver should be of "good and true alloy;" and power was given to the company to "go from shop to shop to assay if the gold was good," and finding that it was not of the right touch, it was to be seized and forfeited for the king. Subsequently, by the statute of 2 Henry VI. (1424), it was provided that none should work gold unless it be as good as the alloy of the "mystery," and that silver wares should be as good or better than the king's coin. It was further provided, that when the goods were finished they should be brought to the Hall to be assayed; and when found of the right touch it should be stamped with the owner's and assayer's marks, as well as with the "Liberdshede crowned." These powers have been confirmed in numerous Acts of Parliament, the most important of which are the following:—12 Geo. II. c. 26 (1739), which provides that no goldsmith, silver smith, or other trader shall work or make any vessel of gold of less than 22-carat fineness (that is, 22 parts of fine gold to 2 parts of alloy), nor any silver vessel or plate of less than eleven ounces and two pennyweights of fine silver, and 18 pennyweights of alloy, in a pound troy, under a penalty of £10. But this does not extend to jewelry, earrings, gold springs, lockets, &c. It also provides for the proper assaying and stamping of the same. In 1784, the Act 24 Geo. III. c. 53, made provision for imposing a duty on the article assayed and stamped, and from that time the king's or queen's head has appeared as a mark. In 1798, the Act 38 Geo. III. c. 69, gave permission for a lower standard of gold, namely 18-carat gold (that is, 18 parts of fine gold to 6 of alloy); and by the Act 7 and 8 Vict. c. 22 (1844), the penalty for using false stamps, &c., was ameliorated. Lastly, by the Act 17 and 18 Vict. c. 96, three still lower standards of gold were permitted, namely 15-carat gold, 12-carat gold, and 9-carat gold, each of which was to be designated by the number and the decimal. At present, therefore, all gold and silver plate, as well as wedding and mourning rings, must be assayed and stamped before their sale; and other articles may be assayed and stamped in like manner at the option of the maker or dealer. The stamps or marks impressed on gold are the following, namely,—1*st*, The initials of the maker's name; 2*d*, The duty mark (a king's or queen's head); 3*d*, The crown and standard number, indicating the quality of the gold; 4*th*, The assayer's stamp (a leopard's head for Goldsmiths' Hall); and 5*th*, The letter denoting the year of assay. In the case of silver, the stamps are—1*st*, The initial letters of the maker; 2*d*, A lion; 3*d*, The assayer's stamp (in London, a leopard's head); 4*th*, The letter indicating the year of assay; and 5*th*, The duty mark (a king's or queen's head). Silver goods of higher value, that is, with a mixture of 11 ounces and 10 pennyweights of fine silver, instead of 11 ounces and 2 pennyweights, is called new sterling, and is, as formerly, marked with a figure of Britannia, and a lion's head erased. As in olden times, the Goldsmiths' Company have still power to break, cut, or otherwise destroy all gold and silver plate which is below the legal standard. (H. L.)

ADULTERY (from the Latin *adulterium*) is the sexual intercourse of a married person with another than the offender's husband or wife. Among the Greeks, and in the earlier period of Roman law, it was not adultery unless a married woman was the offender. The foundation of the later Roman law with regard to adultery was the *lex Julia de adulteriis coercendis* passed by Augustus about B.C. 17. (See *Dig.* 48, 5; Paull. *Rec. Sent.* ii. 26; Brisson, *Ad Leg. Jul. de Adult.*) In Britain it has been reckoned a spiritual offence, that is, cognisable by the spiritual courts only. The common law took no farther notice of it than to allow the party aggrieved an action of damages. In England, however, the action for "criminal conversation," as it was called, is nominally abolished by 20 and 21 Vict. c. 85, § 59; but by the 33d section of the same Act, the husband may claim damages from one who has committed adultery with his wife in a petition for dissolution of the marriage, or for judicial separation, or in a special petition for the purpose in the Divorce Court. In Scotland damages may be recovered against an adulterer in an ordinary action of damages in the civil court, and the latter may be found liable for the expenses of an action of divorce if joined with the guilty spouse as a co-defender.

Adultery is, both in England and Scotland, a ground of divorce. In England, a *complete* divorce or dissolution of the marriage could, until the creation of the Court of Probate and Divorce by 20 and 21 Vict. c. 85, be obtained only by an Act of Parliament. In Scotland a complete divorce may be effected by proceedings in the Court of Session, as succeeding to the old ecclesiastical jurisdiction of the commissioners. A person divorced for adultery is, by the law of Scotland, prohibited from intermarrying with the paramour. See DIVORCE.

ADVENT, the period of the approach of the nativity, lasting, in the Greek Church, from St Martin's Day (Nov. 11), and, in other churches, from the Sunday nearest to St Andrew's Day (Nov. 30) till Christmas. The observance of it dates from the 4th century, and it has been recognised since the 6th century as the commencement of the ecclesiastical year. With the view of directing the thoughts of Christians to the coming of Christ as Saviour, and to his second coming as Judge, special lessons are prescribed for the four Sundays in Advent. At one time Advent was observed almost as strictly as Lent, but the rule is now relaxed, and in the Church of England fasting is confined to the week in which Ember Day (13th Dec.) occurs. The phrase *second advent* is commonly used to denote our Lord's "appearing the second time, without sin, unto salvation," which is so often spoken of in the New Testament. Various opinions have been held as to the time and manner of this event. In the apostolic churches it was commonly regarded as imminent, though this was not the opinion of the apostle Paul, as may be gathered from 2 Thess. ii. 3, 4. The discussion in later times has centred itself chiefly round the question whether the second advent is premillennial or post-millennial.

ADVERTISEMENT (from the French *avertissement*, a giving notice, or announcement) denotes in a general sense any information publicly communicated through the press or otherwise. It is the profit derived from advertisements that supports the larger number of newspapers. While some of these drag out a sickly existence, others derive a large revenue from this source. The duty upon advertisements (which existed in Britain[1] previous to 1853) was not unjustly branded as a tax upon knowledge. It was certainly very unequal and oppressive, being the same upon the sale of an estate worth £100,000 as on a servant's notice wanting a place, upon an advertisement of a sixpenny

[1] There is no duty on advertisements in the United States, Germany, or France. In France, however, there is a duty of 10 per cent. on the raw paper, and a further duty of 20 per cent. on all newspapers printed.

pamphlet and an expensive book. Previous to 1833 the duty on each advertisement was 3s. 6d. in Great Britain, and 2s. 6d. in Ireland; in that year it was reduced to 1s. 6d. in Great Britain, and 1s. in Ireland. In 1832 (the last year of the high duty) the total number of newspaper advertisements in the U. K. was 921,943: viz., 787,649 in England, 108,914 in Scotland, and 125,380 in Ireland; the amount of duty paid in that year being £172,570. In 1841 the number of advertisements had increased to 1,778,957: viz., 1,386,625 for England, 188,189 for Scotland, and 204,143 for Ireland; and the total duty paid amounted to £128,318. In 1851 the amount of duty rose to £175,094, 10s. 8d.; being for England £142,365, 3s. 6d.; Scotland, £19,940, 11s.; Ireland, £12,788, 16s. 2d. In compliance with the all but unanimous voice of the public, this duty was abolished in 1853; since which time the system of advertising has increased to an unprecedented extent, in consequence of the low rate at which short advertisements are now inserted. To advertise advantageously requires both experience and judgment; without a knowledge of the character and circulation of the public journals, much expenditure may be wasted by advertising in papers that have either a limited or inappropriate circulation. The sale of some commodities (such as quack medicines) depends almost wholly on advertising, of which it has been said that if the vender has the courage to continue advertising to the extent of £20,000, he will make his fortune by a drug thoroughly worthless. Advertising often falls disproportionately on books, as it is necessary that new publications should be freely advertised. On small low-priced books the expense is particularly heavy, an advertisement of a one shilling book costing as much as one selling at twenty shillings. From this, and their generally ephemeral character, it may be said that ninety-nine out of a hundred pamphlets are published at a loss.

Interesting information on the subject of advertisements will be found in an article in the *Edinburgh Review* for 1st Feb. 1843, "On the Advertising System," and in the *Quarterly Review* for June 1855, "On the Rise and Progress of Advertisements, from the establishment of the Newspaper Press of this Country till the Present Time." In the latter article it is stated that the first advertisement occurs in the *Mercurius Politicus* for Jan. 1652, the subject of the advertisement being a heroic poem of congratulation on Cromwell's victories in Ireland. A writer in *Notes and Queries* for July 6, 1872, has found two examples of advertisements previous to that date, which occur in the *Mercurius Elencticus* of Oct. 1648. See also *The Newspaper Press*, by James Grant (2 vols., 1871), and the article NEWSPAPERS.

ADVOCATE (from the Latin *advocatus*), a lawyer authorised to plead the causes of litigants in courts of law. The word is used technically in Scotland in a sense virtually equivalent to the English term *barrister;* and a derivative from the same Latin source is so used in most of the countries of Europe where the civil law is in force. The *advocatus* of the Romans meant, as the word implies, a person whose assistance was called in or invoked. The word is not often used among the earlier jurists, and appears not to have had a strict meaning. It is not always associated with legal proceedings, and might apparently be applied to a supporter or coadjutor in the pursuit of any desired object. When it came to be applied with a more specific limitation to legal services, the position of the *advocatus* was still uncertain. It was different from, and evidently inferior to, that of the *juris-consultus*, who gave his opinion and advice in questions of law, and may be identified with the consulting counsel of the present day. Nor is the merely professional advocate to be confounded with the more distinguished *orator*, or *patronus*, who came forward in the guise of the disinterested vindicator of justice. This distinction, however, appears to have arisen in later times, when the profession became mercenary. By the *lex Cincia*, passed about two centuries before Christ, and subsequently renewed, the acceptance of remuneration for professional assistance in lawsuits was prohibited. This law, like all others of the kind, was evaded. The skilful debater was propitiated with a present; and though he could not sue for the value of his services, it was ruled that any *honorarium* so given could not be demanded back, even though he died before the anticipated service was performed. The traces of this evasion of a law may be found in the existing practice of rewarding counsel by fees in anticipation of services. In the Justinian collection we find that legal provision had been made for the remuneration of advocates. (*Dig.* lib. 50, tit. 12, § 10–13; Brissonius, *De Sig. Verb.;* Heineccius *ad Pand.* lib. iii. tit. 1.) The *advocatus fisci*, or fiscal advocate, was an officer whose function, like that of a solicitor of taxes at the present day, was connected with the collection of the revenue. (See generally on this subject Forsyth's *Hortensius*, London, 1849.) The term advocate is of frequent use in the chronicles, capitularies, chartularies, and other records of ecclesiastical matters, during the Middle Ages. (See Du Cange, s.v. *Advocati Ecclesiarum*, who affords a profuse supply of references to authorities.) The term was applied in the primitive church to those who defended the Christians against malignants or persecutors. As the church waxed rich and powerful, its temporal supporters assumed a more important position. The advocate, defender, or patron, was of a temporal rank, corresponding to the power of the ecclesiastical body who sought his advocacy. Princes sought the distinction from Rome; and it was as a relic of the practice of propitiating temporal sovereigns by desiring their protection that Henry VIII. received his title of "Defender of the Faith." The office of advocate to any of the great religious houses, possessed of vast wealth, was one of dignity and emolument, generally held by some feudal lord of power and influence. This kind of protection, however, was sometimes oppressive. In the authorities quoted by Du Cange we find that, so early as the 12th century, the advocates were accused of rapine and extortion; and by a capitulary of the popedom of Innocent III. they are prohibited from taking and usurping rewards and privileges beyond use and wont. The office at length assumed a fixed character in its powers and emoluments; and it became the practice for the founders of churches and other ecclesiastical endowments to reserve the office of advocate to themselves and their representatives. The term advocate was subsequently superseded by the word patron; but a relic of it still exists in the term *advowson*, and the word *advowee*, which is the form in which the Latin *advocatus* found its way into the technicalities of English law. Until lately, advocate was the proper designation of legal practitioners in the Probate and Admiralty courts, and still is the name given to those who practise in what remains of ecclesiastical courts. In France, corporations or faculties of avocats were attached to the parliaments and other tribunals. They formed, before the revolution, a part of the extensive and powerful body commonly called the nobility of the robe. It was not necessary that the avocat should be born noble, and his professional rank was little respected by the hereditary aristocracy; but as a middle rank, possessed of great powers and privileges, which it jealously guarded, the profession acquired great influence. In the *Encyclopédie Methodique*, the avocat is called "the tutelary genius of the repose of families, the friend of man, his guide and protector." The avocats, as a body, were reorganised under the empire by a decree of 15th December 1810. (See Camus, *Lettres sur la Profession d'Advocat;* A. Young, *The French Bar.*) In

France there is a distinction between *avocats* and *avoués*. The latter, whose number is limited, act as procurators or agents, representing the parties before the tribunals, draft and prepare for them all formal acts and writings, and prepare their lawsuits for the oral debates. The office of the *avocat*, on the other hand, consists in giving advice as to the law, and conducting the causes of his clients by written and oral pleadings. The number of avocats is not limited; every licentiate of law being entitled to apply to the corporation of avocats attached to each court, and after presentation to the court, taking the oath of office, and passing three years in attendance on some older advocate, to have himself recognised as an advocate. The Faculty of Advocates is the collective term by which the members of the bar are known in Scotland. They professionally attend the supreme courts in Edinburgh; but they are privileged to plead in any cause before the inferior courts, where counsel are not excluded by statute. They may act in cases of appeal before the House of Lords; and in some of the British colonies, where the civil law is in force, it is customary for those who practise as barristers to pass as advocates in Scotland. This body has existed by immemorial custom. Its privileges are constitutional, and are founded on no statute or charter of incorporation. The body formed itself gradually, from time to time, on the model of the French corporations of avocats, appointing like them a dean or doyen, who is their principal officer. No curriculum of study, residence, or professional training was, until 1856, required on entering this profession; but the faculty have always had the power, believed to be liable to control by the Court of Session, of rejecting any candidate for admission. The candidate undergoes two private examinations—the one in general scholarship, in lieu of which, however, he may produce evidence of his having graduated as master of arts in a Scottish university, or obtained an equivalent degree in an English or foreign university; and the other, at the interval of a year, in Roman, private international, and Scots law. He must, before the latter examination, produce evidence of attendance at classes of Scots law and conveyancing in a Scottish university, and at classes of civil law, public or international law, constitutional law, and medical jurisprudence in a Scottish or other approved university. He has then to undergo the old academic form of the public impugnment of a thesis on some title of the pandects; but this ceremony, called the public examination, has degenerated into a mere form. A large proportion of the candidate's entrance fees (amounting to £339) is devoted to the magnificent library belonging to the faculty, which literary investigators in Edinburgh find so eminently useful.

Lord Advocate, or King's Advocate, is the principal law-officer of the crown in Scotland. His business is to act as a public prosecutor, and to plead in all causes that concern the crown. He is at the head of the system of public prosecutions by which criminal justice is administered in Scotland, and thus his functions are of a far more extensive character than those of the English law-officers of the crown. He is aided by a solicitor-general and subordinate assistants called advocates-depute. The office of king's advocate seems to have been established about the beginning of the 16th century. Originally he had no power to prosecute crimes without the concurrence of a private party; but in the year 1597 he was empowered to prosecute crimes at his own instance. He has the privilege of pleading in court with his hat on.

ADVOCATION, in *Scottish Law*, was a mode of appeal from certain inferior courts to the supreme court. It was abolished in 1868, a simple "appeal" being substituted.

ADVOWSON, or Advowzen (*advocatio*), in *English Common Law*, the right of presentation to a vacant ecclesiastical benefice, is so called because the patron defends or advocates the claims of the person whom he presents. Originally all appointments within a diocese lay with the bishop; but when a landowner founded a church on his estate and endowed it, his right to nominate the incumbent was usually recognised. Where the right of presentation remains attached to the manor, it is called an advowson *appendant*, and passes with the estate by inheritance or sale without any special conveyance. But where, as is often the case, the right of presentation has been sold by itself, and so separated from the manor, it is called an advowson *in gross*. Advowsons are further distinguished into *presentative*, *collative*, and *donative*. In a *presentative* advowson, the patron presents a clergyman to the bishop, with the petition that he be instituted into the vacant living. The bishop is bound to induct if he find the clergyman canonically qualified, and a refusal on his part is subject to an appeal to an ecclesiastical court either by patron or by presentee. In a *collative* advowson the bishop is himself the patron, either in his own right or in the right of the proper patron, which has lapsed to him through not being exercised within the statutory period of six months after the vacancy occurred. No petition is necessary in this case, and the bishop is said to *collate* to the benefice. In a *donative* advowson, the sovereign, or any subject by special licence from the sovereign, confers a benefice by a simple letter of gift, without any reference to the bishop, and without presentation and institution. The incumbent of such a living is to a great extent free from the jurisdiction of the bishop, who can only reach him through the action of an ecclesiastical court. When an ecclesiastical body owned an advowson, it very frequently, by *appropriation*, exercised the right in its own favour, the corporation becoming the incumbent of the living, the actual duties of which were discharged by a *vicar* or *perpetual curate*. An advowson, being property, may be sold, or mortgaged, or seized by the creditors on a bankrupt estate, under certain restrictions intended to prevent simony. A sale is absolutely prohibited during the mortal sickness of the incumbent, or during the existence of a vacancy. There are upwards of 13,000 benefices in the Church of England, the advowsons being distributed as shown in the following list, which may be taken as approximately correct:—Under the patronage of the crown there are 1144 livings; bishops, 2324; deans and chapters, 938; the universities, 770; parochial clergy, 931; and private persons, 7000.

ADYTUM, the most retired and sacred place of ancient temples, into which none but the officiating priests were allowed to enter. The Most Holy Place of the temple of Solomon was of the nature of the pagan adytum; none but the high priest being admitted into it, and he but once a year.

Æ, or AE, a diphthong, compounded of A and E, of frequent occurrence in Latin and in Anglo-Saxon. In the best editions of the classics the form now preferred is *ae*. In English words derived from Latin the diphthong is generally converted into the simple *e*, but it is not unfrequently retained, as in *Æolian*, *mediæval*, &c. In some words it represents the Greek αι, to which the Latin *æ* corresponds, as in *æsthetics* (αἰσθητικά).

ÆACUS, in *Mythology*, the son of Jupiter by Ægina. When the isle of Ægina was depopulated by a plague, his father, in compassion to his grief, changed all the ants upon it into men and women, who were called *Myrmidones*, from μύρμηξ, *an ant*. The foundation of the fable is said to be, that when the country had been depopulated by pirates, who forced the few that remained to take shelter in caves, Æacus encouraged them to come out, and by commerce and industry to recover what they had lost. His character for justice and piety was such that, in a time of universal drought, he was nominated by the Delphic oracle

to intercede for Greece and his prayer was answered. The ancients also imagined that Æacus, on account of his impartial justice, was chosen by Pluto one of the three judges of the dead, and that it was his province to judge the Europeans.

ÆDILE (*ædilis*), in *Roman Antiquity*, a magistrate whose chief business was to superintend buildings of all kinds, but more especially public ones, as temples, aqueducts, bridges, &c. To the ædiles likewise belonged the care of the highways, public places, weights and measures, &c. They also superintended the markets, fixed the prices of provisions, took cognisance of breaches of decency and public order, and took charge of police matters generally. The custody of the *plebiscita*, or decrees of the people, and *senatus consulta*, or decrees of the senate, was likewise committed to them. They had the inspection of theatres and plays, and were obliged to exhibit magnificent games to the people, usually at their own expense, whereby many of them were ruined. They had the power, on certain occasions, of issuing edicts, and by degrees they procured to themselves a considerable jurisdiction. At first there were only two ædiles, viz., the ædiles of the people, *ædiles plebeii*, or *minores*. They were first created in the same year as the tribunes, B.C. 494; for the tribunes, finding themselves oppressed with the multiplicity of affairs, demanded of the senate to have officers to whom they might entrust matters of less importance; and accordingly two ædiles were created; and henceforward the ædiles were elected every year at the same assembly as the tribunes. But these plebeian ædiles having refused, on a signal occasion, to continue the great games for four days instead of three, on account of the expense, the patricians made an offer to do it, provided they were admitted to the honours of the ædileship. Accordingly two new ædiles were created, from the order of the patricians, in the year of Rome 388. They were called *ædiles curules*, or *majores*, as having a right to sit on a curule chair when they gave audience; whereas the plebeian ædiles only sat on benches. The curule ædiles alone had the right to issue edicts. Otherwise they shared all the ordinary functions of the plebeian ædiles; they had to procure the celebration of the grand Roman games, and to exhibit comedies, shows of gladiators, &c., to the people; and they were also appointed judges in all cases relating to the selling or exchanging of estates. To assist these first four ædiles, Cæsar (B.C. 45) created a new kind, called *ædiles cereales*, so named from their being deputed chiefly to take care of the supply of corn, which was called *donum Cereris*. These ædiles cereales were also taken out of the order of patricians. In the municipal cities and colonies there were ædiles having much the same authority as at Rome. We also read of an *ædilis alimentarius*, expressed in abbreviature by *ædil. alim.*, whose business seems to have been to provide diet for those who were maintained at the public charge, though others assign him a different office. In an ancient inscription we also meet with ædile of the camp, *ædilis castrorum*.

ÆGADES, or ÆGATES, a group of islands off the western coast of Sicily, between Trapani and Marsala, consisting of Maretimo, Levanzo, and Favignana. These islands are rendered historically famous by the great naval victory gained there by the Romans over the Carthaginians in B.C. 241, which put an end to the first Punic war.

ÆGEAN SEA, a part of the Mediterranean, now more usually called the Archipelago or Grecian Archipelago, bounded on the north by Thrace and Macedonia, on the west by Greece, and on the east by Asia Minor. The origin of the name is uncertain. Various derivations are given by the ancient grammarians—one from the town of Ægæ; another from Ægea, queen of the amazons, who perished in this sea; and a third from Ægeus, the father of Theseus, who threw himself headlong into it. See ARCHIPELAGO.

ÆGEUS, in *Fabulous History*, the son of Pandion, was king of Athens, and the father of Theseus. He was one of the Athenian heroes, but is notable chiefly for the manner of his death. The Athenians having killed Androgeus, the son of Minos, king of Crete, for carrying away the prize for wrestling from them, Minos made war upon them; and being victorious, imposed this severe condition on Ægeus, that he should annually send into Crete seven of the noblest of the Athenian youths and as many maidens, chosen by lot, to be devoured by the Minotaur. On the fourth year of this tribute the choice fell on Theseus, or, as others say, he himself entreated to be sent. The king at his son's departure gave orders that, as the ship sailed with black sails, it should return with the same in case he perished; but if he came back victorious he should change them for white. When Theseus returned from Crete after killing the Minotaur, he forgot to change the sails in token of his victory, according to the agreement; and his father, who sat on a rock watching the return of the vessel, imagining from the black sails that his son was dead, cast himself headlong into the sea, which was supposed in consequence to have obtained the name of the *Ægean Sea*. The Athenians decreed divine honours to Ægeus, and sacrificed to him as a marine deity and an adopted son of Neptune.

ÆGINA, in *Fabulous History*, the daughter of Asopus, king of Bœotia, was beloved by Jupiter, who carried her from Epidaurus to a desert island called *Œnone* or *Œnopia*, which was afterwards called by her name. See ÆACUS.

ÆGINA, or EGINA, or ENGIA, an island in the Saronic gulf, 20 miles distant from the Piræus, formerly vying with Athens in naval power, and at the sea fight of Salamis disputing the palm of victory with the Athenians. It was the native country and kingdom of Æacus, who called it *Ægina*, from his mother's name. (Ovid.) The inhabitants were called *Æginetæ* and *Æginenses*. Ægina is triangular in shape, and is about 8 miles long from N.W. to S.E., and about 6 broad, with an area of about 41 square miles. Strabo states its circumference at 180 stadia, or about 22½ English miles. Its western side consists of stony but fertile plains, which are well cultivated, and produce luxuriant crops of grain, with some cotton, vines, almonds, and figs. The rest of the island is mountainous, and rather barren. The southern end rises in the conical Mount Oros, and the Panhellenian ridge stretches to the north, from which fertile narrow valleys descend on either hand. From the absence of marshes, and its insularity, the climate is mild, and the most salubrious of Greece. The ruins of the ancient Ægina extend along two small ports, still protected by well-built ancient moles, and the shores of an open bay, defended by an ancient breakwater, near the N.W. cape of the island. On the land side the city walls are still distinctly traceable, 10 feet in thickness, strengthened by towers at unequal distances, and pierced by three gates. They abutted on those of the ports, which were thus included within the line of fortifications, as at Athens and elsewhere in ancient Greece. Two elegant Doric columns and substructures are all that remain of the buildings noticed by Pausanias within the precincts of a city that was long the greatest and most opulent maritime power of Greece; but the ruins of seventeen Christian churches, still visible, prove that after the glories of the proud city had passed away—after what it suffered from the jealousy of its rival Athens, and from an earthquake about the beginning of our era—a considerable modern town had occupied its site. Some of these may perhaps only date from the time that Ægina remained under its Venetian masters, as does a tower erected at the entrance

of the largest port. The Venetians resigned possession of the island to the Turks in 1715, under whom it became the prey of Mainote and other pirates, until the emancipation of Greece made it, in 1828–29, the seat of the Greek government. On a hill near the N.E. corner of the island stands the modern little town of Ægina (as it is pronounced by the modern Greeks). It is separated by a ravine from the hill, on which rise in lonely majesty the ruins of a noble temple, supposed to be that of *Jupiter Panhellenius*, though the point has been disputed. The temple occupies the rocky summit of a hill, in the midst of a forest of pines, at the extremity of the Panhellenian ridge. It was a ruin in the days of Cicero, as mentioned in one of his letters, and seems to have been thrown down by an earthquake at an unknown epoch. This temple is conspicuous from a distance, and was visited by Chandler in the last century; but has been chiefly known to us by the successful excavations of our countrymen Cockerell and Foster, assisted by Baron Haller and M. Linckh of Stuttgard, in 1811. These gentlemen united in clearing away the rubbish which the lapse of 2000 years had accumulated on the basement and floor of the cella; and after twenty days' exertion they were rewarded by the discovery not only of many interesting details relating to Grecian architecture, but also of many statues, in wonderfully energetic attitudes, that had once adorned the fallen pediments of this celebrated temple. These consist of the eleven figures of the eastern and five statues of the western pediment, almost entire, besides fragments of the rest, and two statuettes, and other ornaments of the acroteria. These sculptures supply an important link in the history of ancient art, and connect the schools of early Greece with that of Etruscan sculpture. The efforts of Messrs Cockerell and Foster to secure those treasures to their country are well known, as well as their failure through an unlucky mistake of the agent sent out to purchase them for the British Museum. They now form one of the most interesting acquisitions of the magnificent *Glyptothek* of Munich. The temple stands on a stylobate of 94 feet by 45 feet. The original number of columns in the peristyle was thirty-two, of which twelve were ranged on each side, and six in each front, 17 feet 2 inches high, including the wide spreading ovolo of the capital, and a diameter of 3 feet 3 inches at the base. Two other columns, of 3 feet 2 inches between antæ, are in the pronaos, and two similar in the opisthodomos or *posticum*. The cella had a door at each end; a double row of smaller columns, 2 feet 4 inches in diameter, were within the cella to support its partial roof; but the greatest portion of the cella was open, as this temple was *hypæthral*. There still remain twenty-one columns of the peristyle, with their architraves; six of the eastern front, and continuously with them are five columns of the north side; the four columns of the pronaos and opisthodomos, and the lower part of the shafts of five within the cella. The tympana had been painted of a bright azure, to give relief to the statues; and the drapery of Minerva, the middle figure of each group, had been painted red and blue. The whole of the ornaments on the cornices and upper mouldings of the pediment had been painted in *encaustic*, not carved. The subject of the groups of statuary appears to be the contest for the body of Patroclus, one of the *Æacidæ* (or royal progeny of Ægina of old), as described by Homer. (Cockerell *On the Ægina Marbles;* Brand's *Journal.*) This magnificent structure was erected most probably in the 6th century B.C., but, at all events, undoubtedly belongs to the brilliant period of Æginetan power, when its navy and its commerce were the pride of Greece, and carried its citizens to the remotest shores of the Mediterranean and the Euxine. Silver money is said to have been struck at Ægina long before it was coined even at Athens. The victory of Salamis was in a great measure owing to the thirty ships of Ægina, and the voice of grateful Greece assigned to her warriors on that eventful day the prize of valour. Yet not long after, the rivalry of Athens began to cloud the prosperity of the haughty islanders, whose fleet she had before defeated; and Ægina at length sunk under the enmity of a relentless commercial rival, that banished her citizens and supplied their place with Attic colonists. After the close of the Peloponnesian war Lysander restored the banished inhabitants, but Ægina never recovered its ancient prosperity.

ÆGINETA, Paulus, a celebrated surgeon of the island of Ægina, whence he derived his name. According to Le Clerc's calculation, he lived in the 4th century; but Abulfaragius the Arabian places him with more probability in the 7th. His knowledge in surgery was very great, and his works are deservedly famous. The title of the most important of them, as given by Suidas, is Ἐπιτομῆς Ἰατρικῆς Βιβλία Ἕπτα (*Synopsis of Medicine in Seven Books*). The sixth book, which treats of surgery, is particularly interesting. The whole work in the original Greek was published at Venice in 1528, and another edition appeared at Basle in 1538. Several Latin translations have been published, and an excellent English version, with commentary, by Dr F. Adams (1844–48). Ægineta is the first writer who takes notice of the cathartic property of rhubarb, and, according to Dr Milward, is the first in all antiquity who deserves the title of accoucheur.

ÆGIS, in *Classical Mythology*, a name given to the shield or buckler of Jupiter. The goat Amalthæa, which had suckled that god, being dead, he is said to have covered his buckler with the skin, or used the skin as a buckler; whence the appellation *ægis*, from αἴξ, αἰγός, *goat*. Jupiter afterwards restored the animal to life, covered it with a new skin, and placed it among the stars. A full description of the ægis of Jupiter is given by Homer, *Il.* v. 738, *sqq.* Apollo is also represented as bearing the *ægis*, and Minerva still more frequently. After Perseus killed Medusa, Minerva nailed her head in the middle of the ægis, which thenceforth had the faculty Medusa herself had during her life of converting all who looked on it into stone. Later writers regard the ægis sometimes as a buckler, but oftener as a cuirass or breastplate. The ægis of Pallas, described by Virgil (*Æn.* lib. viii. v. 435), must have been a cuirass, since the poet says expressly that Medusa's head was on the breast of the goddess. But the ægis of Jupiter, mentioned a little before (v. 354), seems from the description to have been a buckler. The ægis appears to have been really the goat's skin used, as well as the skins of other animals, as a belt to support the shield. When so used it would usually be fastened on the right shoulder, and would partially envelope the chest as it passed obliquely round in front and behind to be attached to the shield under the left arm. Hence, by transference, it would be employed to denote at times the shield which it supported, and at other times a *lorica* or *cuirass*, the purpose of which it in part served. Illustrations of the assumption of the ægis by the Roman emperors may be seen in ancient statues and cameos.

ÆGISTHUS, in *Ancient History*, was the son of Thyestes by his own daughter Pelopea, who to conceal her shame exposed him in the woods. Some say he was taken up by a shepherd and suckled by a goat; whence he was called *Ægisthus*. After he grew up he was recognised by his father, and on the death of the latter he became king of Mycenæ. He did not join the expedition against Troy; and after the departure of the expedition he seduced Clytemnestra, the wife of Agamemnon, and lived with her during the siege of Troy. Afterwards, with her assistance, he slew her husband, and reigned seven years in Mycenæ. He was slain, together with Clytemnestra, by Orestes.

ÆGOSPOTAMI, in *Ancient Geography*, a small river in the Thracian Chersonesus, running south-east, and falling into the Hellespont to the north of Sestos,—with a town of the same name, and a station or road for ships, at its mouth. Here the Athenians under Conon, through the fault of his colleague Philocles, received a signal overthrow from the Lacedemonians under Lysander (B.C. 405), which involved the taking of Athens, and put an end to the Peloponnesian war. The town does not appear to have existed till after the date of the battle.

ÆLFRIC, "the Grammarian," as he has been called, is one of the most voluminous of our old English writers before the Conquest. He flourished at the latter end of the 10th century and the beginning of the 11th. Of his personal history little can be learned, and his birth and death are alike involved in obscurity. We know that he was a pupil of Ethelwold, the friend of Dunstan, at Abingdon. On Ethelwold's advancement to the see of Winchester, Ælfric accompanied him, and filled the office of chief instructor in the diocese. For the use of his scholars he wrote his Latin and English *Grammar and Glossary* and his *Colloquium*. The last of these is in Latin, with an old English interlinear translation, in which the Latin is rendered word for word. It is interesting for its account of ancient manners, and shows that Ælfric made use of the conversational method in his teaching. The words in his Glossary are not arranged alphabetically, but grouped together into classes. Ælfric afterwards removed to Cerne Abbey, in Dorsetshire, where he composed his *Homilies*, the work on which his fame as an author chiefly depends. They are 80 in number, and were edited by Thorpe in 1844–46 for the Ælfric Society. In composing them, Ælfric drew largely from the fathers. Their style is very simple and pleasing, and obscure words are carefully avoided in order to adapt them to the capacity even of the most ignorant. Subsequent writers made great use of them, and not a few are to be found unabridged in the transition (semi-Saxon) English of the succeeding centuries. They excited great attention about the time of the Reformation, and were appealed to—especially the "Paschal Homily"—to prove that the doctrines of the English Church before the Conquest were at variance with those held by the Church of Rome. Among Ælfric's other works may be mentioned his *Treatise on the Old and New Testaments*, and his *Abridgment of the Pentateuch and the Book of Job*. Of the rest of his life we have little on which we can rely. He attained to the dignity of abbot, but he seems to be a different person from Ælfric, archbishop of Canterbury (995–1006), with whom he is sometimes confounded.

ÆLIA CAPITOLINA, a name given to the city built by the Emperor Hadrian, A.D. 134, near the spot where the ancient Jerusalem stood, which he found in ruins when he visited the eastern parts of the Roman empire. A Roman colony was settled here, and a temple was dedicated to Jupiter Capitolinus. Hence the name Capitolina, to which Hadrian prefixed that of his own family.

ÆLIANUS, CLAUDIUS, born at Præneste, in Italy. He taught rhetoric at Rome, under the Emperor Alexander Severus, according to Perizonius, but more probably under Hadrian. He was surnamed Μελίγλωσσος, "Honey-tongued," on account of the ease and accuracy with which he spoke and wrote Greek; and he was also named "the Sophist," from his being a teacher of rhetoric. He loved retirement, and devoted himself to study. He greatly admired and studied Plato, Aristotle, Isocrates, Plutarch, Homer, Anacreon, Archilochus, &c.; and, though a Roman, gives preference to the writers of the Greek nation, and employs the Greek language in his works. His curious and entertaining work entitled *Varia Historia* has been frequently republished, as well as his treatise *De Natura Animalium*. A very useful edition of the latter was published by Schneider, at Leipsic, in 1784, in 8vo; another at Jena, in 1832, by Fr. Jacobs. The collected edition of his works, by Gesner, 1556, fol., contains another work ascribed to him, named *Epistolæ Rusticæ*.

ÆMILIUS, PAULUS, the name of a celebrated family of the Æmilia Gens. See PAULUS.

ÆMILIUS, PAULUS, or PAOLO EMILIO, a celebrated historian, born at Verona, who obtained such reputation in Italy that he was invited into France by the cardinal of Bourbon, in the reign of Charles VIII., in order to write the history of the kings of France in Latin, and was presented to a canonry in Notre Dame. He enjoyed the patronage and support of Louis XII. He died at Paris on the 5th of May 1529. His work entitled *De Rebus gestis Francorum* was translated into French by Renard in 1581, and has also been translated into Italian and German.

ÆNEAS, in *Fabulous History*, a Trojan prince, the son of Venus and Anchises. He plays a conspicuous part in the *Iliad*, and is represented, along with Hector, as the chief bulwark of the Trojans. Homer always speaks of Æneas and his descendants as destined to reign at Troy after the destruction of Priam and his house. Virgil has chosen him as the hero of his great epic, and the story of the *Æneid*, though not only at variance with other traditions, but inconsistent with itself, can never lose its place as a biography of the mythical founder of the Latin power. Æneas is described in the *Æneid* as escaping from the destruction of Troy, bearing his aged father on his shoulders, carrying in one hand his household gods, while with the other he leads his little son Ascanius or Iülus. His wife Creüsa is separated from them and lost in the tumult. After a perilous voyage he lands in Africa, and is kindly received by Dido, queen of Carthage; who, on his forsaking her to seek a new home, destroys herself. Again escaping the dangers of the sea, he arrives in Italy, where he lands in Latium, and forms an alliance with Latinus, the king of the country, marries his daughter Lavinia, and founds a city which he calls, after her, Lavinium. Turnus, king of the Rutuli, a rejected suitor of Lavinia, makes war on Latinus, and both are slain in battle. The story of the *Æneid* ends with the death of Turnus. According to Livy, on the death of Latinus, Æneas assumes the sovereignty of Latium, and the Trojan and Latin powers are united in one nation. After a reign of three years, Æneas falls in a battle with the Rutuli, assisted by Mezentius, king of Etruria, and is supposed to be carried up into heaven, because his body cannot be found. After his death or disappearance he receives divine honours.

ÆNEAS SYLVIUS, POPE. See PIUS II.

ÆOLIÆ INSULÆ, the modern LIPARI ISLANDS, a group of islands between Italy and Sicily. They are so called from Æolus, the god of the winds, who was supposed to rule over them; but they are also frequently termed *Insulæ Vulcaniæ*, or *Hephæstiæ*, from their volcanic eruptions, and *Insulæ Lipareorum*, from *Lipara* (modern Lipari), the chief of the group. According to Pliny, the other islands are *Hiera*, now *Vulcano; Strongyle*, now *Stromboli; Didyme*, now *Salina; Phœnicusa*, now *Felicudi; Euonymus*, probably *Panaria;* and *Ericusa*, now *Alicudi*. Besides these there are several small islets. Homer mentions only one Æolian island (*Od.* x. 1).

ÆOLIAN HARP, named from Æolus, god of the wind, a musical instrument consisting of cat-gut strings stretched over a wooden sound-box. When exposed to a current of air, the strings produce a variety of pleasing harmonic sounds in strange succession and combination.

ÆOLIS, or ÆOLIA, in *Ancient Geography*, a country of Asia Minor, settled by colonies of Æolian Greeks. The

name in its limited sense was applied to the coast extending from the river Hermus to the promontory of Lectum, on the north side of the entrance to the Gulf of Adramyttium, and lying between Ionia to the S. and Troas to the N. In its wider acceptation it comprehended Troas and the coasts of the Hellespont to the Propontis, where there were likewise several Æolian colonies.

ÆOLUS, in *Heathen Mythology*, the god and father of the winds, was variously represented as the son of Hippotes, or of Neptune by a daughter of Hippotes, or of Jupiter. In the *Odyssey* he is mentioned as the king of the Æolian isle to whom Jupiter had given the superintendence and distribution of the winds. Later poets make him the god and father of the winds, who dwelt in one of the Æolian islands—according to some in Stromboli, according to others in Lipari, while others place his residence at Rhegium in Italy. He is represented as having authority over the winds, which he confined in a vast cavern. Strabo and some other writers consider him to have had a real existence; and derive the fable of his power over the winds from his skill in meteorology and the management of ships.

> Hic vasto rex Æolus antro,
> Luctantes ventos tempestatesque sonoras
> Imperio premit, ac vinclis et carcere frenat.
> Illi indignantes magno cum murmure montis
> Circum claustra fremunt; celsâ sedet Æolus arce
> Sceptra tenens, mollitque animos, et temperat iras:
> Ni faciat, maria ac terras cœlumque profundum
> Quippe ferant rapidi secum, verrantque per auras.
>
> *Æneid*, lib. i. 52.

> Here Æolus, in cavern vast,
> With bolt and barrier fetters fast
> Rebellious storm and howling blast.
> They with the rock's reverberant roar
> Chafe blustering round their prison door:
> He, throned on high, the sceptre sways,
> Controls their moods, their wrath allays.
> Break but that sceptre, sea and land,
> And heaven's etherial deep,
> Before them they would whirl like sand,
> And through the void air sweep.
>
> *Conington's Translation.*

Through Hippotes, Æolus is usually represented as descended from Æolus, one of the sons of Hellen, and the mythological ancestor of the Æolian tribes.

ÆON (αἰών), a space of time, was often used in Greek to denote indefinite or infinite duration; and hence, by metonymy, for a being that exists for ever. In the latter sense it was chiefly used by the Gnostic sects to denote those eternal beings or manifestations which emanated from the one incomprehensible and ineffable God. See GNOSTICISM.

ÆPINUS, FRANZ MARIA ULRICH THEODOR, a distinguished German natural philosopher, was born at Rostock in Saxony in 1724, and died at Dorpat in August 1802. He was descended from John Æpinus (*b.* 1499—*d.* 1553), the first to adopt the Greek form (αἰπεινός) of the family name, a leading theologian and controversialist at the time of the Reformation. After studying medicine for a time, Francis Æpinus devoted himself to the physical and mathematical sciences, in which he soon gained such distinction that he was admitted a member of the Berlin Academy of Sciences. In 1757 he settled in St Petersburg as member of the Imperial Academy of Sciences and professor of physics, labouring there and pursuing his favourite studies with great success till his death. He enjoyed the special favour of the Empress Catharine II., who appointed him tutor to her son Paul, and endeavoured, without success, to establish normal schools throughout the empire under his direction. Æpinus is best known by his researches, theoretical and experimental, in electricity and magnetism. His principal work, *Tentamen Theoriæ Electricitatis et Magnetismi*, published at St Petersburg in 1759, may be regarded as the first systematic and successful attempt to apply mathematical reasoning to these subjects. Adopting Franklin's theory of positive and negative electricities, or electric forces, he investigated the relations of these fully, and especially the conditions of their equilibrium; and many of the conclusions he arrived at do not depend for their value and importance on the theory of Franklin. Æpinus himself extended the theory, holding that the particles of the electric fluid repel each other, attract the particles of all bodies, and are attracted by them, with a force inversely proportional to the distance; that the fluid resides in the pores of the surfaces of bodies, moving readily through some, called conductors or non-electrics, and with difficulty through others; and that electric phenomena are produced either by the approach of bodies unequally charged, or by the unequal distribution of the fluid in the same body. He propounded a kindred theory of magnetism, a magnetic fluid being supposed to exist corresponding to the electric fluid, but acting on, and acted on by, the particles of iron only. It is to be added that Æpinus was the first to perceive and define, with any measure of clearness, the affinity between electricity and magnetism. There is a remarkable similarity between portions of the work above named and a paper by Cavendish—the result of independent investigations—given in the *Philosophical Transactions* for 1771. In 1787 the Abbé Haüy published an exposition of Æpinus's theories. Æpinus did not confine himself to one or two departments of natural science. He published a treatise, in 1762, *On the Distribution of Heat at the Surface of the Earth;* and he was also the author of valuable memoirs on different subjects in astronomy, mechanics, optics, meteorology, and pure mathematics, contained in the journals of the learned societies of St Petersburg and Berlin. His discussion of the effects of parallax in the transit of a planet over the sun's disc excited great interest, having appeared (in 1764) between the dates of the two transits of Venus that took place during last century.

ÆQUI, an ancient and warlike people of Italy, inhabiting the upper valley of the Anio, who, in confederacy with the Volsci, carried on a long series of hostilities with the early Romans, but were finally subdued in the year 302 B.C.

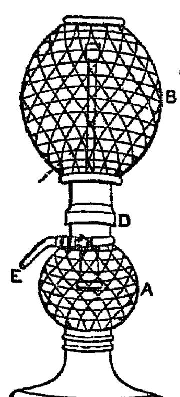
ÆRARIANS, a class in ancient Rome, composed of citizens who had suffered the severest kind of degradation the censors could inflict, but concerning whose exact position we have no precise information. Though heavily taxed, they did not enjoy the rights of citizenship beyond their liberty and the general protection of the state. They could not vote in assemblies or serve in the army, and were deprived of and excluded from all posts of honour and profit. Romans of the higher classes, as well as the plebeians, were liable to become Ærarians. The name may be derived from *æs, æris,* money, since they were mere tax-payers; or, which is more probable, it may refer to the list of them which the censors gave in to the *ærarium* or public treasury.

ÆRARIUM, the public treasury at ancient Rome. It contained the moneys and accounts of the state, and also the standards of the legions, the public laws engraven on brass, the decrees of the senate, and other papers and registers of importance. The place where these public treasures were deposited, from the time of the establishment of the republic, was the temple of Saturn, on the eastern slope of the Capitoline hill. In addition to the common treasury, supported by the general taxes and charged with the ordinary expenditure, there was a reserve treasury, also in the temple of Saturn, the *ærarium sanctum* (or *sanctius*), maintained chiefly by a tax of 5 per cent. on the value of all manumitted slaves, which was not to

be had recourse to, or even entered, except in the extreme necessity of the state. Under the emperors the senate continued to have at least the nominal management of the *ærarium*, while the emperor had a separate exchequer, called the *fiscus*. But after a time, as the power of the emperors increased and their jurisdiction extended till the senate existed but in form and name, this distinction virtually ceased. Besides creating the *fiscus*, Augustus also established a military treasury (*ærarium militare*), containing all moneys raised for and appropriated to the maintenance of the army. The later emperors had a separate *ærarium privatum*, containing the monies allotted for their own use, distinct from the *fiscus*, which they administered in the interests of the empire.

AERATED WATERS. Waters impregnated with an unusually large proportion of carbonic acid, or other gaseous substances, occur abundantly in springs throughout the world; and, in addition to their gaseous constituents, generally hold in solution a large percentage of different salts. The manufacture of aerated waters arose out of the attempt to imitate these by artificial means, but till about the beginning of the present century such efforts did not meet with great success. The earliest method of producing acidulated water was that which still obtains in the preparation of effervescing draughts, such as are made from "Seidlitz" powders. These powders consist of separate portions of sodium bicarbonate and tartaric acid, which, on being dissolved together in water, form sodium tartrate and liberate carbonic acid, which bubbles up through the water. In recent years "granular" effervescent preparations have been introduced, in which the acid and salt are mixed in a dry state, and produce their reaction on being dissolved. The popular preparation termed effervescent citrate of magnesia, and several others under a variety of names, consist essentially of sodium bicarbonate and tartaric acid, to which a little citric acid is sometimes added. A limit, however, is set to the use of waters so aerated on account of the purgative action of the alkaline earths they necessarily contain.

In the manufacture of common aerated waters the carbonic acid is prepared apart from the pure water in which it is to be dissolved. There are essentially only two methods on which the manufacture is conducted, although there is an endless variety in the apparatus used. In the first process, which may be distinguished as the method of chemical pressure, the carbonic acid gas saturates the water by its own pressure, passing directly from the chamber in which it is produced and purified into the cylinder or cylinders containing the water to be aerated. The small apparatus frequently used in private houses and hospitals may be taken as an illustration of this method. The most common form consists of two strong glass globes A and B, protected by netting in case of breakage. Into the globe A are placed the materials for generating carbonic acid, usually in this case tartaric acid and sodium bicarbonate. When charged with these materials, a metal tube C, accurately fitted to the aperture in the globe, is inserted. The globe B is inverted and filled with water, and in this position the globe A is screwed tightly up by the joint D, the metal tube reaching to near the top of globe B. On placing the apparatus upright, a proportion of water escapes through the metal tube into globe A, acts on the charge it contains, and evolves carbonic acid, which passes up the tube and saturates the water in B. As the pressure of the gas augments, the quantity absorbed increases, and when fully saturated the aerated water may be drawn off by the cock E. In manufacturing on a large scale, a combination of globes or cylinders is used for producing continuous action, and less expensive sources of carbonic acid than sodium bicarbonate and tartaric acid are employed. The second or mechanical pressure process is that generally followed in the manufacture in this country. In this process the gas is prepared in a lead chamber by the action of sulphuric acid on chalk, and is washed by passing through water into the gas-holder in which it is collected. By the action of a force-pump, water, filtered when necessary, and carbonic acid, are pressed, in due proportions, into a very strong copper cylinder, tinned internally, termed a receiver or saturator, in which an agitator is kept revolving. A pressure gauge is attached to the receiver, and when the index indicates from 120 to 140 ℔ pressure per square inch, what is termed aerated water, and very frequently does duty for soda-water, is ready for drawing off at the bottling apparatus. Real soda-water is best prepared by adding to the water before aeration a proportion of sodium bicarbonate equal to about 30 or 36 grains per pint of water. Potash-water, Seltzer, lithia, Carrara, bromide of potassium, and a host of other waters, are similarly prepared, the various salts being used in different proportions, according to the taste and experience of manufacturers. Lemonade, and other aerated drinks flavoured with fruit syrups, have the proportion of syrup placed in the bottle to which simple aerated water taken from a receiver, indicating a pressure of 80 to 100 ℔ per square inch, is added. From a syrup composed of 14 ℔ of sugar, $2\frac{1}{2}$ oz. of tartaric acid, $3\frac{1}{2}$ oz. of citric acid, and $4\frac{1}{2}$ drachms of essence of lemon, dissolved in $2\frac{1}{2}$ gallons of water, 30 dozen bottles of an excellent quality of lemonade can be prepared. On account of the rapidity with which the gas escapes on the removal of pressure, special arrangements are required for the bottling and corking processes, and the frequent explosion of bottles necessitates guards to protect the bottler. A dexterous bottler will fill and cork 5000 bottles in ten hours. The consumption of aerated waters, especially in hot climates, is very great.

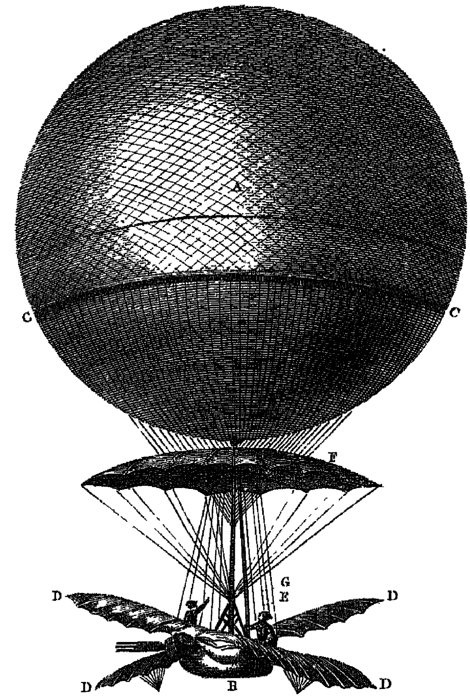


AEROE, or ARROE, an island of Denmark, in the Little Belt, lying $7\frac{1}{2}$ miles S. of Funen, between Alsen and Langeland. It is of an irregular triangular shape, about 15 miles long and 8 broad at the widest points, with a hilly surface, but a fertile and well-cultivated soil. Population, 10,200; chief town, Aeroeskjobing, on the east coast.

AEROLITE (ἀήρ, air, and λίθος, a stone), a stony or metallic body, which, falling through the atmosphere, reaches the earth's surface. These meteoric stones generally contain a considerable proportion of iron; indeed, the iron in some of these substances exceeds the siliceous matter, and some have then given them the name of meteoric irons. A remarkable aerolite that fell at Ægospotami, in 467 B.C., was, according to Pliny, to be seen in his day, and was then as large as a waggon. In 1492 one fell at Ensisheim, in Alsace, that weighed 270 ℔.; and, not to mention others, one of 12 ℔ weight is reported to have fallen in California in August 1873, which penetrated the earth to the depth of 8 feet, and when dug up was so hot that it could not be handled. Aerolites often reach the earth in groups or showers, as at L'Aigle, in Normandy, in 1803; at New Concord, Ohio, in May 1860; and at Dhurmsala, in the Punjaub, in July the same year. The area on which a shower of aerolites falls is usually elliptical, the largest stones being near one end of the ellipse, the major axis of which extends in some cases to a length of eighteen or twenty miles. See METEOR.

MONTGOLFIER'S BALLOON

BLANCHARD'S BALLOON



References to Blanchards Balloon

A *The Balloon made of Taffeta 26 Feet in diameter covered with a Net*

B *The Car suspended by longitudinal Cords from the Hoop C*

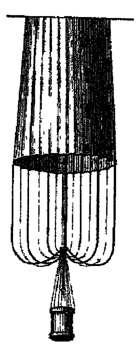
D D D D *The Wings moved by Rack-work E*

F *A Parachute or Umbrella to break the force of descent if the Balloon should burst*

G *A Tube communicating with the inside of the Balloon*

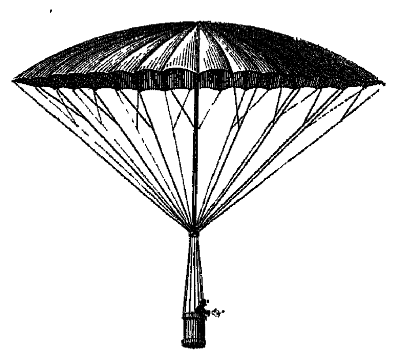
GARNERIN'S PARACHUTE

in ascending

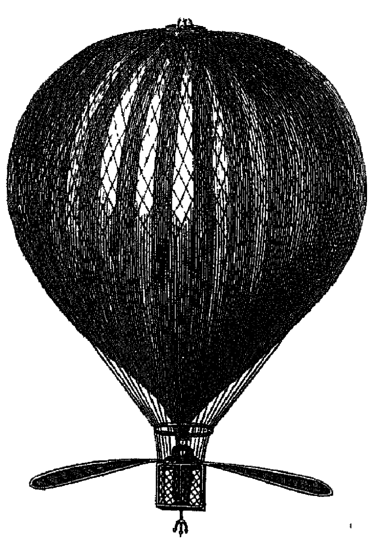


GARNERIN'S PARACHUTE

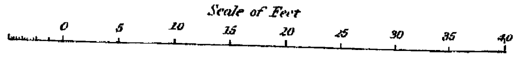
in descending



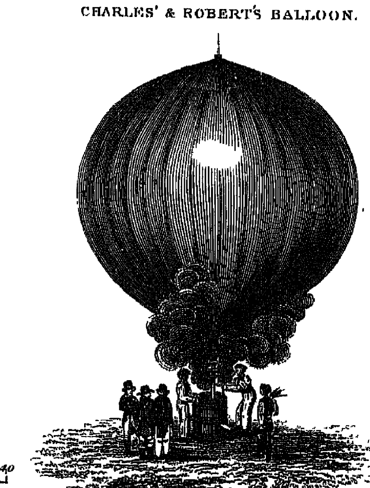
LUNARDI'S BALLOON



Scale of Feet



CHARLES' & ROBERT'S BALLOON.



W & A K Johnston

AERONAUTICS

Gradual discovery of navigation.

In every stage of society men have sought, by the combination of superior skill and ingenuity, to attain those distinct and obvious advantages which nature has conferred on the different tribes of animals, by endowing them with a peculiar structure and a peculiar force of organs. The rudest savage learns from his very infancy to imitate the swimming of a fish, and plays on the surface of the water with agility and perseverance. But an art so confined in its exercise, and requiring such a degree of bodily exertion, could not be considered of much avail. It must have been soon perceived (even if the discoveries of the arts of natation and navigation were not absolutely simultaneous), that the fatigue of impulsion through the water could be greatly diminished by the support and floating of some light substance. The trunk of a tree would bear its rude proprietor along the stream; or, hollowed out into a canoe and furnished with paddles, it might enable him even to traverse a river. From this simple fabric the step was not great to the construction of a boat or barge, impelled by the force of oars. But it was a great advance to fix masts and apply sails to the vessel, and thus substitute the power of wind for that of human labour. The adventurous sailor, instead of plying on the narrow seas or creeping timidly along the shore, could now launch with confidence into the wide ocean. Navigation, in its most cultivated form, may be fairly regarded as one of the sublimest triumphs of human genius, industry, courage, and perseverance.

Analogy between navigation and flying only very vague.

Having by his skill achieved the conquest of the waters that encompass the habitable globe, it was natural for man to desire likewise the mastery of the air in which we breathe. In all ages, therefore, great ingenuity has been expended in efforts at flying, all of which have as yet resulted in failure. But the analogy between sailing on the water and sailing in the air is not so close as many enthusiasts have supposed it to be. There is a general resemblance, inasmuch as in both cases the propulsion must be made by means of a fluid. But in the one case the fluid is inelastic, in the other elastic; and the physicist or mathematician knows how vastly different are the properties of liquids, even in fundamental points, from those of aeriform or gaseous bodies. Again, in the one case the vessel floats on the surface of the water, in the other it must float totally immersed in the aerial fluid. A ship, while sailing, is acted on by two fluids—the water supports it and the air propels it; but a ship sailing in the air would be only under the action of the one fluid that surrounds it on all sides. These few considerations—and many more might be added—indicate the essential distinctions between the two cases; and a very little thought shows that it is not so remarkable as it at first sight appears, that the invention of the art of sailing on the water should be lost in prehistoric antiquity, while that of sailing in the air is not a century old; and that while navigation is one of the most perfect of the arts, the power of directing a body floating in the air still remains unattained. Many have argued, that because navigation is an accomplished fact, therefore the navigation of the air must be possible; and without denying the truth of the conclusion, it is worth while at the outset of this article to point out the fallacy of the reasoning. It is true that there is no reason to despair of the attainment of aerial navigation, as the history of invention and science records many victories as great and at one time apparently as far off; still, it is as well to notice how little assistance the old discovery affords towards the solution of the new: it may, indeed, even be that progress has been retarded by the false analogy, for we may feel pretty certain that if ever the air is navigated, it will be by ships presenting little resemblance to those that traverse the ocean.

Aerostatic attempts of the Greeks and Romans. Dædalus and Icarus.

The subject of aerostation is scarcely ever alluded to by the classical writers, and the fable of Dædalus and Icarus, and the dove of Archytas, form almost all we have to record in relation to flying previous to the dark ages. Dædalus, an Athenian, killed his nephew Talus through jealousy of his talents, and fled with his son Icarus to Crete, where he built the celebrated labyrinth for Minos, the king. But having offended Minos, so that he was imprisoned by him, he made wings of feathers, cemented with wax, for himself and his son, so that they might escape by flight. He gave his son directions to fly neither too low nor too high, but to follow him. Icarus, however, becoming excited, forgot his father's advice, and rose so high that the heat of the sun melted the wax of his wings, and he fell into the sea near Samos, the island of Icaria and the Icarian sea being named after him. Dædalus accomplished his flight in safety. (Ovid, *Met.* lib. viii. Fab. iii.) The explanation of the myth may be, as has been supposed, that Dædalus used sails, which, till then, according to Pausanius and Palæphatus, were unknown, and so was enabled to escape from Minos' galleys, which were only provided with oars; and that Icarus was drowned near the island Icaria. But the whole story of Dædalus is so fanciful a romance, that it is scarcely worth while even to speculate upon what the infinitesimal fragment of truth that lay at the bottom of it may have been.

Archytas.

Archytas of Tarentum was a well-known geometer and astronomer, and he is apostrophised by Horace (*Ode* 28, lib. i.) The account of his flying pigeon or dove we owe to Aulus Gellius (*Noctes Atticæ*), who says "that it was the model of a dove or a pigeon formed in wood, and so contrived as by a certain mechanical art and power to fly: so nicely was it balanced by weights, and put in motion by hidden and enclosed air." Gellius gives as his authorities "many men of eminence among the Greeks," whom he does not mention by name, and Favorinus the philosopher.

Archytas thus has been regarded as holding to aeronautics much about the same position as Archimedes does to the mechanical sciences; but while the claim of the latter rests on real discoveries and great contributions to knowledge, the former owes his position merely to an unsupported and untrustworthy tradition. When the fire-balloon was invented, it was only natural that many should see in the "hidden and enclosed air" of Archytas' dove a previous discovery of the hot-air balloon. It is quite possible that Archytas may have rarefied the air in his dove by heat, and so made it ascend; but in this case it certainly could not have been made of wood. But if the dove ever was made to appear to fly, it is much the more probable that this effect was produced, as in the scenes at theatres, by means of fine strings or wires invisible to the spectators.

The ancients seem to have been convinced of the impossibility of men being able to fly, and they appear to have made no attempts in this direction at all. The power of flying was attributed only to the most powerful of the divinities; and it was regarded as only secondary to Jupiter's prerogative of flashing the lightning and hurling the thunderbolt.

Aerostatics in the dark ages.

The history of aerostatics in the Middle Ages, like that of every other subject relating even remotely to science or knowledge of any kind, is little better than a record of the falsehoods or chimeras circulated by impostors or enthusiasts. Truth was completely obscured by ignorance and fanaticism, and every person of superior talents and acquire

ments was believed to deal in magic, and to perform his feats of skill chiefly through the secret aid granted him by the prince of darkness; and in a later and comparatively recent period, those wretched creatures whom the unfeeling credulity of our ancestors, particularly during the prevalence of religious fanaticism, stigmatised and murdered under the denomination of witches, were supposed to work all their enchantments, to change their shapes at will, and to transport themselves through the air with the swiftness of thought, by a power derived from their infernal master, to whom was thus assigned the privilege of conferring the gift of aerial navigation upon his servants.

During the darkness of the Middle Ages every one at all distinguished for his knowledge in physics was generally reputed to have obtained the power of flying in the air. Friar Bacon did not scruple to claim the invention; and the credulity and indulgent admiration of some authors have lent to these pretensions more credit than they really deserved. Any one who takes the trouble to examine the passages of Bacon's obscure and ponderous works will find that the propositions advanced by him are seldom founded on reality, but ought rather to be considered as the illusions of a lively fancy. Albertus Magnus, who flourished in the first half of the 13th century, was reputed to have discovered the art; and to give an idea of the state of the physical sciences at that time, it is worth while to quote the following recipes from his *De Mirabilibus Naturæ*:—"Take one pound of sulphur, two pounds of willow-carbon, six pounds of rock-salt ground very fine in a marble mortar; place, when you please, in a covering made of flying papyrus to produce thunder. The covering, in order to ascend and float away, should be long, graceful, well filled with this fine powder; but to produce thunder, the covering should be short, thick, and half full." (Quoted in *Astra Castra*, p. 25.) Regiomontanus, the first real mathematician after the partial revival of learning, is said, like Archytas, to have formed an artificial dove, which flew before the Emperor Charles V. at his public entry into Nuremberg; but the date of Regiomontanus' death shows this to have been impossible.

Attempts at flying.

Attempts at flying have, as a rule, been made by a somewhat low class of projectors, who have generally united some little share of ingenuity to a smattering of mechanics. At the beginning of the 16th century an Italian alchemist visited Scotland, and was collated by James IV. to the abbacy of Tungland, in Galloway. Having constructed a set of wings, composed of various plumage, he undertook from the walls of Stirling Castle to fly through the air to France. This feat he actually attempted, but he soon came to the ground, and broke his thigh-bone by the violence of the fall—an accident he explained by asserting that the feathers of some fowls were employed in his wings, and that these had an affinity for the dunghill, whereas, if composed solely of eagles' feathers, they would have been attracted to the air. This anecdote has furnished to Dunbar, the Scottish poet, the subject of one of his rude satires. In 1617, Fleyder, rector of the grammar school at Tübingen, delivered a lecture on flying, which he published eleven years afterwards. A poor monk, however, ambitious to reduce the theory to practice, provided himself with wings; but his machinery broke down, and falling to the ground, he broke his legs and perished. Bishop Wilkins (*Mathematical Magick*, 1648) says it was related that "a certain English monk called Elmerus, about the Confessor's time," flew by means of wings from a tower a distance of more than a furlong; that another person flew from St Mark's steeple at Venice; and another, at Nuremberg. He also quotes Busbequius to the effect that a Turk also attempted something of the kind at Constantinople. It would probably not be very difficult to make a long list of such narrations, in some of which the experimenter is related to have been successful, and in others to have failed; but the evidence is in no case very good, and we may feel certain that all the traditions of attempts with a successful issue are false.

Borelli shows the impossibility of man flying by the aid of wings.

In Borelli's posthumous work, *De Motu Animalium*, published at Rome in 1680–81, he calculated the enormous strength of the pectoral muscles in birds; and his proposition cciv. (vol. i. pp. 322–326) is entitled "Est impossibile, ut homines propriis viribus artificiosè volare possint," in which he clearly points out the impossibility of man being able by his muscular strength to give motion to wings of sufficient extent to keep him suspended in the air. But Borelli did not, of course, as has sometimes been stated, demonstrate the impossibility of man's flying otherwise than merely by means of his own muscular power.

Sailing in the air.

A very slight consideration of the matter shows that, although the muscles of man may not be of sufficient strength to enable him to use wings, this objection does not apply against the possibility of making a flying chariot in which the motive power should be produced mechanically as in a watch, or a boat to float in the atmosphere. Both these projects have therefore always engaged the attention of abler men than has the art of flying, and it was only the ignorance of the nature and force of the atmosphere, as well as of the properties of all aeriform bodies, that caused so long a time to elapse before the invention of the balloon.

Albert of Saxony.

Albert of Saxony, a monk of the order of St Augustine, and a commentator on the physical works of Aristotle, seems first to have comprehended (though in a very vague and erroneous manner) the principles on which a body might be made to float in the atmosphere. Adopting, of course, Aristotelian views with regard to the nature of the elements, he considered that, as fire is more attenuated, and floats above our atmosphere, therefore a small portion of this ethereal substance, enclosed in a light hollow globe, would raise it to a certain height and keep it suspended in the air; and that, if more air were introduced, the globe would sink like a ship when water enters by a leak.

Francis Mendoza.

Long afterwards Francis Mendoza, a Portuguese Jesuit, who died in 1626, at the age of forty-six, embraced this theory, and he held that the combustible nature of fire was no real obstacle, as its extreme levity and the extension of the air would prevent it from supporting inflammation.

Casper Schott.

Casper Schott, also a Jesuit, adopted the same speculation, only that he replaced the fire by the thin ethereal substance which he believed floated above our atmosphere; but, of course, the difficulty of procuring any of this ether was a sufficient obstacle.

Alchemical notions.

Similar notions have been revived at different times. They were likewise often blended with the alchemical tenets so generally received in the course of the 15th, 16th, and part of the 17th centuries.

Lauretus Laurus.

Thus Schott quotes Lauretus Laurus to the effect that if swans' eggs or leather balls be filled with nitre, sulphur, or quicksilver, and be exposed to the sun, they will ascend. It was also believed that dew was of celestial origin, being shed by the stars, and that it was drawn up again in the course of the day to heaven by the heat of the sun. Thus Laurus states that hens' eggs filled with dew and exposed to the solar heat will rise. He was so grossly ignorant, however, of the principles of motion, that it is not worth while even to allude to his other assertions.

Romance of Cyrano de Bergerac.

Cyrano de Bergerac (born 1620) wrote a philosophical romance entitled *Histoire Comique des Estats et Empire de la Lune*, and *Les Estats et Empire du Soleil* (from which Swift is supposed to have derived the idea of writing portions of *Gulliver's Travels*). To equip himself for performing the journey to the moon, the French traveller fastens round his body a multitude of very thin flasks

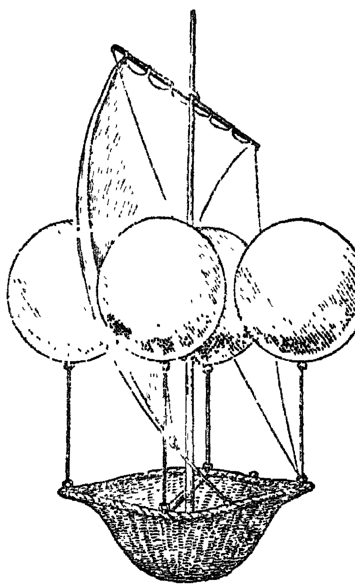
filled with the morning's dew; the heat of the sun, by its attractive power on the dew, raised him up to the middle region of the atmosphere, whence, some of the flasks being broken, the adventurer sank again to the ground. Other aeronautical ideas occur in the romance.

Cardan. Fabry.

Cardan proposed that ascensional power might be applied as in a rocket; and one Honoratus Fabry has described a huge apparatus, consisting of long tin pipes, worked by air compressed by the action of fire.

Francis Lana.

The most noted scheme for navigating the air promulgated previously to the successful experiments of the Montgolfiers, is due to a Jesuit, Francis Lana, and was proposed by him in a work entitled *Prodromo dell'Arte Maestra*, Brescia, 1670. His idea, though useless and unpractical in so far that it could never be carried out, is yet deserving of notice, as the principles involved are sound; and this can be said of no earlier attempt. His project was to procure four copper balls of very large dimensions, yet so extremely thin that after the air was exhausted from them they would be lighter than the air displaced, and so would rise; and to those four balls he proposed to attach a boat, with sails, &c., and which would carry up a man. He submitted the whole matter to calculation, and proposed that the globes should be about 25 feet in diameter and $\frac{1}{225}$th of an inch in thickness; this would give from all four balls a total ascensional force of about 1200 lb, which would be quite enough to raise the boat, sails, passengers, &c. But the obvious objection to the whole scheme is, that it would be quite impossible to construct a globe of so large a size and of such small thickness which would even support its own weight without falling to pieces if placed on the ground, much less bear the external atmospheric pressure when the internal air was removed. Lana himself noticed the latter objection, but he thought that the spherical form of the copper shell would, notwithstanding its extreme thinness, enable it, after the exhaustion was effected, to sustain the enormous pressure, which, acting equally on every point of the surface, would tend to consolidate rather than to break the metal. Of course this assumed the ball to be absolutely spherical, a state of affairs as impossible as indifferent equilibrium actually is. He proposed to exhaust the air from the globes by attaching each to a tube 36 feet long, fitted with a stopcock, and so produce a Torricellian vacuum. He was thus apparently ignorant of the invention of the air-pump by Otto Guericke about 1650; and though his project is noteworthy as the hydrostatics of it is correct, still Lana displays his ignorance of philosophical facts known in his day, quite as much as his originality; and his proposition has, since Montgolfier's discovery, received a greater share of notice than it deserves.



Lana's Aeronautical Machine.

Joseph Galien.

So late as 1755, and not long before the invention of balloons, a very fanciful scheme was proposed by Joseph Galien, a Dominican friar, and professor of philosophy and theology in the papal university of Avignon. This visionary proposed to collect the diffuse air of the upper regions, and to enclose it in a huge vessel extending more than a mile every way, and intended to carry fifty-four times as much weight as did Noah's ark. It is unnecessary to notice at greater length this absurd chimera, which is merely mentioned here at all because it is sometimes referred to, though only on account of the magnitude of the fantastic scheme.

False ideas with regard to the atmosphere.

It is proper here to remark, that nearly all the early projectors imagined that the atmosphere was of no great height, and that it covered the earth like a shallow ocean, having a well-defined boundary; and the aerial vessels which they proposed were intended to float on the surface of this ocean, exactly as ships do on the sea, with their upper portions in the ether or diffuse air, or whatever the fluid might be, that lay above. And these ideas were, of course, not dispelled till after the invention of the barometer and the discovery of the law of the decrease of atmospheric pressure with elevation.

Confused ideas of Bacon on aeronautics.

Some writers have stated that Francis Bacon first published the true principles of aeronautics. This assertion we cannot help noticing, because it has really no foundation except in the propensity, fostered by indolence, which would gladly refer all the discoveries ever made to a few great names. They mistake, indeed, the character of Bacon who seek to represent him as an inventor. His claim to immortality rests chiefly on the profound and comprehensive views which he took of the bearings of the different parts of human knowlege; for it would be difficult to point out a single fact or observation with which he enriched the store of physical science. On the contrary, being very deficient in mathematical learning, he disregarded or rejected some of the noblest discoveries made in his own time.

We can find only two passages in Bacon's works which can be considered as referring to aeronautics, and they both occur in that collection of loose facts and inconclusive reasonings which he has entitled *Natural History*. The first is styled *Experiment Solitary, touching Flying in the Air*, and runs thus—"Certainly many birds of good wing (as kites and the like) would bear up a good weight as they fly; and spreading feathers thin and close, and in great breadth, will likewise bear up a great weight, being even laid, without tilting up on the sides. *The farther extension of this experiment might be thought upon.*" The second passage is more diffuse, but less intelligible; it is styled *Experiment Solitary, touching the Flying of unequal Bodies in the Air*:—"Let there be a body of unequal weight (as of wool and lead or bone and lead); if you throw it from you with the light end forward, it will turn, and the weightier end will recover to be forwards, unless the body be over long. The cause is, for that the more dense body hath a more violent pressure of the parts from the first impulsion, which is the cause (though heretofore not found out, as hath been often said) of all violent motions; and when the hinder part moveth swifter (for that it less endureth pressure of parts) than the forward part can make way for it, it must needs be that the body turn over; for (turned) it can more easily draw forward the lighter part." The fact here alluded to is the resistance that bodies experience in moving through the air, which, depending on the quantity of surface merely, must exert a proportionally greater effect on rare substances. The passage itself, however, after making every allowance for the period in which it was written, must be deemed confused, obscure, and unphilosophical.

Discovery of the balloon.

We now come to the discovery of the balloon, which was due to Stephen and Joseph Montgolfier, sons of Peter Montgolfier, a large and celebrated papermaker at Annonay,

The brothers Montgolfier.

a town about 40 miles from Lyons. The brothers had observed the suspension of clouds in the atmosphere, and it occurred to them that if they could enclose any vapour of the nature of a cloud in a large and very light bag, it might rise and carry the bag with it into the air. They accordingly made experiments, inflating bags with smoke from a fire placed underneath, and found either that the smoke or some vapour emitted from the fire did ascend and carry the bag with it. Being thus assured of the correctness of their views, they determined to have a public ascent of a balloon on a large scale. They accordingly invited the States of Vivarais, then assembled at Annonay, to witness their aerostatic experiment; and on June 5, 1783, in the presence of a considerable concourse of spectators, a linen globe of 105 feet in circumference was inflated over a fire fed with small bundles of chopped straw, and when released rapidly rose to a great height, and descended, at the expiration of ten minutes, at the distance of about 1½ mile. This was the discovery of the balloon. The brothers Montgolfier imagined that the bag rose because of the levity of the smoke or other vapour given forth by the burning straw; and it was not till some time later that it was recognised that the ascending power was due merely to the lightness of heated air compared to an equal volume of air at a lower temperature. Air, like all other fluids, expands by heat, and thereby becomes rarefied, so that any volume of hot air weighs less than the corresponding volume of air at a lower temperature. If, then, the air inside the balloon be so heated that it, together with the balloon, weighs less than the air displaced, the balloon will rise till it arrives at such a height that it and the enclosed air are equal in weight to that of the displaced air, when equilibrium will be obtained. In Montgolfier's first balloon, no source of heat was taken up with it, so that the air inside rapidly cooled, and the balloon soon descended.

Ascent of the first air-balloon.

The news of the experiment at Annonay rapidly spread over Europe, and at Paris attracted so much attention that M. Faujas de Saint-Fond, a naturalist, set on foot a subscription for paying the expense of repeating the experiment. The balloon was constructed by two brothers of the name of Robert, under the superintendence of M. Charles, professor of natural philosophy in Paris, and afterwards a member of the Academy of Sciences. It had at first been suggested to copy the process of Montgolfier, but Charles proposed the application of hydrogen gas, which was adopted. The filling of the balloon, which was made of thin silk varnished with a solution of elastic gum, and was about 13 feet in diameter, was commenced on August 23, 1783, in the Place des Victoires. The hydrogen gas was obtained by the action of dilute sulphuric acid upon iron filings, and was introduced through leaden pipes; but as the gas was not passed through cold water, great difficulty was experienced in filling the balloon completely; and altogether about 500 ℔ of sulphuric acid and twice that amount of iron filings were used. Bulletins were issued daily of the progress of the inflation; and the crowd was so great that on the 26th the balloon was moved to the Champ de Mars, a distance of 2 miles. This was done secretly, in the middle of the night, to avoid the crowd; and the appearance of the balloon being thus removed, preceded by lighted torches and escorted by a detachment of soldiers, is described as having been very remarkable. On the next day, August 27, an immense concourse of people covered the Champ de Mars, and every spot from which a view could be obtained was crowded. About five o'clock a cannon was discharged as the signal for the ascent, and the balloon when liberated rose to the height of about 3000 feet with great rapidity. A shower of rain which began to fall directly after the balloon had left the earth in no way checked its progress; and the excitement was so great, that thousands of well-dressed spectators many of them ladies, stood exposed, watching it intently the whole time it was in sight, and were drenched to the skin. The balloon, after remaining in the air for about three-quarters of an hour, fell in a field near Gonesse, about 15 miles off, and terrified the peasantry so much that it was torn into shreds by them. Hydrogen gas was at this time known by the name of inflammable air; and balloons inflated with gas have ever since been called by the people air-balloons, the kind invented by the Montgolfiers being designated fire-balloons. French writers have also very frequently styled them after their inventors, *Charlières* and *Montgolfières*.

Ascent of a sheep, a cock, and a duck.

On the 19th of September 1783 Joseph Montgolfier repeated the Annonay experiment at Versailles, in the presence of the king, the queen, the court, and an immense number of spectators. The inflation was commenced at one o'clock, and completed in eleven minutes, when the balloon rose to the height of about 1500 feet, and descended after eight minutes, at a distance of about two miles, in the wood of Vaucresson. Suspended below the balloon, in a cage, had been placed a sheep, a cock, and a duck, which were thus the first aerial travellers. They were quite uninjured, except the cock, which had its right wing hurt in consequence of a kick it had received from the sheep; but this took place before the ascent. The balloon, which was painted with ornaments in oil colours, had a very showy appearance. See Plate I.

Ascent of M. Pilâtre de Rozier and the Marquis d'Arlandes.

The first human being who ascended in a balloon was M. François Pilâtre de Rozier, a young naturalist, who, two years afterwards, was killed in an attempt to cross the English Channel in a balloon. On October 15, 1783, and following days, he made several ascents (generally alone, but once with a companion, M. Girond de Villette), in a captive balloon (*i.e.*, one attached by ropes to the ground), and demonstrated that there was no difficulty in taking up fuel and feeding the fire, which was kindled in a brazier suspended under the balloon, when in the air. The way being thus prepared for aerial navigation, on November 21, 1783, M. Pilâtre de Rozier and the Marquis d'Arlandes first trusted themselves to a free fire-balloon. The experiment was made from the Jardin du Chateau de la Muette, in the Bois de Boulogne. The machine employed, which was a large fire-balloon, was inflated at about two o'clock, and leaving the earth at this time, it rose to a height of about 500 feet, and passing over the Invalides and the Ecole Militaire, descended beyond the Boulevards, about 9000 yards from the place of ascent, having been between twenty and twenty-five minutes in the air. The result was completely successful; and it is scarcely necessary to add, the excitement in Paris was very great.

Ascent of MM. Charles and Robert in a balloon inflated with hydrogen gas. See Plate I.

Only ten days later, viz., on December 1, 1783, MM. Charles and Robert ascended from Paris in a balloon inflated with hydrogen gas. The balloon, as in the case of the small one of the same kind previously launched from the Champ de Mars, was constructed by the brothers Robert. It was 27 feet in diameter, and the car was suspended from a hoop surrounding the middle of the balloon, and fastened to a net which covered the upper hemisphere. The balloon ascended very gently from the Tuileries at a quarter to two o'clock, and after remaining for some time at an elevation of about 2000 feet, it descended in about two hours at Nesle, a small town about 27 miles from Paris, when M. Robert left the car, and M. Charles made a second ascent by himself. He had intended to have replaced the weight of his companion by a nearly equivalent quantity of ballast; but not having any suitable means of obtaining such ready at the place of descent, and it being just upon sunset, he gave the word

to let go, and the balloon being thus so greatly lightened, ascended very rapidly to a height of about 2 miles. After staying in the air about half-an-hour, he descended 3 miles from the place of ascent, although he believed the distance traversed, owing to different currents, to have been about 9 miles. In this second journey M. Charles experienced a violent pain in his right ear and jaw, no doubt produced by the rapidity of the ascent. He also witnessed the phenomenon of a double sunset on the same day; for when he ascended, the sun had set in the valleys, and as he mounted he saw it rise again, and set a second time as he descended.

All the features of the modern balloon as now used are more or less due to Charles, who invented the valve at the top, suspended the car from a hoop, which was itself attached to the balloon by netting, &c. The M. Robert who accompanied him in the ascent was one of the brothers who had constructed it.

Ascent of seven persons at Lyons.

On January 19, 1784, the largest balloon on record (if the contemporary accounts are correct) ascended from Lyons. It was more than 100 feet in diameter, about 130 feet in height, and when distended had a capacity, it is said, of over half-a-million cubic feet. It was called the *Flesselles* (from the name of its proprietor or owner, we believe), and after having been inflated from a straw fire in seventeen minutes, it rose with seven persons in the car, viz., Joseph Montgolfier, Pilâtre de Rozier, Count de Laurencin, Count de Dampierre, Prince Charles de Ligne, Count de Laport d'Anglefort, and M. Fontaine, the last gentleman having leaped into the car just as the machine had started. The fire was fed with trusses of straw, and the balloon rose majestically to the height of about 3000 feet, but descended again after the lapse of about a quarter of an hour from the time of starting, in consequence of a rent in the upper part.

American aerostatic experiment in 1783.

It is proper here to state that researches on the use of gas for inflating balloons seem to have been carried on at Philadelphia nearly simultaneously with the experiments of the Montgolfiers; and when the news of the latter reached America, Messrs Rittenhouse and Hopkins, members of the Philosophical Academy of Philadelphia, constructed a machine consisting of forty-seven small hydrogen gas-balloons attached to a car or cage. After several preliminary experiments, in which animals were let up to a certain height by a rope, a carpenter, one James Wilcox, was induced to enter the car for a small sum of money; the ropes were cut, and he remained in the air about ten minutes, and only then effected his descent by making incisions in a number of the balloons, through fear of falling into the river, which he was approaching.

Remarks on the discovery of the balloon.

The improvements that have been made in the management and inflation of balloons in the last ninety years have only had reference to details, so that as far as essential principles are concerned the subject is now in pretty much the same state as it was in 1783. We have therefore arrived at a point in the history of the balloon where it is well to consider how much the Montgolfiers and Charles owed to their predecessors; and it is proper here to state that, although we have assigned the invention to the two brothers, Stephen and Joseph—as no doubt they both conducted the early experiments together—still there is reason to believe that the share of the latter was very small. Stephen, however, although the originator of balloons, does not appear ever to have ascended himself, and Joseph did not repeat the ascent just mentioned in the *Flesselles*. The Montgolfiers had studied Priestley's *Experiments relating to different kinds of Air*, whence they first conceived the possibility of navigating the atmosphere; but their experiment was so simple as to require scarcely any philosophical knowledge. They had seen smoke ascend, and thought that if they could imprison it in a bag, the bag might ascend too; and the observation and reasoning were both such as might occur to anybody. This does not detract from their merit; it, on the contrary, adds to it The fact that millions of persons must have observed the same thing, and had *not* derived anything practical therefrom, only enhances the glory of those who in such well-worn tracts did make a discovery; but the simplicity of the invention shows that it is needless to inquire whence the brothers were led to make it, and how far any part of the credit is due to their predecessors. It is scarcely possible to imagine anything more remarkable than that the fact that a light bag held over a fire would ascend into the air was not discovered till 1783, notwithstanding that men in all ages had seen smoke ascend from fire (though, of course, the fire-balloon does not ascend for exactly the same reason that smoke does). It might be supposed that the connection of the Montgolfiers with a paper manufactory gave them facilities for constructing their experimental balloons of thin paper; and perhaps such was the case, although we can find no evidence of it. With regard to Charles's substitution of hydrogen gas, there are anticipations that must be noticed. As early as 1766 Cavendish showed that this gas was at least seven times lighter than ordinary air, and it immediately occurred to Dr Black, of Edinburgh, well known as the discoverer of latent heat, that a thin bag filled with hydrogen gas would rise to the ceiling of a room. He provided, accordingly, the allantois of a calf, with the view of showing at a public lecture such a curious experiment; but for some reason it seems to have failed, and Black did not repeat it, thus allowing a great discovery, almost within his reach, to escape him. Several years afterwards a similar idea occurred to Tiberius Cavallo, who found that bladders, even when carefully scraped, are too heavy, and that China paper is permeable to the gas. But in 1782, the year before the invention of the Montgolfiers, he succeeded in elevating soap-bubbles by inflating them with hydrogen gas. The discovery of fire-balloons might have taken place almost at any time in the world's history, but the substitution of hydrogen gas for heated air could not have been made previously to the latter half of the last century; and although all the honour of an independent discovery belongs to the Montgolfiers, Charles, by his substitution of "inflammable air" for heated air, merely showed himself acquainted with the state of chemical science of his day. Charles never again ascended after his double expedition on the 1st of December 1783.

Dr Black's experiments.

Cavallo inflated soap bubbles with hydrogen gas in 1782.

First ascents of balloons in England.

We now return to the history of aerial navigation, and commence with an account of the first ascents of balloons in this country. Although the news of the Annonay and subsequent experiments in France rapidly spread all over Europe, and formed a topic of general discussion, still it was not till five months after the Montgolfiers had first publicly sent a balloon into the air that any aerostatic experiment was made in England. In November 1783 Count Zambeccari, an Italian, who happened to be in London, made a balloon of oil-silk, 10 feet in diameter, and weighing 11 ℔. It was publicly shown for several days, and on the 25th it was three-quarters filled with hydrogen gas, and launched from the Artillery ground at one o'clock. It descended after two hours and a half near Petworth, in Sussex, 48 miles from London. This was the first balloon that ascended from English ground. On February 22, 1784, a hydrogen gas balloon, 5 feet in diameter, was let up from Sandwich, in Kent, and descended at Warneton, in French Flanders, 75 miles distance. This was the first balloon that crossed the Channel. The difficulties and dangers of aerial navigation having been surmounted by the end of the year

1783, the ascents of balloons were now multiplied in all quarters. It will therefore be sufficient to notice very briefly only the more remarkable of the succeeding ascents.

Andreani. The Chevalier Paul Andreani, of Milan, constructed a fire-balloon 68 feet in diameter, and on February 25, 1784, ascended from Milan with two brothers of the name of Gerli, and remained in the air for about twenty minutes. This is usually regarded as the first ascent in Italy (but see Monck Mason's *Aeronautica*, p. 247). Andreani ascended again on March 13, with two other persons.

Blanchard. On the 2d of March M. Jean Pierre Blanchard, who had been for some years before occupied with projects for flying, made his first voyage from Paris in a balloon 27 feet in diameter, and descended at Billancourt, near Sevres. Just as the balloon was about to ascend, a young man jumped into the car, and, drawing his sword, declared his determination to ascend with Blanchard. He was ultimately removed by force. The episode is worth noting, as it has sometimes been stated that the young man was Napoleon Bonaparte, but this is untrue; his name was Dupont de Chambon. Blanchard made subsequently, it is said, more than thirty aerial voyages, and he is one of the most celebrated of the earlier aeronauts. He also crossed the English Channel, as noticed further on.

On July 15, 1784, the Duc de Chartres and the two brothers Robert ascended from St Cloud; but the neck of the balloon becoming choked up with an interior balloon filled with common air, intended to regulate the ascending and descending power, they were obliged to make a hole in the balloon, in order to allow of the escape of the gas, but they descended in safety.

Tytler. The first person who rose into the air from British ground appears to have been Mr J. Tytler,[1] who ascended from the Comely Gardens, Edinburgh, on August 27, 1784, in a fire-balloon of his own construction. He descended on the road to Restalrig, about half-a-mile from the place where he rose. A brief account appeared in a letter, under date August 27, in the *London Chronicle*, and we have seen a picture of the balloon copied in some journal from a "ticket in the British Museum." Mr Tytler's claims were for a long time entirely overlooked, the honour being invariably assigned to Lunardi, till attention was called to them by Mr Monck Mason in 1838. After Lunardi's successful ascents in 1785, Mr Tytler addressed a set of verses to him (quoted in *Astra Castra*, p. 108), in a note, to which he gives a modest account of his own "misfortunes," describing his two "leaps." This is, perhaps, the most correct name for them, as his apparatus having been damaged at different times, he merely heated the air in the balloon, and went up without any furnace, being seated in an ordinary basket for carrying earthenware. He reached a height of from 350 to 500 feet.

Lunardi. Although by a few days Tytler has the precedence, still his attempts and partial success were all but totally unknown; whereas Lunardi's experiments excited an enormous amount of enthusiasm in London, and it was he that practically introduced aerostation into this country in the face of very great disadvantages. We have already referred to the extraordinary apathy displayed in England with regard to aerostatic experiments, one consequence of which was that their introduction was due to a foreigner. Vincent Lunardi was secretary to Prince Caramanico, the Neapolitan ambassador, and his published letters to his guardian, the Chevalier Compagni, written while he was carrying out his project, and detailing all the difficulties, &c., he met with as they occurred, are very interesting, and give a vivid account of the whole matter. His balloon was 33 feet in circumference, and was exposed to the public view at the Lyceum in the Strand, where it was visited by upwards of 20,000 people. It was his original intention to have ascended from Chelsea Hospital, but the conduct of a crowd at a garden at Chelsea, which destroyed the fire-balloon of a Frenchman named De Moret, who announced an ascent on August 11, but was unable to keep his word, led to the withdrawal of the leave that had been granted. Ultimately, after some difficulties had been arranged, he was permitted to ascend from the Artillery ground, and on September 15, 1784, the inflation with hydrogen gas took place. It was intended that Mr Biggin, an English gentleman, should accompany Lunardi; but the crowd becoming impatient, the latter judged it prudent to ascend with the balloon only partially full rather than risk a longer delay, and accordingly Mr Biggin was obliged to leave the car. Lunardi therefore ascended alone, in presence of the Prince of Wales and an enormous crowd of spectators. He took up with him a pigeon, a dog, and a cat, and the balloon was provided with oars, by means of which he hoped to raise or lower it at pleasure. Shortly after starting, the pigeon escaped, and one of the oars became broken and fell to the ground. In about an hour and a half he descended at South Mimms, in Hertfordshire, and landed the cat, which had suffered from the cold: he then ascended again, and descended, after the lapse of about three-quarters of an hour, at Standon, near Ware, where he had great difficulty in inducing the peasants to come to his assistance; but at length a young woman, taking hold of one of the cords, urged the men to follow her example, which they then did. The excitement caused by this ascent was immense, and Lunardi at once became the star of the hour. He was presented to the king, and was courted and flattered on all sides. To show the enthusiasm displayed by the people during his ascent, he tells himself, in his sixth letter, how a lady, mistaking the oar which fell for himself, was so affected by his supposed destruction that she died in a few days; but, on the other hand, he says he was told by the judges "that he had certainly saved the life of a young man who might possibly be reformed, and be to the public a compensation for the death of the lady;" for the jury were deliberating on the fate of a criminal, whom they must ultimately have condemned, when the balloon appeared, and every one became inattentive, and to save time they gave a verdict of acquittal, and the whole court came out to view the balloon. The king also was in conference with his ministers; but on hearing that the balloon was passing, he broke up the discussion, remarking that they might resume their deliberations, but that perhaps they might not see Lunardi again; upon which he, Mr Pitt, and the other ministers viewed the balloon through telescopes. The balloon was afterwards exhibited in the Pantheon. In the latter part of the following year (1785) Lunardi made several very successful ascents from Kelso, Edinburgh, and Glasgow (in one of which he traversed a distance of 110 miles): these he has described in a second series of letters. He subsequently returned to Italy, where we believe he still followed the practice of aerostation, and made many ascents. He died on July 31, 1806, at Lisbon, according to the *Gentleman's Magazine*, but a contemporary newspaper gives Genoa as the place, and adds that he died in a state of very great indigence.

See Plate I.

Other ascents in England. Lunardi's example was soon followed by others, and on October 16, 1784, Blanchard ascended from Little Chelsea with Mr Sheldon, and having deposited the latter at Sunbury, rose again alone, and descended at Romney Marshes. On November 12, Mr James Sadler, sen., ascended from Oxford, and there is every reason to believe that he made a previous ascent from the same place on October 12, four

[1] Mr Tytler contributed largely to, and, indeed, appears to have been virtually editor of, the second edition (1778–83) of the *Encyclopædia Britannica*.

days previous to Blanchard's (see Monck Mason, p. 274, where it is stated that he attempted to ascend in a fire-balloon on September 12, but that the balloon was burnt). On November 30, 1784, Blanchard again ascended, accompanied this time by Dr J. Jeffries, an American physician. On January 4, 1785, Mr Harper ascended from Birmingham; and on January 7, Blanchard and Dr Jeffries achieved the feat of crossing the Channel from Dover to Calais. At seven minutes past one the balloon left Dover Castle, and in their passage they had a most magnificent view of both shores. When about one-third across they found themselves descending, and threw out every available thing from the boat or car. When about three-quarters across they were descending again, and had to throw out not only the anchor and cords, but also to strip and throw away part of their clothing, after which they found they were rising, and their last resource, viz., to cut away the car, was rendered unnecessary. As they approached the shore the balloon rose, describing a magnificent arch high over the land. They descended in the forest of Guinnes.

Blanchard and Jeffries cross the Channel.

Fate of Zambeccari.

On March 23, 1785, Count Zambeccari, who had, as we have seen, launched the first balloon from English ground, ascended for the first time with Admiral Vernon from London. Shortly afterwards he returned to his own country, and there applied himself assiduously to the practice of aerial navigation. He twice, in 1803 and 1804, descended into the Adriatic, and both times only escaped after undergoing much danger. Descending in a fire-balloon on September 21, 1812, after a voyage from Bologna, the shock of the grapnel catching in a tree caused the balloon to catch fire; and to save themselves from being burnt, Zambeccari and his companion, Signor Bonaga, leaped from the car. The former was killed on the spot, but the latter, though fearfully injured, escaped with his life.

Fate of Pilâtre de Rozier.

On June 15, 1785, Pilâtre de Rozier made his last fatal voyage from Boulogne. It was his intention to have repeated the exploit of Blanchard and Jeffries in the reverse direction, and have crossed from Boulogne to England. For this purpose he had contrived a double balloon, which he expected would combine the advantages of both kinds—a fire-balloon, 10 feet in diameter, being placed underneath a gas-balloon of 37 feet in diameter, so that by increasing or diminishing the fire in the former it might be possible to ascend or descend without waste of gas. Rozier was accompanied by M. P. A. Romain, and for rather less than half-an-hour after the aerostat ascended all seemed to be going on well, when suddenly the whole apparatus was seen in flames, and the unfortunate adventurers came to the ground from the supposed height of more than 3000 feet. Rozier was killed on the spot, and Romain only survived about ten minutes. A monument was erected on the place where they fell, which was near the sea-shore, about four miles from the starting-point. The Marquis de la Maisonfort had accompanied Rozier to Boulogne, intending to ascend with him, but M. Romain there insisted on a prior promise. Either the upper balloon must have been reached by the flames, and the gas taken fire, or the gas must have poured down into the lower balloon, and so have caused the explosion.

Female aeronauts.

We must not omit to mention that on June 4, 1784, Madame Thible ascended from Lyons in a fire-balloon with M. Fleurand, in the presence of King Gustavus of Sweden, then travelling under the name of Count Haga. Madame Thible is very likely the only woman who ever ascended in a fire-balloon. The first Englishwoman who ever ascended into the air was Mrs Sage, who accompanied Mr Biggin in his voyage from London on June 29, 1785.

Ascent at Constantinople.

Accounts are given of an ascent at Constantinople, made in the presence of the Sultan, by a Persian physician, accompanied by two Bostangis, early in the year 1786, who, crossing the sea which divides Europe from Asia, descended about 30 leagues from the coast.

[illegible] for plea-sure, and [illegible]

We have now given a brief account of all the noteworthy voyages that took place within the first two or three years after the discovery of the balloon by Montgolfier. Ascents were multiplied from this time onwards, and it is impossible to give even a list of the many hundreds that have taken place since: this omission is, however, of slight importance, as henceforth the balloon became little better than a toy, let up to amuse people at *fêtes* or other public occasions. When the first ascents were made in France, the glow of national vanity was lighted up, and the most brilliant expectations were felt with regard to aerostation, and the glory to the nation that would accrue therefrom. These anticipations have not been realised, and the balloon at this moment has received no great improvement since the time of Charles, except the substitution of ordinary coal-gas for hydrogen, which has rendered the inflation of a balloon at any gas-works a comparatively simple matter, bearing in mind the elaborate contrivances required for the generation of hydrogen in sufficient quantities. But in one respect the balloon has been of real service, viz., to science, in rendering the attainment of observations in the higher strata of the atmosphere not only possible but practicable. In regard to such matters the balloon is unique, as the atmosphere is the great laboratory of nature, in which are produced all the phenomena of weather, the results of which we perceive on the earth; and no observations made on mountain-sides can take the place of those made in the balloon, as what is required is the knowledge of the state of the upper atmosphere itself, free from the disturbing effects of the contiguity of the land. Although, therefore, in what follows, we shall notice any particularly remarkable ascents, we shall chiefly confine ourselves to the few that have been undertaken for the sake of advancing science, and which alone are of permanent value. It will be necessary to make one exception to this rule, however, in the case of the parachute, the experiments with which require some notice, although they have been put to no useful purpose. The balloon has also been used in warfare as a means of observing the movements of the enemy; and the applications of it to this purpose deserve notice, although we think not so much use has been made of the balloon in this direction as might have been.

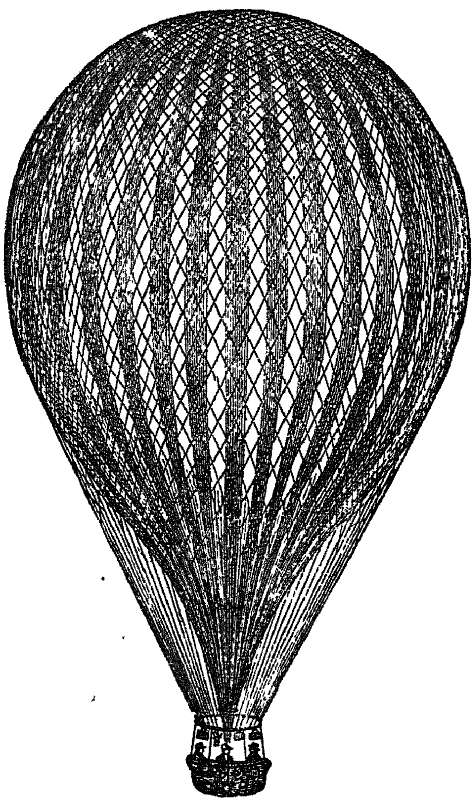
Substitution of coal-gas for hydrogen by Mr Green.

The substitution of coal-gas for hydrogen is due to Mr Charles Green, the veteran aeronaut, who made several hundred ascents, the first of which took place on July 19, 1821, the coronation day of George IV. In this ascent ordinary coal-gas was first used; and every balloon, with very few exceptions, that has ascended since this date has been so inflated. Pall Mall was first lighted by gas in 1807, and at the end of 1814 the general lighting of London by gas commenced; so that coal-gas could not have been available for filling balloons long before it was actually used.

Subsequent famous ascents (non-scientific).

Leaving out of consideration the ascents undertaken for scientific objects (very many of which were remarkable for the height attained or the distance traversed, and which will be specially noticed further on), we proceed to mention the most noteworthy ascents that have taken place and that have not ended fatally (these latter will be referred to separately). Mr Crosbie, a gentleman who was the first to ascend from Ireland (January 19, 1785), on the 19th July 1785 attempted to cross St George's Channel to England, but fell into the sea; he was saved by some vessels that came to his rescue. Lunardi also fell into the sea, about a mile and a half from the shore, after an ascent from Edinburgh in December 1785; he was rescued by a fishing-boat. Richard Maguire was the second person

who ascended from Ireland. Mr Crosbie had inflated his balloon on May 12, 1785, but it was unable to take him up, when Mr Maguire, a student at the university, who was present, offered to ascend. His offer was accepted, and he made the ascent. For this he was knighted by the Lord-Lieutenant (Monck Mason, p. 266). On July 22, 1785, Major Money ascended from Norwich. The balloon was blown out to sea, and he was obliged to descend into the water. After remaining there seven hours he was rescued by a revenue cutter which had been despatched to his assistance. Mr James Sadler attempted to cross St George's Channel on the 1st of October 1812, and had nearly succeeded, when, in consequence of a change in the wind, he was forced to descend into the sea off Liverpool. After remaining in the water some time, he was rescued by a fishing-boat. But on July 22, 1817, Mr Windham Sadler, his second son, succeeded in crossing the Channel from Dublin to Holyhead. On May 24, 1837, Mr Sneath ascended from near Mansfield in a fire-balloon, and descended safely. At half-past one o'clock on November 7, 1836, Mr Robert Hollond, Mr Monck Mason, and Mr Charles Green ascended from Vauxhall Gardens, and descended at about two leagues from Weilburg, in the duchy of Nassau, at half-past seven the next morning, having thus traversed a distance of about 500 miles in 18 hours; Liége was passed in the course of the night, and Coblentz in the early morning. A full account of this trip is given by Mr Monck Mason in his *Aeronautica* (1838). The balloon in which the journey was performed (a very large one, containing about 85,000 cubic feet of gas), was subsequently called the *Nassau Balloon*, and under that name became famous, and ascended frequently.



The Great Nassau Balloon.

Equestrian ascents.

We ought also, perhaps, to notice a curious ascent made by Mr Green on July 29, 1828, from the Eagle Tavern, City Road, on the back of a favourite pony. Underneath the balloon was a platform (in place of a car) containing places for the pony's feet, and some straps went loosely under his body, to prevent his lying down or moving about. Everything passed off satisfactorily, the balloon descending safely at Beckenham; the pony showed no alarm, but quietly ate some beans with which its rider supplied it in the air. Equestrian ascents have since been repeated. In 1852, Madame Poitevin, who had made several such journeys in Paris, ascended from Cremorne Gardens, London, on horseback (as "Europa on a bull"); but after the first journey its repetition was stopped in England by application to the police courts, as the exhibition outraged public feeling. Lieutenant Gale was killed at Bordeaux on Sept. 8, 1850, in descending after an equestrian ascent, through mismanagement in landing of the horse. M. Poitevin, descending in 1858, after an equestrian ascent from Paris, was nearly drowned in the sea near Malaga. Among remarkable balloon ascents must also be noticed that of Mr Wise, from St Louis, on June 23, 1859, in which a distance of 1120 miles was traversed.

Nadar's balloon.

In 1863, Nadar, a well-known photographer at Paris, constructed an enormous balloon, which he called "Le Géant." It was the largest gas-balloon ever constructed, containing over 200,000 cubic feet of gas. Underneath it was placed a smaller balloon, called a compensator, the object of which was to prevent loss of gas during the voyage. The car had two stories, and was, in fact, a model of a cottage in wicker-work, 8 feet in height by 13 feet in length, containing a small printing-office, a photographic department, a refreshment-room, a lavatory, &c. The first ascent took place at five o'clock on Sunday, October 4, 1863, from the Champ de Mars. There were thirteen persons in the car, including one lady, the Princess de la Tour d'Auvergne, and the two aeronauts Louis and Jules Godard. In spite of the elaborate preparations that had been made and the stores of provisions that were taken up, the balloon descended at nine o'clock, at Meaux, the early descent being rendered necessary, it was said, by an accident to the valve-line. A second ascent was made a fortnight later, viz., on October 18; there were nine passengers, including Madame Nadar. The balloon descended at the expiration of seventeen hours, near Nienburg in Hanover, a distance of about 400 miles. A strong wind was blowing, and the balloon was dragged over the ground a distance of 7 or 8 miles. All the passengers were bruised, and some more seriously hurt. The balloon and car were then brought to England, and exhibited for some time at the Crystal Palace at the end of 1863 and beginning of 1864. The two ascents of Nadar's balloon excited an extraordinary amount of enthusiasm and interest, vastly out of proportion to what they were entitled to. The balloon was larger than any of the same kind that had previously ascended; but this was scarcely more than just appreciable to the eye, as the doubling the contents of a balloon makes comparatively slight addition to its diameter. M Nadar's idea was to obtain sufficient money, by the exhibition of his balloon, to carry out a plan of aerial locomotion he had conceived possible by means of the principle of the screw; in fact, he spoke of "Le Géant" as "the last balloon." He also started *L'Aeronaute*, a newspaper devoted to aerostation, and published a small book, which was translated into English under the title *The Right to Fly*. Nadar's ascents had not the remotest connection with science, although he claimed that they had, nor was his knowledge, as shown in his writings, sufficient to have enabled him to advance it in any way.

Eugene Godard's large fire-balloon.

Directly after Nadar's two balloon ascents, M. Eugene Godard constructed what was perhaps the largest aerial machine that has ever been made. It was a Montgolfier or fire-balloon, of nearly half-a-million cubic feet capacity (more than double the capacity of Nadar's). The balloon *Flesselles*, 1783, is said to have slightly exceeded this size. The air was heated by an 18 feet stove, weigh-

ing, with the chimney, 980 lb. This furnace was fed by straw; and the "car" consisted of a gallery surrounding it. Two ascents of this balloon were made from Cremorne Gardens, on July 20 and July 28, 1864. After the first journey the balloon descended at Greenwich, and after the second at Walthamstow, where it was injured by being blown against a tree. Notwithstanding the enormous size of the balloon, M. Godard asserted that it could be inflated in half an hour, and the inflation at Cremorne did not occupy more than an hour. The ascent of the balloon was a very striking sight, the flames roaring up the chimney of the furnace into the enormous globe above. The trusses of straw were suspended by ropes from the gallery below the car, and were drawn up and placed in the furnace as required. This was the first fire-balloon seen by the inhabitants of London, and it was the second ascent of this kind that had been made in this country, Mr Sneath's ascent at Mansfield having been the first, as Mr Tytler's experiment at Edinburgh in 1784 was a leap, not an ascent, as no source of heat was taken up. In spite of the rapidity with which the inflation was effected, few who saw the ascent could fail to receive an impression most favourable to the gas-balloon in the matter of safety, as a rough descent, with a heated furnace as it were in the car, could not be other than most dangerous.

Projected balloon voyage across the Atlantic in 1873.

In the summer of 1873 the proprietors of the New York *Daily Graphic*, an illustrated paper, determined to construct a very large balloon, and enable Mr Wise, the well-known American aeronaut, to realise his favourite scheme of crossing the Atlantic Ocean to Europe. It was believed by many that a current from west to east existed constantly at heights above 10,000 feet, but this seems very uncertain. Mr Green having stated that he had met with such a current, Mr Glaisher made a point of investigating the directions of the wind at different heights in his ascents, but found that they were as capricious as near the ground. The same result was found by others, and a comparison of the courses of the balloons sent up from Paris during the siege will show that no constant current exists. The American project came to nothing owing to the quality of the material of which the balloon was made. The size was said to be such as to contain 400,000 cubic feet, so that it would lift a weight of 14,000 lb. On September 12, 1873, during its inflation, Mr Wise declared the material of which it was made was so bad that he could not ascend in it, though the other two persons who were to accompany him agreed to go. When, however, 325,000 feet of gas had been put into the balloon, a rent was observed, and the whole rapidly collapsed. Although this accident was greatly regretted at the time, it seems pretty certain, from what subsequently took place, that the aeronauts would not have succeeded in their object, and a serious mishap was probably avoided. On October 6, 1873, Mr Donaldson and two others ascended from New York in the balloon after it had been repaired, and effected a perilous descent in Connecticut. During the autumn of 1873 a great amount of discussion took place both in England and America about the existence of the westerly current and the subject of aerostation. In September 1873 Mr Barnum, the well-known American showman, visited England with the view of eliciting whether, in the opinion of those best qualified, there was sufficient probability of a successful result to induce him to undertake the construction of a suitable balloon.

Celebrated aeronauts.

By aeronauts (omitting the pioneers Lunardi, Zambeccari, and others who have been already spoken of) we mean persons who have followed ballooning as a business or trade. Of these, perhaps the best known and most successful have been Blanchard, Garnerin, the Sadlers, Mr Charles Green, Mr Wise, Mr Coxwell, and the brothers Godard. Blanchard made, it is said, thirty-six ascents, his first having taken place on March 2, 1784. His wife also made many ascents; she was killed on July 7, 1819. Garnerin is said to have ascended more than fifty times; he introduced night ascents with fireworks, &c., the first of which took place on August 4, 1807. We shall have occasion to refer to him again when we treat of parachutes. Mr James Sadler made about sixty ascents, the first of which took place on October 12, 1784. His two sons, John and Windham, both followed in their father's steps; the latter was killed in 1817. In the minds of most Englishmen the practice of ballooning will, for a long time, be associated with the name of Mr Charles Green, the most celebrated of English aeronauts, who, having made his first ascent on July 19, 1821, only died in the year 1870, at a very advanced age. He is credited with 526 ascents by Mr Turnor; and from advertisements, &c., we see that in 1838 he had made 249. Mr Green may be said to have reduced ballooning to routine, and he made more ascents than any other person has ever accomplished. He accompanied Mr Welsh in his scientific ascents, and to him is also due the invention of the *guide rope*, which he used in many of his voyages with success. It merely consisted of a rope not less than 1000 feet in length, which was attached to the ring of the balloon (from which the car is suspended), and hung down so that the end of it was allowed to trail along the surface of the ground, the object being to prevent the continual waste of gas and ballast that takes place in an ordinary balloon journey, as such an expenditure is otherwise always going on, owing to the necessity of keeping the balloon from getting either too high or too low. If a balloon provided with a guide rope sinks so low that a good deal of the rope rests on the earth, it is relieved of so much weight and rises again; if, on the contrary, it rises so high that but a little is supported by the earth, a greater weight is borne by the balloon, and equilibrium is thus produced. Mr Green frequently used the guide rope, and found that its action was satisfactory, and that it did not, as might be supposed, become entangled in trees, &c. It was used in the Nassau journey, but more recent aeronauts have dispensed with it. Still, in crossing the sea or making a very long journey, where the preservation of the gas was of great importance, it could not fail to be valuable. Mr Green had, in his time, more experience in the management than has fallen to the lot of any one else, and he brought to bear on the subject a great amount of skill and practical knowledge. There is also a plain matter-of-fact style about his accounts of his ascents that contrasts very favourably with the writings of some other aeronauts. Mr Coxwell, who has made several hundred ascents, first ascended in 1844, under the name of Wells. He it was who, as aeronaut, accompanied Mr Glaisher in most of his scientific ascents, 1862–65. The Godard family have made very many ascents in France, and are well known in all countries in connection with aeronautics. It was to two of the Godards that the management of the military balloons in the Italian campaign was entrusted; it was M. Jules Godard who succeeded in opening the valve in the dangerous descent of Nadar's balloon in Hanover in 1863, and it was Eugene Godard who constructed perhaps the largest Montgolfier ever made, an account of the ascensions of which has been given above. M. Dupuis Delcourt was also a well-known aeronaut; he has written on the subject of aerostation, and his balloons were employed by MM. Bixio and Barral in their scientific ascents. In America Mr Wise is *par excellence* the aeronaut; he has made several hundred ascents, and many of them are distinguished for much skill and daring. He also appears to have pursued his profession with more energy and capacity than has any other aeronaut in recent times, and his *History*

of Aerostation shows him to possess much higher scientific attainments than balloonists usually have. In fact, Mr Wise stands alone in this respect, as nearly all professional aeronauts are destitute of scientific knowledge.

Balloon accidents that have terminated fatally.

The number of fatal accidents that have occurred in the history of balloons is not very great, and nearly all have resulted either from the use of the fire-balloon, or from want of knowledge, or carelessness on the part of the aeronauts themselves. We have already referred to the accidents that closed the careers of Pilâtre de Rozier and Zambeccari. On November 25, 1802, Signor Olivari, at Orleans, and on July 17, 1812, Herr Bittorff, at Mannheim, perished in consequence of the accidental combustion of their *Montgolfières*. On April 7, 1806, M. Mosment ascended from Lille upon a platform, from which he accidentally fell and was killed. On July 7, 1819, Madame Blanchard ascended from Paris at night with fireworks attached to the car, a spark from one of which ignited the gas in the balloon, and she was precipitated to the ground and killed. Lieut. Harris ascended from London on May 25, 1824, but, through mismanagement of the valve-line, he allowed all the gas to escape suddenly from the balloon, which descended with terrible velocity. He was killed by the fall, but his companion, Miss Stocks, escaped almost uninjured. In an ascent from Blackburn on September 29, 1824, by Mr Windham Sadler, the balloon, in rising, struck against a chimney, and the aeronaut fell over the side of the car and was killed. On July 24, 1837, Mr Cocking descended from a balloon in a parachute, which struck the ground with such violence that he was killed on the spot. In descending with a horse on September 8, 1850, Lieut. Gale was killed; and in 1863 Mr Chambers was killed at Nottingham, his death arising from suffocation by the gas that poured out at the neck of the balloon, which was not separated from the car by a sufficient interval.

The number of persons who have ascended in balloons.

The number of accidents that have occurred bears but a very small proportion to the number of successful ascents that have been made. Mr Monck Mason, in his *Aeronautica*, gives a list of the names, with the dates and places of their ascent, of all persons who, as far as he could find, had ascended previously to 1838. His list contains 471 names, which are distributed among the inhabitants of the different countries as follows:—England, 313; France, 104; Italy, 18; Germany and the German States, 17; Turkey, 5; Prussia, 3; Russia, 2; Poland, 2; Hungary, 2, Denmark, 1; Switzerland, 1; and the United States, 3. Among these are the names of 49 women, of whom 28 are English, 17 French, 3 German, and 1 Italian. Some of the persons had ascended a great number of times; thus Mr Charles Green's ascents alone amounted to more than 249; and those of the members of the same family to 535. Mr Mason calculated that the whole number of ascents executed by Englishmen was 752. Of the 471 adventurers only nine were killed, and of these six owed their fate to the dangers attendant on the use of the fire-balloon, and one to bravado. The great number of our own countrymen that appear in the above list is no doubt partially due to the fact that it was compiled by an Englishman, to whom English newspapers and other records were more accessible; still there is no reason to doubt that a much greater number of Englishmen have ascended than inhabitants of any other country, as balloons as an amusement at fêtes, &c., have been more common here. The number of Englishmen who have ascended might now be estimated at from 1500 to 2000.

We can call to mind but three fatal casualties that have taken place since Mr Mason compiled his list, viz., Mr Cocking's parachute accident, Mr Gale's death in 1850, and Mr Chambers' death in 1863.

Scientific ascents.

We come now to an account of the use to which the balloon has been applied for the advancement of science. The ascents that have been made are by Sacharof, Biot, and Gay-Lussac in 1804, by Bixio and Barral in 1850, by Mr Welsh in 1852, by Mr Glaisher in 1862-66, and MM. Flammarion and De Fonvielle in 1867-68. We shall give a brief account of these ascents, because, as has been remarked, with a few exceptions, they form the only useful purpose to which the balloon has been applied. The general description of the phenomena, &c., met with in a high ascent, and the general results found, are referred to in the account of Mr Glaisher's experiments, as not only are his accounts more detailed, but the number of ascents made by him is much in excess of that of all the others put together.

Ascent of M. Sacharof at St Petersburg, January 30, 1804.

The Academy of Sciences at St Petersburg, entertaining the opinion that the experiments made on mountain-sides by De Luc, De Saussure, Humboldt, and others must give results different from those made in free air at the same heights, resolved in 1803 that a balloon ascent should be made for the purpose of making scientific researches. Accordingly, on January 30, 1804, M. Sacharof, a member of the academy, ascended, with M. Robertson as aeronaut, in a balloon belonging to the latter, which was inflated with hydrogen gas. The ascent was made at a quarter past seven, and the descent effected at a quarter to eleven. No great height was reached, as the barometer never sank below 23 in., corresponding to less than 1½ mile. The experiments were not very systematically made, and the chief results were the filling and bringing down several flasks of air collected at different elevations, and the supposed observation that the magnetic dip was altered. A telescope was fixed in the bottom of the car pointing vertically downwards, so that the travellers might be able to ascertain exactly the spot over which they were floating at any moment. M. Sacharof found that, on shouting downwards through his speaking-trumpet, the echo from the earth was quite distinct, and at his height was audible after an interval of about ten seconds. M. Sacharof's account is given in the *Philosophical Magazine* (Tilloch's), vol. xxi. pp. 193-200 (1805).

At the commencement of 1804 Laplace proposed to the members of the French Academy of Sciences that balloons should be employed for the purpose of solving certain physical problems, adding that, as the government had placed funds at their disposal for the prosecution of useful experiments, he thought they might be well applied to this kind of research. The proposition was supported by Chaptal the chemist, who was then minister of the interior, and accordingly the necessary arrangements were speedily effected, the charge of the experiments being given to MM. Gay-Lussac and Biot.

Ascent of Gay-Lussac and Biot, August 24 1804.

The principal object of this ascent was to determine if the magnetic force experienced any appreciable diminution at heights above the earth's surface, De Saussure having found that such was the case upon the Col du Géant. On August 24, 1804, MM. Gay-Lussac and Biot (the former eminent as a chemist and the latter as a natural philosopher) ascended from the Conservatoire des Arts at ten o'clock in the morning. Their magnetic experiments were incommoded by the rotation of the balloon, but they found that, up to the height of 13,000 feet, the time of vibration of a magnet was appreciably the same as on the earth's surface. They found also that the air became drier as they ascended. The height reached was about 13,000 feet, and the temperature declined from 63° Fahr. to 51°. The descent was effected about half-past one, at Meriville, 16 leagues from Paris.

Ascent of M. Gay-Lussac, September 16, 1804.

In a second experiment, which was made on September 16, 1804, M. Gay-Lussac ascended alone. The balloon left the Conservatoire des Arts at 9.40 A.M., and descended at 3.45 P.M. between Rouen and Dieppe. The chief result obtained was that the magnetic force, like gravitation, did

not experience any sensible variation at heights from the earth's surface which we can attain to. Gay-Lussac also brought down air collected at the height of nearly 23,000 feet, and on analysis it appeared that its constitution was the same as that of air collected at the earth's surface. At the time of leaving the earth the thermometer stood at 82° Fahr., and at the highest point reached (23,000 feet) it was 14°·9 Fahr. Gay-Lussac remarked that at his highest point there were still clouds above him.

Ascent of MM. Bixio and Barral on June 29, 1850.

From 1804 to 1850 there is no record of any scientific ascents in balloons having been undertaken. In the latter year MM. Bixio and Barral made two ascents for this purpose. They ascended from the Paris Observatory on June 29, 1850, at 10.27 A.M., the balloon being inflated with hydrogen gas. The day was a rough one, and the ascent took place suddenly, without any previous attempt having been made to test the ascensional force of the balloon. When liberated, it rose with great rapidity, and becoming fully inflated it pressed upon the network, bulging out at the top and bottom. As the ropes by which the car was suspended were too short, the balloon soon covered the travellers like an immense hood. In endeavouring to secure the valve-rope, a rent was made in the balloon, and the gas escaped so close to the faces of the voyagers as almost to suffocate them. Finding that they were descending then too rapidly, they threw overboard everything available, including their coats, and only excepting the instruments. The ground was reached at 10h. 45m., near Lagny. Of course no observations were made.

On July 27, 1850.

MM. Bixio and Barral determined to ascend again without delay, and accordingly, on July 27, 1850, they repeated the experiment. The ascent was remarkable on account of the extreme cold met with. At about 20,000 feet the temperature was 15° Fahr., the balloon being enveloped in cloud; but on emerging from the cloud, at 23,000 feet, the temperature sank to − 38° Fahr., no less than 53° Fahr. below that experienced by Gay-Lussac at the same elevation. The existence of these very cold clouds served to explain certain meteorological phenomena that were observed on the earth both the day before and the day after the ascent. Some pigeons were taken up in this, as in most other high ascents, and liberated; they showed a reluctance to leave the car, and then fell heavily downwards.

Mr Welsh's four ascents in 1852.

In July 1852 the committee of the Kew Observatory resolved to institute a series of balloon ascents, with the view of investigating such meteorological and physical phenomena as require the presence of an observer at a great height in the atmosphere. Mr Welsh, of the Kew Observatory, was the observer, and Mr Green's great Nassau balloon was employed, Mr Green himself being the aeronaut. Four ascents were made in 1852, viz., on August 17, August 26, October 31, and November 10, when the respective heights of 19,510, 19,100, 12,640, and 22,930 feet were attained. A siphon barometer, dry and wet bulb thermometers, aspirated and free, and a Regnault's hygrometer were taken up. Some air collected at a considerable height was found on analysis not to differ appreciably in its composition from air collected near the ground. The original observations are printed *in extenso* in the *Philosophical Transactions* for 1853, pp. 311–346. The lowest temperatures met with in the four ascents were respectively 8°·7 Fahr. (19,380 feet); 12°·4 Fahr. (18,370); 16°·4 Fahr. (12,640); − 10°·5 Fahr. (22,370); the decline of temperature being very regular.

British Association appoints balloon committee

At the meeting of the British Association for the Advancement of Science held at Aberdeen in 1859, a committee was appointed for the purpose of making observations in the higher strata of the atmosphere by means of the balloon. For the first two years nothing was effected, owing to the want both of an observer and of a suitable balloon. In 1861, at Manchester, the committee was reappointed, and it then consisted of Colonel Sykes (chairman), Mr Airy, Sir David Brewster, Mr Fairbairn, Admiral Fitzroy, Mr Gassiot, Mr James Glaisher, Sir J. Herschel, Dr Lee, Dr Lloyd, Dr W. A. Miller, Dr Robinson, and Dr Tyndall. Some unsuccessful experiments were made with a balloon of Mr Green's, and also with one hired from the proprietors of Cremorne Gardens, which turned out to be in a hopelessly leaky condition; the trained observers also, on whom the committee had relied, failed to perform their duties. In this state of affairs, Mr Coxwell, an aeronaut who had made a good many ascents, was communicated with, and he agreed to construct a new balloon, of 90,000 cubic feet capacity, on the condition that the committee would undertake to use it, and pay £25 for each high ascent made especially for the committee, the latter defraying also the cost of gas, &c., so that the expense of each high ascent amounted to nearly £50. An observer being still wanted, Mr Glaisher, a member of the committee, offered himself to take the observations, and accordingly the first ascent was made on July 17, 1862, from the gas-works at Wolverhampton, this town being chosen on account of its central position in the country. Altogether, Mr Glaisher made twenty-eight ascents, the last having taken place on May 26, 1866. Of these only seven were specially high ascents, although six others were undertaken for the objects of the committee alone. On the other occasions Mr Glaisher availed himself of public ascents from the Crystal Palace and other places of entertainment, merely taking his place like the other passengers. In the last six ascents another aeronaut, Mr Orton, and a smaller balloon, were employed. The dates, places of ascent, and greatest heights (in feet) attained in the twenty-eight ascents were—1862: July 17, Wolverhampton, 26,177; July 30, Crystal Palace, 6937; August 18, Wolverhampton, 23,377; August 20, Crystal Palace, 5900; August 21, Hendon, 14,355; September 1, Crystal Palace, 4190; September 5, Wolverhampton, 37,000; September 8, Crystal Palace, 5428. 1863: March 31, Crystal Palace, 22,884; April 18, Crystal Palace, 24,163; June 26, Wolverton, 23,200; July 11, Crystal Palace, 6623; July 21, Crystal Palace, 3298; August 31, Newcastle-upon-Tyne, 8033; September 29, Wolverhampton, 16,590; October 9, Crystal Palace, 7310. 1864: January 12, Woolwich, 11,897; April 6, Woolwich, 11,075; June 13, Crystal Palace, 3543; June 20, Derby, 4280; June 27, Crystal Palace, 4898; August 29, Crystal Palace, 14,581; December 1, Woolwich, 5431; December 30, Woolwich, 3735. 1865: February 27, Woolwich, 4865; October 2, Woolwich, 1949; December 2, Woolwich, 4628. 1866: May 26, Windsor, 6325. Of these, all the ascents from Wolverhampton (four in number) and from Woolwich (seven in number) were undertaken wholly for the committee, and Mr Glaisher was merely accompanied by the aeronaut, whose business it was to manage the balloon. The expense of the special high ascents (about £50 for each, as stated above) rendered it desirable, when possible, to take advantage of the desire felt by many to accompany Mr Glaisher in his journey, and admit one or two other travellers; and of this kind were one or two of the ascents from the Crystal Palace, though the majority, in which the elevation attained frequently fell short of a mile, were the ordinary public ascents advertised beforehand. It is not possible here to give any complete account of the results obtained, and it would be superfluous, as the observations, both as made and after reduction, are printed in the *British Association Reports*, 1862–66. It will be enough, after explaining the objects of the experiments, &c., to describe briefly one or two of the most remarkable ascents, and then state the kind of conclusions that follow from them as a whole.

Mr Glaisher's ascents.

Objects of the experiments

The primary object was to determine the temperature of the air, and its hygrometrical state at different elevations to as great a height as could be reached; and the secondary objects were—(1) to determine the temperature of the dew-point by Daniell's and Regnault's hygrometers, as well as by the dry and wet bulb thermometers, and to compare the results; (2) to compare the readings of an aneroid barometer with those of a mercurial barometer up to the height of 5 miles; (3) to determine the electrical state of the air, (4) the oxygenic condition of the atmosphere, and (5) the time of vibration of a magnet; (6) to collect air at different elevations; (7) to note the height and kind of clouds, their density and thickness; (8) to determine the rate and direction of different currents in the atmosphere; and (9) to make observations on sound.

Instruments and apparatus.

The instruments used were mercurial and aneroid barometers, dry and wet bulb thermometers, Daniell's dew-point hygrometer, Regnault's condensing hygrometer, maximum and minimum thermometers, a magnet for horizontal vibration, hermetically sealed glass tubes exhausted of air, and an electrometer. In one or two of the ascents a camera was taken up.

Observing arrangements.

One end of the car was occupied by the aeronaut; near the other, in front of Mr Glaisher, was placed a board or table, the extremities of which rested on the sides of the car; upon this board was placed suitable framework to carry the several thermometers, hygrometers, magnet, aneroid barometer, &c.; a perforation through it admitted the lower branch of the mercurial barometer to descend below, leaving the upper branch at a convenient height for observing. A watch was placed directly opposite to Mr Glaisher, the central space being occupied by his note-book. The aspirator (for Regnault's hygrometer) was fixed underneath the centre of the board, so as to be conveniently workable by either feet or hands. Holes were cut in the board to admit the passage of the flexible tubes required for Regnault's hygrometer and the dry and wet bulb thermometers.

Mr Glaisher's ascent on July 17, 1862.

The first ascent was made, as has been stated, from Wolverhampton on July 17, 1862, and the journey was remarkable on account of a warm current that was met with at a great elevation. The weather, previous to the ascent, had been bad for a long time, and it had been delayed in consequence. The wind was still blowing from the west, and considerable difficulty was experienced in the preliminary arrangements, so that no instrument was fixed before starting. The balloon left at 9.43 A.M., and a height of 3800 feet was reached before an observation could be taken. At 4000 feet clouds were entered, and left at 8000 feet. The temperature of the air at starting was 59° Fahr., at 4000 feet it was 45°, and it descended to 26° at 10,000 feet, from which height to that of 13,000 feet there was no diminution. While passing through this space Mr Glaisher put on additional clothing, feeling certain that a temperature below zero would be attained before the height of 5 miles was reached; but at the elevation of 15,500 feet the temperature was 31°, and at each successive reading, up to 19,500, it *increased*, and was there 42°. The temperature then decreased rapidly, and was 16° at 26,000 feet. On descending it increased regularly to 37°·8 at 10,000 feet. A very rough descent, in which nearly £50 worth of instruments were broken, was effected near Oakham, in Rutlandshire, Mr Coxwell having judged it prudent to descend on account of the proximity, as be supposed, of the Wash. In coming down, a cloud was entered at an elevation of 12,400 feet, and proved to be more than 8000 feet in thickness. The rise of temperature met with in this ascent was most remarkable.

Ascent from Wolverhampton, August 18, 1862

The weather on the day (Aug. 18, 1862) of the third ascent was favourable, and there was but little wind. All the instruments were fixed before leaving the earth. A height of more than 4 miles was attained, and the balloon remained in the air about two hours. When at its highest point there were no clouds between the balloon and the earth, and the streets of Birmingham were distinctly visible. The descent was effected at Solihull, 7 miles from Birmingham. On the earth the temperature of the air was 67°·8, and that of the dew-point 54°·6; and they steadily decreased to 39°·5 and 22°·2 respectively at 11,500 feet. The balloon was then made to descend to the height of about 3000 feet, when both increased to 56°·0 and 47°·5 respectively. On throwing out ballast the balloon rose again, and the temperature declined pretty steadily to 24°·0, and that of the dew-point to − 10°·0, at the height of 23,000 feet. During this ascent Mr Glaisher's hands became quite blue, and he experienced a qualmish sensation in the brain and stomach, resembling the approach of sea-sickness; but no further inconvenience, besides such as resulted from the cold and the difficulty of breathing, was experienced. This feeling of sickness never occurred again to Mr Glaisher in any subsequent ascent.

Ascent from Crystal Palace, August 20, and from Hendon, August 21, 1862.

The ascent from the Crystal Palace on August 20, 1862, was merely an ordinary one for the public amusement, in which Mr Glaisher took a place in the car. In these low ascents from places of entertainment, in which other persons also were passengers, the large board stretching right across the car could not be used. A smaller frame was therefore made, which could be screwed on to the edge of the car, to carry the watch, siphon barometer, aneroid barometer, dry and wet bulb thermometers, grid-iron thermometer,[1] and Daniell's and Regnault's hygrometers, which comprised all the instruments usually taken up in these low ascents. In the first low ascent, July 30, this framework was fixed inside the car; but as it seemed possible that the warmth proceeding from the voyagers might influence the readings of the instruments, it was always afterwards fixed outside, and projected beyond the car, so that all the instruments were freely exposed to the surrounding air. The ascent on August 20 was a low one, and presented no remarkable feature except that the balloon was nearly becalmed over London. The earth was left at 6.26 P.M., and the air was so quiet that at the height of three-quarters of a mile the balloon was still over the Crystal Palace. At 7h. 47m. it was over London, and moving so slowly that it was thought desirable to ascend above the clouds in hopes of meeting with a more rapid current of air. At 8h. 5m. the voyagers were above the clouds, and it became quite light again, darkness having come on whilst hovering over London, at which time the gradual illumination by the lights in the streets formed a most wonderful sight, and one never to be forgotten. The roar, or rather loud hum, proceeding from the great city was also most remarkable. After having been above the clouds some time, the lowing of cattle and other agricultural sounds were heard. Accordingly, the valve-line was pulled, and the balloon descended below the clouds, when the light of London was seen in the distance as a misty glare. The darkness increased as the balloon descended very slowly, and it at length touched the ground so gently in the middle of a field at Mill Hill, near Hendon, that those in the car were scarcely aware of the contact. There were twelve voyagers altogether, and when with some trouble sufficient countrymen were collected to take their places and enable

[1] This was a thermometer with a bulb shaped like a gridiron, so as to have a very great surface exposed to the air. It was thought that the ordinary pea-sized bulb would not permit of the thermometer being sufficiently delicate to register the rapid changes of temperature due to the quick motion of the balloon, as it requires some little time for such a thermometer to take up the temperature of the surrounding medium.

them to leave the car, it was resolved to anchor the balloon for the night and to make an ascent in the early morning. Accordingly, at 4.30 A.M., on August 21, the earth was left, there being altogether five persons in the car. It was a dull, warm, cloudy morning, with the sky overcast. In about an hour the height of 3 miles was attained, and the temperature had fallen to 23°, having been 58° on the earth before leaving. The aspect of the clouds under formation before and during the rising of the sun was marvellous in the extreme, and baffled description. There were seen shining masses of cloud in mountain chains, rising perpendicularly from the plain, with summits of dazzling whiteness, forming vast ravines, down which the balloon appeared to glide, or pass through their sides, into other valleys, until, as the balloon rose far above, all appeared a mighty sea of white cloud. The descent was effected about a quarter past seven, and the transition from the magnificent scene above the clouds to the ugly prospect of the dreary earth as seen early on a dull morning, with a uniform leaden sky, was most depressing. The place of descent was near Biggleswade.

Ascent from the Crystal Palace on September 1, 1862.

The most noteworthy fact in connection with the ascent, September 1, 1862, was, that from the balloon the clouds were observed to be forming below, and seen to be following the whole course of the Thames from the Nore to Richmond. The clouds were above the river following all its windings, and extending neither to the right nor to the left. It was about the time of high water at London Bridge, and the phenomenon was no doubt connected with the warm water from the sea.

Ascent from Wolverhampton on September 5, 1862. The greatest height ever reached.

As in the ascent, September 5, 1862, the greatest height ever reached was attained, it is desirable to give the account of it in some detail, and in Mr Glaisher's own words. It is only necessary to premise that it was intended on this occasion to ascend as high as possible. The following is an extract from Mr Glaisher's account (*British Association Report*, 1862, pp. 383–385):—

This ascent had been delayed owing to the unfavourable state of the weather. The balloon left at 1h. 3m. P.M. The temperature of the air was 59°, and the dew-point 50°. At the height of 1 mile it was 41°, dew-point 38°; and shortly afterwards we entered a cloud of about 1100 feet in thickness, in which the temperature of the air fell to 36½°, the dew-point being the same, thus indicating that the air was here saturated with moisture. On emerging from the cloud at 1h. 17m. we came upon a flood of strong sunlight, with a beautiful blue sky, without a cloud above us, and a magnificent sea of cloud below, its surface being varied with endless hills, hillocks, mountain chains, and many snow-white masses rising from it. I here tried to take a view with the camera; but we were rising with too great rapidity, and going round and round too quickly, to enable me to do so. The flood of light, however, was so great that all I should have needed would have been a momentary exposure, as Dr Hill Norris had kindly furnished me with extremely sensitive dry plates for the purpose. We reached 2 miles in height at 1h. 21m. The temperature had fallen to the freezing-point, and the dew-point to 26°. We were 3 miles high at 1h. 28m., with a temperature of 18°, and dew-point 13°. At 1h. 39m. we had reached 4 miles, and the temperature was 8°, and dew-point − 15°; in ten minutes more we had reached the fifth mile, and the temperature had passed below zero, and then read − 2°, and at this point no dew was observed on Regnault's hygrometer when cooled down to − 30°; but a dew-point obtained from the readings of dry and wet gave − 36°. Up to this time I had taken observations with comfort. I had experienced no difficulty in breathing, whilst Mr Coxwell, in consequence of the necessary exertions he had to make, had breathed with difficulty for some time. At 1h. 51m. the barometer reading was 11·05 inches, but this requires a subtractive correction of 0·25 inch, as found by comparison with Lord Wrottesley's standard barometer just before starting. I afterwards read the dry thermometer as − 5°; this must have been about 1h. 52m. or later; I could not see the column of mercury in the wet bulb thermometer; nor afterwards the hands of the watch, nor the fine divisions on any instrument. I asked Mr Coxwell to help me to read the instruments, as I experienced a difficulty in seeing. In consequence, however, of the rotatory motion of the balloon, which had continued without ceasing since the earth had been left, the valve-line had become twisted, and he had to leave the car and mount into the ring above to adjust it. At this time I looked at the barometer, and found it to be 10 inches, still decreasing fast; its true reading therefore was 9¾ inches, implying a height of 29,000 feet. Shortly afterwards I laid my arm upon the table, possessed of its full vigour, and on being desirous of using it, I found it powerless—it must have lost its power momentarily. I tried to move the other arm, and found it powerless also. I then tried to shake myself, and succeeded in shaking my body. I seemed to have no limbs. I then looked at the barometer, and whilst doing so my head fell on my left shoulder. I struggled and shook my body again, but could not move my arms. I got my head upright, but for an instant only, when it fell on my right shoulder, and then I fell backwards, my back resting against the side of the car, and my head on its edge; in this position my eyes were directed towards Mr Coxwell in the ring. When I shook my body I seemed to have full power over the muscles of the back, and considerable power over those of the neck, but none over either my arms or my legs; in fact, I seemed to have none. As in the case of the arms, all muscular power was lost in an instant from my back and neck. I dimly saw Mr Coxwell in the ring, and endeavoured to speak, but could not; when in an instant intense black darkness came: the optic nerve finally lost power suddenly. I was still conscious, with as active a brain as at the present moment whilst writing this. I thought I had been seized with asphyxia, and that I should experience no more, as death would come unless we speedily descended: other thoughts were actively entering my mind, when I suddenly became unconscious as on going to sleep. I cannot tell anything of the sense of hearing; the perfect stillness and silence of the regions 6 miles from the earth (and at this time we were between 6 and 7 miles high) is such that no sound reaches the ear.

My last observation was made at 1h. 54m. at 29,000 feet. I suppose two or three minutes fully were occupied between my eyes becoming insensible to seeing fine divisions and 1h. 54m., and then that two or three minutes more passed till I was insensible; therefore I think this took place at about 1h. 56m. or 1h. 57m. Whilst powerless I heard the words 'temperature' and 'observation,' and I knew Mr Coxwell was in the car speaking to me, and endeavouring to arouse me; therefore consciousness and hearing had returned. I then heard him speak more emphatically, but I could not see, speak, or move. I heard him again say, 'Do try—now do.' Then I saw the instruments dimly, then Mr Coxwell, and very shortly saw clearly. I rose in my seat and looked round, as though waking from sleep, though not refreshed by sleep, and said to Mr Coxwell, 'I have been insensible.' He said, 'You have; and I too, very nearly.' I then drew up my legs, which had been extended before me, and took a pencil in my hand to begin observations. Mr Coxwell told me that he had lost the use of his hands, which were black, and I poured brandy over them.

"I resumed my observations at 2h. 7m., recording the barometer reading at 11·53 inches and temperature − 2°. I suppose that three or four minutes were occupied from the time of my hearing the words 'temperature' and 'observation' till I began to observe. If so, then returning consciousness came at 2h. 4m., and this gives seven minutes for total insensibility. I found the water in the vessel supplying the wet bulb thermometer, which I had by frequent disturbances kept from freezing, was one solid mass of ice; and it did not all melt until after we had been on the ground some time.

"Mr Coxwell told me that whilst in the ring he felt it piercingly cold; that hoar-frost was all round the neck of the balloon; on attempting to leave the ring he found his hands frozen, and he had to place his arms on the ring and drop down; that he thought for a moment I had lain back to rest myself; that he spoke to me without eliciting a reply; that he then noticed my legs projected and my arms hung down by my side; that my countenance was serene and placid, without the earnestness and anxiety he had noticed before going into the ring, and then it struck him I was insensible. He wished to approach me, but could not, and he felt insensibility coming over himself; that he became anxious to open the valve, but in consequence of his having lost the use of his hands he could not, and ultimately did so by seizing the cord with his teeth, and dipping his head two or three times, until the balloon took a decided turn downwards.

"No inconvenience followed this insensibility, and when we dropped it was in a country where no conveyance of any kind could be obtained, so that I had to walk between 7 and 8 miles.

"The descent was at first very rapid; we passed downwards 3 miles in nine minutes; the balloon's career was then checked, and it finally descended in the centre of a large grass field at Cold Weston, 7½ miles from Ludlow.

"In this ascent six pigeons were taken up. One was thrown out at the height of 3 miles, when it extended its wings and dropped as a piece of paper; a second, at 4 miles, flew vigorously round and round, apparently taking a dip each time; a third was thrown out between 4 and 5 miles, and it fell downwards as a stone; a fourth was thrown out at 4 miles on descending; it flew in a circle, and shortly alighted on the top of the balloon. The two remaining

pigeons were brought down to the ground. One was found to be dead, and the other, a carrier, was still living, but would not leave the hand when I attempted to throw it off, till, after a quarter of an hour, it began to peck a piece of ribbon which encircled its neck, and was then jerked off the finger, and flew with some vigour towards Wolverhampton. One of the pigeons returned to Wolverhampton on Sunday, the 7th, and this is the only one that has been heard of."

Mr Glaisher found from his observation-book that the last observation was made at 29,000 feet, and that at this time the balloon was ascending at the rate of 1000 feet per minute; and that when he resumed his observations, it was descending at the rate of 2000 feet per minute, the interval being thirteen minutes. This gives 36,000 or 37,000 feet for the greatest height attained. Two other series of considerations led to the latter height, and there can be no doubt that the altitude of 37,000 feet, or 7 miles, was attained on this occasion.

Ascent from the Crystal Palace on April 18, 1863.

In the ascent, April 18, 1863, 24,000 feet of elevation was reached. It was remarkable for the rapidity of the descent. At 2h. 44m., the balloon being then at a height of 10,000 feet, Mr Coxwell suddenly caught sight of Beachy Head, and Mr Glaisher, looking over the edge of the car, saw the sea, apparently immediately underneath. There was no time to be lost, and Mr Coxwell hung on to the valve-line, telling Mr Glaisher to leave his instruments and do the same. The earth was reached at 2h. 48m., the two miles of descent having been effected in four minutes. The balloon struck the ground near Newhaven with a terrible crash, but, from the free use of the valve-line, it was so crippled that it did not move afterwards. All the instruments, of the value of more than £25, including some that were unreplaceable, were broken, and Mr Glaisher was hurt. In the descent, after the first high ascent on July 17, 1862, the earth was struck with so much violence that most of the instruments were broken, and Mr Glaisher (who was closed in by his observing-board) was a good deal hurt then. In subsequent ascents, therefore, boxes were used filled with small mattresses, in which the instruments could be hurriedly placed, and the board was so arranged that it could be turned over and hung outside the car. These improvements had the effect of diminishing the danger to himself and the chance of breakage of the instruments, but in the Newhaven descent there was not sufficient time to put them in practice.

Ascent from Wolverton. June 26, 1863.

The circumstances met with in the ascent, June 26, 1863, were so remarkable that a short account cannot be omitted. The morning was at first very bright and fine, but between 11 and 12 o'clock a change took place; the sky became covered with clouds, and the wind rose and blew strongly, so that great difficulty was experienced in completing the inflation. At 1h. 3m. the balloon left; in four minutes, at 4000 feet high, cloud was entered. Mr Glaisher expected soon to break through it, and enter into bright sunshine as usual, but nothing of the sort took place, as, on emergence, clouds were seen both above and below. At 9000 feet the sighing and moaning of the wind were heard, and Mr Glaisher satisfied himself that this was due, not to the cordage of the balloon, but to opposing currents. At this time the sun was seen faintly, but instead of its brilliance increasing, although the balloon was then two miles high, a fog was entered, and the sight of the sun lost. The balloon next passed through a dry fog, which was left at 12,000 feet, and after the sun had been seen faintly for a little time, a wetting fog was entered.

"At 15,000 feet," Mr Glaisher proceeds, "we were still in fog, but it was not so wetting. At 16,000 feet we entered a dry fog; at 17,000 feet saw faint gleams of the sun, and heard a train. We were now about 3 miles high; at this time we were not in cloud, but clouds were below us; others were on our level at a distance, and yet more above us. We looked with astonishment at each other, and said as we were rising steadily we surely must soon pass through them. At 17,500 feet we were again enveloped in fog, which became wetting at 18,500 feet; we left this cloud below at 19,600 feet. At 20,000 feet the sun was just visible. We were now approaching 4 miles high; dense clouds were still above us; for a space of 2000 to 3000 feet we met with no fog, but on passing above 4 miles our attention was first attracted to a dark mass of cloud, and then to another on our level; both these clouds had fringed edges—they were both nimbi. Without the slightest doubt both these clouds were regular rain-clouds. Whilst looking at them we again lost sight of everything, being enveloped in fog whilst passing upwards through 1000 feet. At 22,000 feet we again emerged, and were above clouds on passing above 23,000 feet. At six minutes to 2 o'clock we heard a railway train; the temperature here was 18°. I wished still to ascend to find the limits of this vapour, but Mr Coxwell said, 'We are too short of sand; I cannot go higher; we must not even stop here.' I was therefore most reluctantly compelled to abandon the wish, and looked searchingly around. At this highest point, in close proximity to us, were rain-clouds; below us dense fog. I was again reminded that we must not stop. With a hasty glance everywhere, above, below, around, I saw the sky nearly covered with dark clouds of a stratus character, with cirri still higher, and small spaces of blue sky between them. The blue was not the blue of 4 or 5 miles high as I had always before seen it, but a faint blue, as seen from the earth when the air is charged with moisture."

In the downward journey an even more remarkable series of circumstances was met with; for a fall of rain was passed through, and then *below it* a snow-storm, the flakes being entirely composed of spiculæ of ice and innumerable snow-crystals. On reaching the ground near Ely the lower atmosphere was found to be thick, misty, and murky. At Wolverton the afternoon was cold, raw, and disagreeable for a summer's day. The fact of rain-clouds extending layer above layer to a height of 4 miles, was one never hitherto regarded as possible; and the occurrence of rain and snow, and the latter underneath the former, and all happening on a day in the very middle of summer, formed a series of most curious and unexpected phenomena.

Night ascents.

Mr Glaisher having, in one of his descents, which took place near sunset, observed that the temperature was the same through a very considerable height, it occurred to him that after dark it was quite possible that, for some elevation above the earth's surface, the temperature might even increase with increase of height; and to determine this he arranged for some ascents to be made after sunset, so that the temperature during the night might be observed. For this purpose he procured a couple of Davy lamps, which answered their object satisfactorily. Accordingly, on October 2, 1865, an ascent was made from Woolwich Arsenal, the time of starting being about three-quarters of an hour after the sun had set. The temperature on the earth was 56°, and it steadily increased to 59°·6 at the height of 1900 feet. This was established conclusively by repeated ups and downs, the temperature falling as the balloon descended. The view of London lighted up, as seen from the balloon in this ascent, the night being clear, was most wonderful. A second night ascent was made from the same place on December 2, 1865, and the balloon left the earth 2¾ hours after sunset. On this occasion the temperature did not rise, but the decrease, though steady, was small. In an ascent from Windsor on May 29, 1866, the balloon was kept up till half-past eight o'clock, and the temperature was found to decrease as the earth was approached during the last 900 feet. In this last ascent no paid aeronaut was employed, as Mr Westcar, of the Royal Horse Guards, undertook the management of the balloon. In the preceding five ascents Mr Orton, of Blackwall, was employed as aeronaut.

Results of experiments.

It has been found necessary in the present notice to allude merely to the more striking points noticed in Mr Glaisher's twenty-eight ascents. The number of observations made by him was of course great, and it is only necessary here to repeat that they are to be found in the *Reports of the British Association for the Advancement of Science*,

1862–66. It appeared as one of the results of the experiments that the rate of the decline of temperature with elevation near the earth was very different when the sky was clear from what was the case when it was cloudy; and the equality of temperature at sunset and increase with height after sunset were very remarkable facts which were not anticipated, and which have an important bearing on the theory of refraction, as astronomical observations are usually made at night. Even at the height of 5 miles, cirrus clouds were seen high in the air, apparently as far above as they seem when viewed from the earth, and the air must there be so exceedingly dry that it is hard to believe that their presence can be due to moisture at all. The results of the observations differed very much, and no doubt the atmospheric conditions depended not only on the time of day, but also on the season of the year, and were such that a vast number of ascents would be requisite to determine the true laws with anything approaching to certainty and completeness. It is also clear that England is a most unfit country for the pursuit of such investigations, as, from whatever place the balloon started, it was never safe to be more than an hour above the clouds for fear of reaching the sea. It appeared from the observations that an aneroid barometer could be trusted to read as accurately as a mercurial barometer to the heights reached. The time of vibration of a horizontal magnet was taken in very many of the ascents, and the results of ten different sets of observations proved undoubtedly that the time of vibration was longer than on the earth. In almost all the ascents the balloon was under the influence of currents of air in different directions. The thickness of these currents was found to vary greatly. The direction of the wind on the earth was sometimes that of the whole mass of air up to 20,000 feet, whilst at other times the direction changed within 500 feet of the earth. Sometimes directly opposite currents were met with at different heights in the same ascent, and three or four streams of air were encountered moving in different directions. Ignoring the different currents of air which caused the balloon to change its direction, and at times to move in entirely opposite directions, and simply taking into account the places of ascent and descent, the distances so measured were always very much greater than the horizontal movement of the air as measured by anemometers. For example, on January 12, 1862, the balloon left Woolwich at 2h. 8m. P.M., and descended at Lakenheath, 70 miles distant from the place of ascent, at 4h. 19m. P.M. At the Greenwich Observatory, by Robinson's anemometer, during this time the motion of the air was 6 miles only. With regard to physiological observations, Mr Glaisher found that the number of pulsations increased with elevation, as also the number of inspirations. The number of his pulsations was generally 76 per minute before starting, about 90 at 10,000 feet, 100 at 20,000 feet, and 110 at higher elevations. But a good deal depended on the temperament of the individual. This was also the case in respect to colour; at 10,000 feet the faces of some would be a glowing purple, whilst others would be scarcely affected; at 4 miles high Mr Glaisher found the pulsations of his heart distinctly audible, and his breathing was very much affected, so that panting was produced by the very slightest exertion; at 29,000 feet he became insensible. In reference to the propagation of sound, it was at all times found that sounds from the earth were more or less audible according to the amount of moisture in the air. When in clouds at 4 miles high, a railway train was heard; but when clouds were far below, no sound ever reached the ear at this elevation. The discharge of a gun was heard at 10,000 feet. The barking of a dog was heard at the height of 2 miles, while the shouting of a multitude of people was not audible at heights exceeding 4000 feet.

The majority of Mr Glaisher's experiments were made in the summer, partly because public ascents took place at this time of the year, and partly because the weather was more settled. But some special ascents were made in the winter; these were found to be very troublesome and costly, owing to the time that was wasted before a suitable day occurred, and to the boisterous weather, which damaged the balloon. Altogether the number of ascents bore but a small ratio to the number of days spent over them. Sometimes it was necessary to wait at Wolverhampton a whole week after the day fixed for the ascent, owing to the unfavourable state of the weather and the necessity of keeping the light gas required for the balloon in a separate gasometer (as the lightest gas is the worst in illuminating power), added to the cost and difficulty. When balloons ascend as public exhibitions from places of entertainment it is very rarely that a height of a mile is reached, although, in the absence of instruments, it is not unusual for the aeronaut to exaggerate the elevation, as the passengers have no reason for disputing what is told them. This must be borne in mind when physiological or other phenomena are described by voyagers unprovided with instruments. We have noticed the observations made in Mr Glaisher's ascents at greater length, because they are almost the only ones that have been made in which the height and other matters are determined with certainty. A quantity of air was collected in two large bags at the height of 12,000 feet in the ascent on January 12, 1864, and submitted to Professor Tyndall, but he has never made public the analysis of it.

Ascents of M. Flammarion, 1867–68.

In the years 1867 and 1868 M. Flammarion made eight or nine ascents from Paris for scientific purposes. The heights reached were not great, but the general result of the observations was to confirm those made by Mr Glaisher. See M. Flammarion in *Voyages Aériens*, Paris, 1870, or *Travels in the Air*, London, 1871. Observations were also made in some balloon ascents by M. de Fonvielle, which are noticed in the works just referred to.

Use of balloons for military purposes.

The balloon had not been discovered very long before it received a military status, and soon after the commencement of the French revolutionary war an aeronautic school was founded at Meudon; Guyton de Morveau, the chemist, and Colonel Coutelle being the persons in charge. Four balloons were constructed for the armies of the north, of the Sambre and Meuse, of the Rhine and Moselle, and of Egypt. In June 1794 Coutelle ascended with the adjutant and general to reconnoitre the hostile army just before the battle of Fleurus, and two reconnaissances were made, each occupying four hours. It is generally stated that it was to the information so gained that the French victory was due. The balloon corps was in constant requisition during the campaign, but it does not appear that, with the exception of the reconnaissances just mentioned, any great advantages resulted, except in a moral point of view. But even this was of importance, as the enemy were much disconcerted at having their movements so completely watched, while the French were correspondingly elated at the superior information it was believed they were gaining. An attempt was made to revive the use of balloons in the African campaign of 1830, but no opportunity occurred in which they could be employed. It is said that in 1849 a reconnoitring balloon was sent up from before Venice, and that the Russians used one at Sebastopol. In the French campaign against Italy in 1859 the French had recourse to the use of balloons, but this time there was not any aerostatic corps, and their management was entrusted to the brothers Godard. Several reconnaissances were made, and one of especial interest the day before the battle of Solferino. No information of much importance seems, however, to have been gained thereby. The Fleurus re-

Reconnaissances before the battle of Fleurus.

At Solferino.

connaissance was made in a balloon inflated with hydrogen gas, while at Solferino a fire-balloon was employed. Each system has its advantages and disadvantages; the gas-balloon requires several hours for inflation, but then it can remain in the air any length of time; the fire-balloon can be inflated rapidly, but it will not stay in the air more than five or ten minutes unless a furnace is taken up, the use of which is impracticable in even a moderate wind; besides, the fire-balloon must be of very large dimensions, and only one person could, as a rule, ascend at a time, and he would have to be occupied with the fire: the use of fire-balloons also is always attended with some danger. M. Eugene Godard, who was engaged in the management of the balloons in the Italian campaign, wrote to the *Times*, in August 1864, expressing his opinion of the superiority of fire-balloons for war purposes, as they are so easily inflated and are not destroyed or compelled to descend even if pierced by several balls; and this was also, we believe, the opinion of the Austrians who made experiments with war balloons.

Balloons used in the American war.

In the late American war balloons were a good deal used by the Federals. There was a regular balloon staff attached to M'Clellan's army, with a captain, an assistant-captain, and about 50 non-commissioned officers and privates. The apparatus consisted of two generators, drawn by four horses each; two balloons, drawn by four horses each, and an acid-cart, drawn by two horses. The two balloons used contained about 13,000 and 26,000 feet of gas, and the inflation usually occupied about three hours. (See Captain Beaumont's Account, vol. xii. of the *Royal Engineers' Papers.*) We are not aware of the value set by the officers in command on the information obtained by this means; but as we believe balloons were employed till the conclusion of the war, it is clear that some importance was attached to their use. In 1862 or 1863 one or two experiments to test the use of balloons in making reconnaissances were made at Aldershot, but nothing came of them.

When the Montgolfiers first discovered the balloon, its great use in military operations was at once prophesied; but these anticipations have not been realised. On the other hand, however, there can be no doubt that the balloon has never had a fair trial, being viewed coldly by officers enamoured of routine, and when used, being often left unsupplied with suitable appointments. It is probable that a future still remains for the balloon in this direction.

Use of balloons in the siege of Paris, 1870–71.

The paramount value of the balloon during the recent siege of Paris must be fresh in the minds of all. It was by it alone that communication was kept up between the besieged city and the external world, as the balloons carried away from Paris the pigeons which afterwards brought back to it the news of the provinces. The total number of balloons that ascended from Paris during the siege, conveying persons and despatches, was sixty-four—the first having started on September 23, 1870, and the last on January 28, 1871. Gambetta effected his escape from Paris, on October 7, in the balloon *Armand-Barbès*, an event which doubtless led to the prolongation of the war. Of the sixty-four balloons only two were never heard of; they were blown out to sea. One of the most remarkable voyages was that of the *Ville d'Orléans*, which, leaving Paris at eleven o'clock on November 21, descended fifteen hours afterwards near Christiania, having crossed the North Sea. Several of the balloons on their descent were taken by the Prussians, and a good many were fired at while in the air; but we do not hear of any being injured from this cause. The average size of the balloons was from 2000 to 2050 metres, or from 70,000 to 72,000 cubic feet. The above facts we have extracted from *Les Ballons du Siège de Paris*, a sheet published by Bulla & Sons, Paris; compiled by the brothers Tissandier, well-known French aeronauts, and giving the name, size, and times of ascent and descent of every balloon that left Paris, with the names of the aeronaut and generally also those of the passengers, the weight of despatches, the number of pigeons, &c. Only those balloons, however, are noticed in which some person ascended. A similar list of sixty-two balloons is given by Mr Glaisher in the introduction to the second edition of *Travels in the Air* (1871). It was, however, published too soon after the conclusion of the siege to be quite so complete as the sheet of the MM. Tissandier.

It is perhaps worth stating that the balloons were manufactured and despatched (generally from the platforms of the Orleans or the Northern Railway) under the direction of the Post-Office. The aeronauts employed were mostly sailors, who did their work very well. No use whatever was made in the war of balloons for purposes of reconnaissance. The exceedingly important part played by the balloon in the siege of Paris would alone, if it had been of no other utility, render it one of the most valuable inventions of the last century.

Parachutes.

The principle of the parachute is so simple that the idea must have occurred to persons in all ages. Father Loubere, in his History of Siam, published two centuries ago, tells of a person who frequently diverted the court by the prodigious leaps he used to take, having two parachutes or umbrellas fastened to his girdle. In 1783 a certain M. le Normand practically demonstrated the efficiency of a parachute by descending from a high house at Lyons; but he merely regarded it as a useful means whereby to escape from fire. To Blanchard is due the idea of using it as an adjunct to the balloon. As early as 1785 he had constructed a parachute, to which was attached a basket. In this he placed a dog, which descended safely to the ground when the parachute was released from a balloon at a considerable elevation. It is stated that he descended himself from a balloon in a parachute in 1793; but, owing to some defect in its construction, he fell too rapidly, and broke his leg.

Blanchard

Garnerin.

André Jaques Garnerin was the first person who successfully descended from a balloon in a parachute, and he repeated this experiment so often that he may be said to have first demonstrated the practicability of using the machine; and, in fact, that he invented it in a practical and suitable form. In 1793 Garnerin had been taken prisoner at Marchiennes, and he was confined for between two and three years in the fortress of Bude, in Hungary. While in captivity he elaborated in his mind the means of descending from a balloon by means of a parachute; and on October 22, 1797, he made his first public experiment. He ascended from the park of Monceau at Paris, and when at the height of about $1\frac{1}{4}$ mile he released the parachute, which was attached to the balloon in place of a car; the balloon, relieved suddenly of so great a weight, rose very rapidly till it burst, while the parachute descended very fast, making violent oscillations all the way. Garnerin, however, reached the earth in safety upon the plain of Monceau. In 1802 Garnerin came to England and made a good many ascents in all parts of the country, many of which excited much enthusiasm, as can be seen from the contemporary accounts; and on September 21, 1802, he repeated his parachute experiment in England.

Garnerin descends in a parachute in England. See Plate I

The parachute was dome-shaped, and bore a resemblance to a large umbrella. The case or dome was made of white canvas, and was 23 feet in diameter. At the top was a truck or round piece of wood 10 inches in diameter, with a hole in its centre, fastened to the canvas by 32 short pieces of tape. The parachute was suspended from a hoop attached to the netting of the balloon, and below the parachute was placed a cylindrical basket, 4 feet high and $2\frac{1}{4}$ feet in diameter, which contained the aeronaut. The ascent took place at about six o'clock from North Audley Street, London;

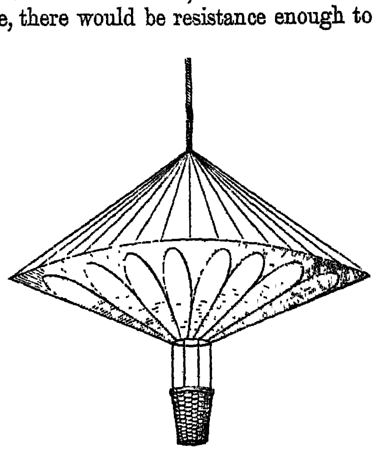
and, at a height of about (it is believed) 8000 feet, Garnerin separated the parachute from the balloon. For a few seconds his fate seemed certain, as the parachute retained the collapsed state in which it had originally ascended, and fell very rapidly. It suddenly, however, expanded, and the rapidity of its descent was at once checked, but the oscillations were so violent that the car, which was suspended 20 feet below, was sometimes on a level with the rest of the apparatus. Some accounts state that these oscillations increased, others that they decreased as the parachute descended, and the latter seems most probable. It came to the ground in a field at the back of St Pancras Church, the descent having occupied rather more than ten minutes. Garnerin was hurt a little by the violence with which the basket containing him struck the earth; but a few cuts and a slight nausea represented all the ill effects of his fall. He made, certainly, one other descent in a similar way (as that just described is stated to have been his third), and we believe several others on the Continent, but this was the only one he effected in England.

Jordaki Kuparento.

Jordaki Kuparento, a Polish aeronaut, is the only person who ever made any real use of a parachute. He ascended from Warsaw on July 24, 1808, in a fire-balloon, which, at a considerable elevation, took fire; but being provided with a parachute, he was enabled to effect his descent in safety.

Fatal parachute descent of Mr Cocking.

The next experiment made with a parachute was that which resulted in the unfortunate death of Mr Robert Cocking. So early as 1814 this gentleman had lectured on the subject before the City Philosophical Society, and also before the Society of Arts. He always retained an interest in ballooning, and made two ascents—one with Mr Sadler, and the other on September 27, 1836, with Mr Green. The success of the balloon trip of Messrs Hollond, Mason, and Green, seems to have incited Mr Cocking to demonstrate practically the truth of his views. He accordingly constructed a suitable parachute on his principles, and having succeeded in obtaining the consent of Messrs Hughes and Gye, the proprietors of Vauxhall Gardens, to permit the ascent to be made there, he prevailed on Mr Green to ascend in his great Nassau balloon with the parachute attached. The great defect of Garnerin's umbrella-shaped parachute was its violent oscillation during descent, and Mr Cocking considered that if the parachute were made of a conical form (vertex downwards), the whole of this oscillation would be avoided; and if it were made of sufficient size, there would be resistance enough to check too rapid a descent. He therefore constructed a parachute on this principle, the radius of which at its widest part was about 17 feet. It was stated in the public announcements previous to the experiment that the whole weighed 223 lb; but from the evidence at the inquest it appeared that the weight must have been over 400 lb. Mr Cocking's weight was 177 lb, which was so much additional. On July 24, 1837, the trial took place; and the Nassau balloon, with Mr Green and Mr Spencer, a solicitor, in the car, and having suspended below it the parachute, in the car of which was Mr Cocking, rose from the ground at twenty-five minutes to eight in the evening. A good deal of difficulty was experienced in rising to a suitable height, partly in consequence of the resistance to the air offered by the expanded parachute, and partly owing to its weight. Mr Cocking wished the height to be 8000 feet; but when the balloon reached the height of 5000 feet, it being then nearly over Greenwich, Mr Green called out to Mr Cocking that he should be unable to ascend to the requisite height if the parachute was to descend in daylight. Mr Cocking accordingly let slip the catch which was to liberate him from the balloon. The parachute for a few seconds descended very rapidly but still evenly, until suddenly the upper rim seemed to give way, and the whole apparatus collapsed (taking a form resembling an umbrella turned inside out, and nearly closed), and the machine descended with great rapidity, oscillating very much. When about two or three hundred feet from the ground, the basket became disengaged from the remnant of the parachute, and Mr Cocking was found in a field at Lee, literally dashed to pieces.



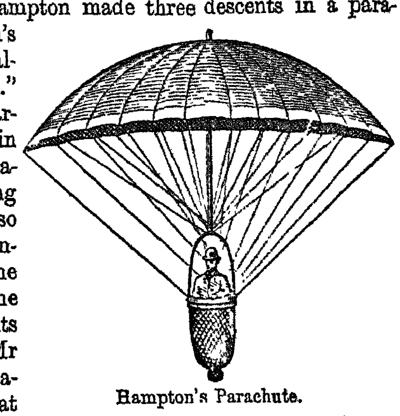
Cocking's Parachute.

Mr Green and Mr Spencer, who were in the car of the balloon, had also a narrow escape. At the moment the parachute was disengaged they crouched down in the car, and Mr Green clung to the valve-line, to permit the escape of the gas. The balloon shot upwards, plunging and rolling, and the gas pouring from both the upper and lower valves, but chiefly from the latter, as the great resistance of the air checked its egress from the former. Mr Green and Mr Spencer applied their mouths to tubes communicating with an air-bag with which they had had the foresight to provide themselves, otherwise they would certainly have been suffocated by the gas. Notwithstanding this precaution, however, the gas almost totally deprived them of sight for four or five minutes. When they came to themselves they found they were at a height of about four miles, and descending rapidly. They effected, however, a safe descent near Maidstone.

Many objections were made, after the result, to the form of Mr Cocking's parachute; but there is little doubt that had it been constructed of sufficient strength, and perhaps of somewhat larger size, it would have answered its purpose. As it was, the upper rim was made of tin, which soon gave way. Mr Wise, the American aeronaut, made some experiments on parachutes of both forms (Garnerin's and Cocking's), and found that the latter always were much more steady, descending generally in a spiral curve.

Mr Hampton's parachute descents.

In 1839 Mr Hampton made three descents in a parachute, on Garnerin's pattern, from his balloon, the "Albion." He followed Garnerin's example in attaching the parachute to the netting of the balloon, so that when the connection between the two was severed the latter was left to its own devices. Mr Hampton took measures, however, that it should descend soon after the parachute, and it was generally found no great distance off, and returned to him. All his parachute descents were safely performed, although in one he was a good deal shaken.



Hampton's Parachute.

Descending balloon takes the parachute form.

We may remark that a descending balloon half-full of gas either does rise, or can with a little management be made to rise, to the top of the netting and take the form of a parachute, thus materially lessening the rapidity of descent. Mr Wise, in fact, having noticed this, once purposely exploded his balloon when at a considerable altitude, and

the resistance offered to the air by the envelope of the balloon was sufficient to enable him to reach the ground without injury. And a similar thing took place in one of Mr Glaisher's high scientific ascents (April 18, 1863), when, at a height of about 2 miles, the sea appeared directly underneath; the gas was let out of the balloon as quickly as possible, and the velocity of descent was so great, that the 2 miles of vertical height were passed through in four minutes. On the balloon reaching the ground at Newhaven, close to the shore, it was found to be nearly empty. The balloon had, in fact, for the last mile or more, merely acted as a parachute; the shock was a severe one, and all the instruments were broken, but nothing serious resulted to the occupants of the car.

Flying machine and navigable balloons.

Numerous attempts have been made both to direct balloons and contrive independent flying machines. After the invention of the balloon by the brothers Montgolfier, it was at once thought that no very great difficulty would be found in devising a suitable steering apparatus; in fact, it was supposed that to rise into the air and remain there was the chief difficulty, and that, this being accomplished, the power of directing the aerostat would be a secondary achievement that must follow before long. Accordingly, in most of the early balloons the voyagers took up oars, sails, or paddles, which they diligently worked while in the air; sometimes they thought an effect was produced, and sometimes not. If we consider the number of different currents in the atmosphere, it is no wonder that some should have announced with confidence that their course was changed from that of the wind by means of the sails or oars that they used; in fact, it is not very often that the whole atmosphere up to a considerable height is moving *en masse* in the same direction, so that generally the course taken by the balloon, as determined merely by joining the places of ascent and descent, is not identical with the direction of the wind, even when it is the same at both places. Although there is no reason why balloons should not be so guided by means of mechanical appliances attached to them as to move in a direction making a small angle with that of the wind, still it must have been evident to any one who has observed a balloon during inflation on a windy day, that any motion in which it would be exposed to the action of a strong current of air must result in its destruction. It has therefore gradually become recognised that the balloon is scarcely a step at all towards a system of aerial navigation; and many have thought that the principles involved in the construction of a flying machine must be very different from the simple statical equilibrium that subsists when a balloon is floating in the air. "To navigate the air the machine must be heavier than the air," has frequently been regarded as an axiom; and there can be no doubt that an apparatus constructed of such light material as is necessary for a balloon must either be destroyed or become ungovernable in a high wind. Recently, however, M. Dupuy de Lôme, an eminent French engineer, has constructed and made experiments with a balloon which he considers satisfies some of the conditions. The balloon is spindle-shaped, the longer axis being horizontal, and it contains about 120,000 cubic feet. The car is suspended below the middle of the balloon, and there are provided a rudder and a screw. The rudder consists of a triangular sail placed beneath the balloon and near the rear, and is kept in position by a horizontal yard, about 20 feet long, turning round a pivot in its forward extremity; the height of the sail is 16 feet, and its surface 160 square feet. Two ropes for working the rudder extend forward to the seat of the steerer, who has before him a compass fixed to the car, the central part of which will contain fourteen men. The screw is carried by the car, and is driven by four or eight men working at a capstan. A trial was made with the machine on February 2, 1872, on a windy day, and M. de Lôme considered that he had been enabled by his screw and rudder to alter his course about 12°. (See *Report of the Aeronautical Society*, 1872).

M. Dupuy de Lôme's navigable balloon.

Whatever difficulties may present themselves in regulating the horizontal movement of the balloon, there can be no doubt that the vertical motion could be obtained by means of a screw or other mechanical means; and the power of being able to ascend or descend without loss of ballast would be a considerable gain. In the opinion of many, however, the balloon is not worth improvement; and as ballooning is now generally practised merely as a spectacle by which the aeronaut or showman gains his living, it is not likely that any advancement will be made.

Of flying machines, in which both buoyancy and motion were proposed to be obtained by purely mechanical means, the number has been very great. Most of the projects have been chimerical, and were due to persons possessed of an insufficient knowledge of the principles of natural philosophy, both theoretically and practically. They serve, however, to show how great a number of individuals must have paid attention to the matter, and even at the present time several patents are taken out annually on the subject. We do not propose here to give an account of any of these projects, for but few have ever passed beyond projects, but will merely refer to Mr Henson's aerial carriage, which in 1843 attracted some attention. The apparatus was an elaborate one, and its principal feature was the great expanse of the sustaining planes. The machine was to advance with its front edge a little raised, the effect of which would be to present its under surface to the air over which it was passing; the resistance of this air, acting on it like the strong wind on the sails of a windmill, would, it was thought, prevent the descent of the machine. Mr Henson invented a steam-engine of great lightness, but he proposed that the machine should be started down an inclined plane, so that the steam-engine would only have to make up for the velocity lost by the resistance of the air. The scheme never came to anything.

Henson's aerial carriage.

In the still air of a room it is, of course, not difficult to attach an apparatus to a balloon so as to direct its motion, and even models of flying machines have been made which, when tried in a room, seemed moderately successful. Some instruments which would very nearly support themselves in the air were shown at the Aeronautical Society's exhibition at the Crystal Palace. A good deal would be accomplished if an accurate knowledge of the exact motion of a bird's wing could be obtained; in fact, until this is known, or until sufficient experiments on the resistance experienced by different-shaped laminæ with different motions are made, there seems little chance of the construction of a satisfactory flying machine, unless means can be found to make a steam-engine of much less weight than is at present necessary.

Aeronautical Society of Great Britain.

In 1865 the Aeronautical Society of Great Britain was founded, the officers being—President, the Duke of Argyle; Treasurer, Mr J. Glaisher; and Secretary, Mr Brearey. It has published an annual report every year since [1873], containing selections from the papers read to the society, and abstracts of the discussions that took place thereon at the meetings. The numerous papers submitted to this society bear witness to the great number of minds that are engaged on the solution of the problem of aerial navigation. Of course, not a few of the methods proposed are the fanciful projects of ignorant men, but some show the careful thought and elaborate experiment of trained engineers and other qualified persons. In 1868 the society held an exhibition of flying machines, &c., at the Crystal Palace, which was visited by many persons. A fire-balloon of a M. de la Marne, which should have ascended during this exhibition,

caught fire and was burnt. In 1871 a series of experiments was made at Penn's factory (Greenwich) on the resistance of different shaped planes placed at different angles, in a current of air produced by a rotary fan. Investigations of this kind not only form the first step towards obtaining data for a true knowledge of the exact nature of flying, but are also independently of high scientific interest. The chief object of the society is to bring together those persons who are interested in the subject of aeronautics (except balloonists by trade, who are ineligible), and to encourage those who, possessing suitable acquirements, are devoting their time to the investigation of the question.

Aerostatic societies have also been founded in other countries; but although they have been inaugurated with considerable *éclat*, more than one have already terminated a short-lived career. The Vienna society seems, however, to have been unusually active during the recent exhibition of 1873.

Theory of the equilibrium of the balloon.

The principle in virtue of which a balloon ascends is exactly the same as that which causes a piece of wood or other material to float partially immersed in water, and may be stated as follows, viz., that if any body float in equilibrium in a fluid, the weight of the body is equal to the weight of the fluid displaced. By the "fluid displaced" is meant the fluid which would occupy the space actually occupied in the fluid by the body if the body were removed. When the fluid is inelastic and incompressible, *i.e.*, a liquid, as water, its density is the same throughout, and bodies placed in it either rise to the surface and float there partially immersed, or sink to the bottom. Thus, suppose a body only one-third as heavy as water (in other words, whose specific gravity is one-third) was floating on the surface of water, then, as the weight of the body must be equal to that of the water it displaces, it is clear that one-third of the body must be immersed. In the case, however, of an elastic or gaseous fluid, such as air, the density gradually decreases as we recede from the surface of the earth, for each layer has to support the weight of all above it, and as air is elastic or compressible, the layers near the earth are more pressed upon, and therefore denser than those above. Thus, if a body lighter than the air it displaces be set free in the atmosphere, it rises to such a height that the air there is so attenuated that the weight of it displaced is equal to that of the body, when equilibrium takes place, and the body ascends no higher. In all cases, therefore, a body floating in the air is totally immersed, and it can never get beyond the atmosphere, and float, as it were, upon its surface.

To find, therefore, how high any body (lighter than the air it displaces), such as a balloon, of given capacity and weight, will rise, it is only necessary to calculate at what height the volume of a quantity of air equal to the given capacity will be equal in weight to the given weight. Leaving temperature out of the question, the law of the decrease of density in the atmosphere is such that the density at a height x is equal to $e^{-\frac{g}{k}x}$ × the density at the earth's surface, g being the measure of gravity, and k also a constant; the value of $\frac{k}{g}$ is called the height of the homogeneous atmosphere, viz., it is equal to what would be the height of the atmosphere if it were homogeneous throughout, and of the same density as at the earth's surface. Its value may be taken at about 26,000 feet. Thus, let V be the volume of a balloon and its appurtenances, car, ropes, &c. (viz., the number of cubic feet, or whatever the unit of solidity may be, that it displaces), and let W be its weight (including that of the gas), then it will rise to a height x such that

$$W = Vg \times \text{density of air},$$
$$= Vg\sigma.e^{-\frac{g}{k}x},$$

g being the value of the force of gravity, and σ_0 being the density of the air at the surface of the earth. This equation is not quite accurate, for several reasons—(1) because the decrease of temperature that results from increase of elevation has not been taken into account; (2) because g has been taken to measure the force of gravity on the earth's surface, whereas it should represent this force at a height x; this is easily corrected by replacing g by g', where $g'=g\frac{a^2}{(a+x)^2}$, a being the radius of the earth, but as a is about 4000 miles, and x is never likely in any ordinary question to exceed 10 miles, we can replace g' by g without introducing sensible error, for the correction due to this cause would be much less than other uncertainties that must arise; and (3) because W and V could not both remain constant. If the balloon be not fully inflated on leaving, so that the gas contained in it can expand, then V, the volume of air displaced, will increase; while, if the balloon be full at starting, the envelope must either be strong enough to resist the increased pressure of the gas inside, due to the removal of some of the pressure outside (owing to the diminished density of the air), or some of the gas must be allowed to escape. The former alternative of the second case could not be complied with, as the balloon would burst; some of the gas must therefore escape, and so W is diminished. The weight of gas of which the balloon is thus eased cannot properly be omitted from the calculation, if x be considerable; but a good approximation is obtained without it, as the weight of the gas that escapes will generally bear a small proportion to the weight of balloon, car, grapnel, passengers, &c. The true equation (except as regards temperature) is therefore, for a balloon full at starting—

$$W - \frac{ga^2v_0\rho_0(1-e^{-\frac{g'}{k}x})}{(a+x)^2} = \frac{ga^2V_0\sigma_0e^{-\frac{g'}{k}x}}{(a+x)^2},$$

v_0 denoting the volume actually occupied by the gas, g' denoting $g\frac{a^2}{(a+x)^2}$, viz., gravity at height x, and ρ_0 being the density of the gas on the ground. It will generally be sufficient, especially when temperature is omitted, to take the formula in the approximate form written previously. As the volume of air displaced by the car, ropes, passengers, &c., is usually trifling compared to that displaced by the balloon itself, no great error can arise from taking $v_0=V_0$. As an example, let us find how high a balloon of 100,000 cubic feet capacity would rise if inflated with pure hydrogen gas, carrying with it a weight of 3000 lb (this including the weight of the balloon itself and appurtenances). A cubic foot of air, at temperature 32° Fahr., and under a pressure of 29·922 in., weighs ·080728 lb, and a cubic foot of hydrogen weighs ·005592 lb, so that (supposing the barometer reading on the earth to be 29·922 in., and the temperature of the air to be 32°) at the surface of the earth the balloon, &c., weighs 3559 lb, and the weight of the air displaced is 8073 lb. The balloon will therefore approximately rise to such a height x that 100,000 cubic feet of air shall there weigh 3559 lb; and x is given in feet by the equation

$$e^{-\frac{x}{26,000}} = \frac{3559}{8073},$$

or $$x = 26,000\,(\log 8073 - \log 3559),$$

the logarithms being hyperbolic; if common or Briggian logarithms be used, the result must be multiplied by 2·30258 . . . (the reciprocal of the modulus). In the above

case we find $x =$ about 21,000 feet, and as at this height rather more than half the gas will have escaped (it having been supposed that the balloon was full at starting). This only reduces the value 3559 by about 300, and the result of taking it into account is only to increase the height just found by about 200 feet. If 2000 ℔ out of the 3000 were thrown away during the ascent, the balloon would reach a height of about 10 miles; the weight of the gas that escapes is here important, as, if it be not taken into account, the height given by the formula is only about 8 miles.

In actual aerostation, as at present practised, ordinary coal gas is used, which is many times heavier than hydrogen, being, in fact, usually not less than half the specific gravity of air. Even when balloons are inflated with hydrogen, generated by the action of sulphuric acid on zinc filings, the gas is very far from pure, and its density is often double that of pure hydrogen, and even greater.

The hydrostatic laws relating to the equilibrium of floating bodies were known long previous to the invention of the balloon in 1783, but it was only in the latter half of the 18th century that the nature of gases was sufficiently understood to enable these principles to have been acted on. As we have seen, both Black and Cavallo did make use of them on a small scale, and if they had thought it possible to make a varnish impervious to the passage of hydrogen gas they could have easily anticipated the Montgolfiers. As it was, no sooner was the fire-balloon invented, than Charles at once suggested and practically carried out the idea of the hydrogen or inflammable air balloon.

Mathematical theory of the motion of a balloon; the last problem that engaged the attention of Euler.

The mathematical theory of the rate of ascent of a balloon possesses remarkable historic interest, from the fact that it was the last problem that engaged the attention of the greatest mathematician of the last century, Euler. The news of the experiment of the Montgolfiers at Annonay on June 5, 1783, reached the aged mathematician (he was in his 77th year) at St Petersburg, and with an energy that was characteristic of him he at once proceeded to investigate the motion of a globe lighter than the air it displaced. For many years he had been all but totally blind, and was in the habit of performing his calculations with chalk upon a black board. It was after his death, on September 7, 1783, that this board was found covered with the analytical investigation of the motion of an aerostat. This investigation is printed under the title, *Calculs sur les Ballons Aérostatiques faits par feu M. Léonard Euler, tels qu'on les a trouvés sur son ardoise, après sa mort arrivée le* 7 *Septembre* 1783, in the *Memoirs of the French Academy* for 1781 (pp. 264–268). The explanation of the earlier date is that the volume of memoirs for 1781 was not published till 1784. The peculiarity of Euler's memoir is that it deals with the motion of a closed globe filled with a gas lighter than air, whereas the experiments of the Montgolfiers were made with balloons inflated with heated air. The explanation of this must be that either an imperfect account reached Euler, and that he supplied the details himself as seemed to him most probable, or that he, like the Montgolfiers themselves, attributed the rising of the balloon to the generation of a special gas given off by the chopped straw with which the fire was fed. The treatment of the question by Euler presents no particular point of importance—indeed, it could not; but the fact of its having given rise to the closing work of so long and distinguished a life, and having occupied the last thoughts of so great a mind, confers on the problem of the balloon's motion a peculiar interest.

Motion of a balloon.

We now proceed to the investigation of the vertical motion of a balloon inflated with gas, the horizontal motion, of course, being always equal to that of the current in which it is placed. In supposing, therefore, the balloon to be ascending vertically into a perfectly calm atmosphere, there is no loss of generality. There are two cases of the problem, viz., when the balloon is only partially filled with gas at starting, and when it is quite filled. The motion in the former case we shall investigate first, as the balloon will ascend till it becomes completely full, and then the subsequent motion will belong to the second case. We may remark that it is usual in investigations relating to the motions of a balloon to regard it in the way that Euler did, viz., as a *closed* inextensible bag, capable of bearing any amount of pressure. In point of fact, the neck or lower orifice of the balloon is invariably open while it is in the air, so that the pressure inside and outside is practically always the same, and when the balloon continues ascending after it has become quite full, the gas pours out of the neck or is allowed to escape by opening the upper valve. It is to be noticed that we have not thought it necessary to transform the formulæ obtained in such wise that they may be readily adapted to numerical calculations as they stand, as our object is rather to exhibit the nature of the motion, and clearly express the conditions that are fulfilled in the case of a balloon, than deduce a series of formulæ for practical use. We shall, however, indicate the simplifications allowable in practical applications. The effect of temperature, though important, is neglected, as the connection between it and height is still unknown. It was chiefly to determine this relation that Mr Glaisher's ascents were undertaken, and at the conclusion of the first eight he deduced an empirical law which seemed to accord pretty well with the observations; the succeeding twenty ascents, however, failed to confirm this law. In fact, it is evident, even without observation, that the rate of the decline of temperature when the sky is clear must differ from what it is when cloudy, and that, being influenced to a great amount by radiation of heat from the earth's surface, it will vary from hour to hour. Under these circumstances, as our object is not to deduce a series of practical rules for calculating heights, &c., we have supposed the temperature to remain constant throughout the atmosphere. The assumption of any law of decrease would considerably complicate the equations. Perhaps the simplest law, mathematically considered, would be to assume the curve of descent of temperature to be $y = e^{-ax}$. The curve Mr Glaisher deduced from his eight ascents was a portion of a hyperbola, the constants being determined empirically.

Motion of a balloon only partially full at starting.

Let M = the mass of the balloon, car, netting, gas, passengers, &c., on starting.
V_0 = the capacity of the envelope of the balloon when full.
v_0 = the volume of gas at the pressure of the air introduced into the balloon before starting.
v = the volume (supposed less than V_0) occupied by the gas at the height x.
ϱ_0 = density of the gas in the balloon on the earth.
ϱ = " " " at the height x.
σ_0 = density of the air on the earth.
σ = " " at the height x.
u = the initial upward velocity of the balloon (which is introduced for the sake of complete generality, but is always zero).
u_0 = the velocity (vertically upwards, as all horizontal motion is ignored) at height x.

Then the equation of motion at any time previous to the balloon becoming completely filled is

$$Mu\frac{du}{dx} = \sigma v g' - Mg' - \lambda u^2 e^{-\frac{b}{k}x},$$

the last term being due to the resistance of the air, which is assumed to vary directly as the square of the velocity and as the density of the air. In very slow motions the

resistance appears from experiments to vary pretty nearly as the velocity; and when the motion is very swift, as in the case of a rifle-bullet, as the cube of the velocity; but when the motion is neither very rapid nor very slow, the law of the square of the velocity probably represents the truth very fairly. By g' is denoted the value of gravity at the height x, so that

$$g' = g\frac{a^2}{(a+x)^2}$$

a being, as above, the radius of the earth. In the exponential term, we shall replace g' by g, as no sensible error can result therefrom. The value of σv is constant, as by Boyle's and Marriotte's law it always $=\sigma_0 v_0$. Writing, therefore, for brevity—

$$\sigma_0 v_0 - \mathrm{M} = c,$$

$$\frac{2\lambda}{\mathrm{M}} = \alpha,\ \frac{2cg}{\mathrm{M}} = \beta,\ \frac{g}{k} = n,\ \frac{\alpha}{n} = m,$$

the equation of motion takes the form

$$\frac{du^2}{dx} + \alpha e^{-nx} u^2 = \beta\frac{a^2}{(a+x)^2};$$

whence, following the usual rule for the integration of linear differential equations of the first order, and writing X for e^{-nx}, for convenience of printing,

$$u^2 e^{-m\mathrm{X}} = \beta a^2 \int e^{-m\mathrm{X}} \frac{dx}{(a+x)^2}$$

$$= \beta a^2 \left\{ -\frac{e^{-m\mathrm{X}}}{a+x} + \alpha\int\frac{e^{-m\mathrm{X}-n\mathrm{X}}dx}{a+x} \right\}$$

$$= \beta a^2 \left\{ -\frac{e^{-m\mathrm{X}}}{a+x} + \alpha\int\frac{dx}{a+x}(e^{-nx} - me^{-2nx} + \frac{m^2}{1.2}e^{-3nx} - \dots) \right.$$

$$= \beta a^2 \Big[-\frac{e^{-m\mathrm{X}}}{a+x} + \alpha\{e^{na}\mathrm{Ei}(-na-nx)$$

$$- me^{2na}\mathrm{Ei}(-2na-2nx)$$

$$+ \frac{m^2}{1.2}e^{3na}\mathrm{Ei}(-3na-3nx) - \dots\} \Big] + \mathrm{C}.$$

Herein put $x=0$, so that $u=u_0$, and we have

$$u_0^2 e^{-m} = \beta a^2 \Big[-\frac{e^{-m}}{a} + \alpha\{e^{na}\mathrm{Ei}(-na) - me^{2na}\mathrm{Ei}(-2na)$$

$$+ \frac{m^2}{1.2}e^{3na}\mathrm{Ei}(-3na-)\dots\} \Big] + \mathrm{C};$$

whence, by subtraction,

$$u^2 e^{-m\mathrm{X}} - u_0^2 e^{-m} = \beta a^2 \Big[\frac{e^{-m}}{a} - \frac{e^{-m\mathrm{X}}}{a+x} + \alpha\{e^{na}\mathrm{Ei}(-na-nx)$$

$$- me^{2na}\mathrm{Ei}(-2na-2nx) + \dots - e^{na}\mathrm{Ei}(-na) + me^{2na}\mathrm{Ei}(-2na) - \dots\} \Big]$$

therefore

$$u^2 = u_0^2 e^{-m(1-\mathrm{X})} + \beta a^2 \Big[\frac{e^{-m(1-\mathrm{X})}}{a} - \frac{1}{a+x}$$

$$+ \alpha e^{m\mathrm{X}}\{e^{na}\mathrm{Ei}(-na-nx) - e^{na}\mathrm{Ei}(-na) - me^{2na}\mathrm{Ei}(-2na-2nx)$$

$$+ me^{2na}\mathrm{Ei}(-2na) + \frac{m^2}{1.2}e^{3na}\mathrm{Ei}(-3na-3nx)$$

$$- \frac{m^2}{1.2}e^{3na}\mathrm{Ei}(-3na) + \dots\} \Big]$$

in which Ei x is used to denote the exponential integral of x, viz.: $\int_{-\infty}^{x} \frac{e^x}{x}dx$, according to a recognised notation. The values of the integral Ei x, which may be regarded as a known function, have been tabulated (see *Philosophical Transactions* for 1870, pp. 367–388).

We thus have, except for temperature, the complete solution of the problem of the motion of the balloon so far as velocity and height are concerned; it would not be possible to connect the time and the height except by the performance of another integration, for the practicability of which it would be necessary to submit to some loss of generality, viz., we should have to regard x as small as compared to a, and take λ as small, and so on. The equation last written gives the motion until the height (say h) is attained at which the balloon becomes quite full, after which the gas begins to escape, and we have the second case of the problem.

Before proceeding, however, to the discussion of this second case, it is worth while to examine the solution more carefully, leaving out of consideration quantities that make no very great difference in the practical result, for the sake of simplicity. Supposing, then, gravity to be constant at all heights, and λ to be zero, the equation of motion takes the simple form

$$\frac{d.u^2}{dx} = \beta$$

whence

$$u^2 - u_0^2 = \beta x;$$

and we see, what is pretty evident from general reasoning, that if a balloon, partially filled, rises at all, it will at least rise to such a height that it will become completely full.

The letters meaning the same as before, the equation of motion of a balloon completely filled at starting is Motion of a balloon full at starting

$$\left\{ \mathrm{M} - \mathrm{V}_0(\rho_0 - \rho) \right\} u\frac{du}{dx} = g\frac{a^2}{(a+x)^2}\left\{ \mathrm{V}_0\sigma - \mathrm{M} + \mathrm{V}_0(\rho_0 - \rho) \right\}$$
$$- \lambda u^2 e^{-nx},$$

or substituting for ρ and σ their values

$$\left\{ \mathrm{M} - \mathrm{V}_0\rho_0(1-e^{-nx}) \right\} u\frac{du}{dx} = g\frac{a^2}{(a+x)^2}\left\{ \mathrm{V}_0\sigma_0 e^{-nx} - \mathrm{M} \right.$$

$$\left. + \mathrm{V}_0\rho_0(1-e^{-nx}) \right\} - \lambda u^2 e^{-nx}.$$

The integral of this differential equation could be obtained in series as before, only that the resulting equations would be more complicated. As we do not propose to discuss the formulæ obtained, it will be sufficient for our purpose to deduce an approximate solution by neglecting $\mathrm{V}_0\rho_0(1-e^{-nx})$ compared to M, viz., neglecting the mass of the gas that has escaped during the ascent compared to the mass of the whole balloon and appurtenances. It must be borne in mind, however, that when coal gas is used, and the ascent is to a great height, the mass of gas that escapes is by no means insensible. The equation thus becomes

$$\tfrac{1}{2}\mathrm{M}\frac{du^2}{dx} + \lambda e^{-nx}u^2 = \frac{ga^2}{(a+x)^2}\left\{ \mathrm{V}_0\sigma_0 e^{-nx} - \mathrm{M} \right\}$$

or

$$\frac{du^2}{dx} + \alpha e^{-nx}u^2 = \frac{\gamma a^2}{(a+x)^2}\left\{ \mathrm{V}_0\sigma_0 e^{-nx} - \mathrm{M} \right\}$$

γ being $\frac{2g}{\mathrm{M}}$. This is an equation which can be integrated in exactly the same way as that previously considered, viz., by multiplying by a factor $e^{-m\mathrm{X}}$, and integrating at once; thus,

$$u^2 e^{-m\mathrm{X}} = \mathrm{V}_0\sigma_0\gamma a^2 \int\frac{e^{-nx-m\mathrm{X}}dx}{(a+x)^2} - \mathrm{M}\gamma a^2\int\frac{e^{-m\mathrm{X}}dx}{(a+x)^3} + \mathrm{C}$$

$$= \mathrm{V}_0\sigma_0\gamma a^2 \left\{ -\frac{e^{-nx-m\mathrm{X}}}{a+x} + \int\frac{dx}{a+x}(-ne^{-nx-m\mathrm{X}} + \alpha e^{-2nx-m\mathrm{X}}) \right\}$$

$$- \mathrm{M}\gamma a^2 \left\{ -\frac{e^{-m\mathrm{X}}}{a+x} + \alpha\int\frac{e^{-m\mathrm{X}-nx}dx}{a+x} \right\} + \mathrm{C}$$

$$= \mathrm{V}_0\sigma_0\gamma a^2 \Big[-\frac{e^{-nx-m\mathrm{X}}}{a+x}$$

$$- n\{e^{na}\mathrm{Ei}(-na-nx) - me^{2na}\mathrm{Ei}(-2na-2nx) + \dots\}$$

$$+ \alpha\{e^{2na}\mathrm{Ei}(-2na-2nx) - me^{3na}\mathrm{Ei}(-3na-3nx) + \dots\} \Big]$$

$$-M\gamma a^2\left[-\frac{\epsilon^{-nx}}{a+x}+\alpha\left\{\epsilon^{na}\mathrm{Ei}\,(-na-nx)\right.\right.$$
$$\left.\left.-m\epsilon^{2na}\mathrm{Ei}\,(-2na-2nx)+\dots\right\}\right]+C,$$

and C is determined as before by putting $x=0$, when we have $u=u_0$.

In this case u_0 is not zero, except when the balloon starts from the earth quite full. The general case is, when the balloon is only partially filled on leaving; the previous equations then hold until a height h, at which it becomes quite full, when the motion changes, and is as just investigated. Then u_0 becomes the velocity at the height h, and everything is measured from this height as if from the surface of the earth, a being then the radius of the earth + h, ρ_0, σ_0 the densities at height h, and ρ, σ at height $x+h$, &c. We have therefore, except as regards time, completely determined the motion of a balloon inflated with gas in an atmosphere of constant temperature. The introduction of temperature would modify the motion considerably, but in the present state of science it cannot be taken into account.

Principle of the fire-balloon.

The general principle of the equilibrium of a fire-balloon is, of course, identical with that of a gas-balloon; but the motion is different, as the degree of buoyancy at each moment varies with the temperature of the air within the balloon, and therefore with the heat of the furnace by which the air is warmed. Dry air expands $\frac{1}{273}$d part of its volume for every increase of temperature of 1° centigrade, or $\frac{1}{491}$th of its volume for every increase of temperature of 1° Fahr. If, therefore, the air in an envelope or bag be heated 60° Fahr. more than the surrounding air, the air within the bag will expand $\frac{60}{491}$th of its volume, and this air must therefore escape. The air within the bag weighs less, therefore, than the air it displaces by the $\frac{60}{491}$th part of the latter; and if the weight of this be greater than the weight of the bag and appurtenances, the latter will ascend. It is, therefore, always easy to calculate approximately the ascensional power of a fire-balloon if the temperature of the surrounding air be known, and also the mean temperature of the air within the balloon. Thus, let the balloon contain V cubic feet of hot air at the temperature t' (Fahr.), and let the temperature of the surrounding air be t (Fahr.) Also, suppose the weight of the balloon, car, &c., is W ℔, and let the barometer reading be h inches, then the ascensional power is equal to the weight of the air displaced − weight of the heated air − W ℔, viz.,

$$\frac{h}{29{\cdot}922}\left\{\frac{V\times{\cdot}080728}{1+\dfrac{t-32}{491}}-\frac{V\times{\cdot}080728}{1+\dfrac{t'-32}{491}}\right\}\text{℔}-W\text{℔},$$

·080728 ℔ being the weight of a cubic foot of air at temperature 32°, under the pressure of one atmosphere, viz., when the reading of the barometer is 29·922 in. Of course, the motion depends upon the temperature of the air in the balloon as due to the furnace, if the latter is taken up with the balloon; but if the air in the balloon is merely warmed, and the balloon then set free by itself, the problem is an easy one, as the rate of cooling can be determined approximately; but it is destitute of interest. We have said that dry air increases its volume by $\frac{1}{491}$th part for every increase of 1° (Fahr.), but the air is generally more or less saturated with moisture. This second atmosphere, formed of the vapour of water, is superposed over that of the air, as it were, and, in a very careful consideration of the question, should be taken into account. Even, however, when the air is completely saturated with moisture but little difference is produced; so that for all practical purposes the presence of the vapour of water in the air may be ignored. Of course the amount of vapour depends on the dew-point, and tables of the pressure of the vapour of water at different temperatures are given in most modern works on heat; but, as has been stated, the matter, in an aeronautical point of view, is of very little importance. At first it was supposed that the cause of the ascent of the balloon of the Montgolfiers was traceable to the generation of gas and smoke from the damp straw which was set light to; but the advance of science showed that the fire-balloon owed its levity merely to the rarefaction of the air produced by the heat generated.

Height of the balloon determined by readings of the barometer and thermometer.

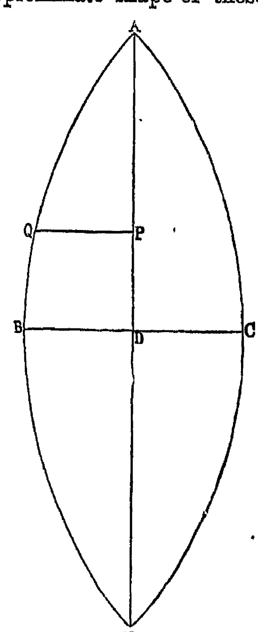
A formula giving the height, in terms of the readings of the barometer and thermometer, on the surface of the earth, and at the place the height of which is required, is easily obtained from the principles of hydrostatics. The formula given by Laplace, reduced to English units, is—

$$Z=\log\left(\frac{h}{h'}\right)\times 60159\left(1+\frac{t+t'-64}{900}\right)(1+{\cdot}002837\cos 2\,L)$$
$$\left(1+\frac{z+52251}{20886900}\right).$$

Z being the height required in feet, h, h' the heights of the barometer in inches at the lower and upper stations, t, t' the temperatures (Fahr.) of the air at the lower and upper stations, L the latitude, z the approximate altitude, and 20,886,900 the earth's mean radius in feet. This was the formula used by Mr Glaisher for the reduction of his observations. It is open to the obvious defect that the temperature is assumed uniform, and equal to the mean of the temperatures at the upper and lower stations; but till the law of decline of temperature is better determined, perhaps this is as good an approximation to the truth as we can have without introducing needless complication in the formula.

Shape of a gore of a balloon.

A sphere is not a developable surface—*i.e.*, it cannot be divided in any manner so as to admit of its being spread out flat upon a plane, so that no spherical balloon could be made of *stiff* plane material. However, the silk or cotton of which balloons are manufactured is sufficiently flexible to prevent any deviation from the sphere being noticeable. Balloons are made in *gores*, a gore being what, in spherical trigonometry, is called a *lune*, viz., the surface enclosed between two meridians. The approximate shape of these gores is very easy to calculate. Thus, let ABEC be a gore, then the sides ABE, ACE, are not arcs of circles, but curves of sines, viz., PQ bears to DB the ratio that sin AP does to sin AD, or, which comes to the same thing, supposing AD = 90°, and AP = x°, then PQ = BD sin x°. It is thus easy, by means of a table of natural sines, to form a pattern gore, whatever the required number of gores may be. Thus, supposing there are to be n gores, then B C must be $\frac{1}{n}$th of the circumference—viz., $\frac{2}{n}$ths of AE; and BD and AD being given, any number of points can be found on the curve ABE in the manner indicated above. A slight knowledge of spherical trigonometry shows the reason for the above rule. Balloons, as usually constructed, are spherical, except for the neck, which is made to slope down, so that the whole



Balloon Gore.

shape resembles rather that of a pear. The pattern gore should originally be made as if for a spherical balloon, and afterwards the slight modification necessary for the formation of the neck should be applied.

Construction of a balloon.

The gores are sewn together, and a small portion of the upper end of each is cut away, so as to leave an aperture at the top of the balloon of from 1 to 3 feet in diameter. This space is occupied by the valve, which is generally made of strong wood, and consists of two semicircular shutters hinged to a diameter of the circular frame, and kept closed by a spring. The valve is opened by pulling a string, technically called the valve-line, which passes down through the balloon and out at the lower orifice in which the neck terminates. The net-work which, like the gores, is attached to the circumferences of the valve, passes over the surface of the balloon, and supports the ring or hoop from which the car is suspended by half a dozen strong ropes, of perhaps 4 or 5 feet in length. The net-work is thus stretched between the valve and the ring. It is very important that all the ropes by which the car hangs from the ring should be so adjusted that each may bear pretty nearly the same weight, as otherwise the whole netting and balloon will be strained, and perhaps to a serious extent. The car is usually merely a large basket made of wicker-work. The neck of the balloon should be 7 or 8 feet above the car, so that the aeronaut can easily reach it by mounting into the ring. The best material for the envelope is silk; but on account of the expense cotton or alpaca is generally used: in all cases it must be varnished, in order to render it more impervious to the gas. The grapnel or anchor is a large five-pronged hook attached to the ring by a rope 100 or 120 feet long. The first care of the aeronaut on leaving the earth is to lower the grapnel gently to the full extent that the rope will permit. Thus, when the balloon is in the air, the grapnel hangs down below it, and when the descent is being effected, is the first thing to touch the ground. If the descent is well managed, and the balloon is moving downwards slowly, the weight of which it is relieved when the grapnel is supported by the earth checks any further descent, and the wind carries the balloon along horizontally, the grapnel trailing over the ground until it catches in some obstruction and is held fast. The balloon is then in much about the same position as a kite held by a string, and if the wind be strong, plunges about wildly, striking the ground and rebounding, until the aeronaut, by continued use of the valve-line, has allowed sufficient gas to escape to deprive it of all buoyancy and prevent its rising again.

Practice of aerostation.

The chief danger attending ballooning lies in the descent; for if a strong wind be blowing, the grapnel will sometimes trail for miles over the ground at the rate of ten or twenty miles an hour, catching now and then in hedges, ditches, roots of trees, &c.; and, after giving the balloon a terrible jerk, breaking loose again, till at length some obstruction, such as the wooded bank of a stream, affords a firm hold. If the balloon has lost all its buoyant power by the escape of the gas, the car also drags over the ground. But even a very rough descent is usually not productive of any very serious consequences; as, although the occupants of the car generally receive many bruises, and are perhaps cut by the ropes, it rarely happens that anything worse occurs. On a day when the wind is light (supposing that there is no want of ballast) nothing can be easier than the descent, and the aeronaut can decide several miles off on the field in which he will alight. It is very important to have a good supply of ballast, so as to be able to check the rapidity of the descent, as in passing downwards through a wet cloud the weight of the balloon is enormously increased by the water deposited on it; and it there is no ballast to throw out to compensate this accession of mass, the velocity is sometimes very great. It is also convenient, if the district upon which the balloon is descending appear unsuitable for landing, to be able to rise again. The ballast consists of fine baked sand, which becomes so scattered as to be inappreciable before it has fallen far below the balloon. It is taken up in bags containing about ¼ cwt. each. The balloon at starting is liberated by a spring catch which the aeronaut releases, and the ballast should be so adjusted that there is nearly equilibrium before leaving, else the rapidity of ascent is too great, and has to be checked by parting with gas. It is almost impossible to liberate the balloon in such a way as to avoid giving it a rotary motion about a vertical axis, which continues during the whole time it is in the air. This rotation makes it difficult for those in the car to discover in what direction they are moving; and it is only by looking down along the rope to which the grapnel is suspended that the motion of the balloon over the country below can be traced. We may mention that the upward and downward motion at any instant is at once known by merely dropping over the side of the car a small piece of paper: if the paper ascends or remains on the same level or stationary, the balloon is descending; while, if it descends, the balloon is ascending. This test is so delicate that it sometimes showed the motion at a particular instant with more precision than did Mr Glaisher's very delicate instruments.

Contrivances are often proposed by which the valve might be opened in less crude ways than by merely pulling a string attached to it; by which the jerks produced by the catching of the grapnel might be diminished, &c. These improvements are not adopted, because simplicity is requisite before everything. Any mechanical contrivance might be broken and rendered useless by the first blow of the car on the earth; whereas the primitive arrangements in use are such that scarcely any rough treatment can impair their efficiency.

Works on aerostation.

The most important works that have appeared on the subject of aerostation are—

Dædalus, or Mechanical Motions, by Bishop Wilkins, London, 1648; *A Treatise on the Nature and Properties of Air and other Permanently Elastic Fluids*, by Tiberius Cavallo, London, 1781; *Account of the First Aerial Voyage in England, in a Series of Letters to his Guardian*, by Vincent Lunardi, London, 1784; *History and Practice of Aerostation*, by Tiberius Cavallo, London, 1785; *Annals of some Remarkable Aerial and Alpine Voyages, including those of the author*, by T. Forster, London, 1832; *Aeronautica*, by Monck Mason, London, 1838; *A System of Aeronautics, comprehending its Earliest Investigations*, by John Wise, Philadelphia, 1850; *Astra Castra, Experiments and Adventures in the Atmosphere*, by Hatton Turnor, London, 1865; *Voyages Aériens*, par J. Glaisher, C. Flammarion, W. de Fonvielle, et G. Tissandier, Paris, 1870; the same translated into English and published, edited by James Glaisher, under the title, *Travels in the Air*, London, 1871.

All the above books we have seen ourselves, and used in the preparation of the present article. *Astra Castra* is a work of 530 pp. large quarto; it consists chiefly of extracts from other works and writings, and it is useful as affording data for a history rather than as a history itself. On pp. 463–465 is a list of books and papers on aeronautics, which seems fairly complete up to the date 1864. In the list are also included memoirs and papers which we have not noted in the last paragraph, as the most important of them are referred to under their special subjects in the course of this article. We should advise any one desirous of studying the history of aeronautics to consult Mr Turnor's list in *Astra Castra*, which is the most perfect we have met with. He has marked with an asterisk those works that may be consulted by the public in the library of the Patent Office, which contains, besides books, a valuable collection of prints and broadsheets on the subject of aerostation. (J. G.)

ÆRTSZEN, PIETER, called "Long Peter" on account of his height, an historical painter of great merit as regards both drawing and colouring, was born at Amsterdam in 1520, and died in 1573. When a youth he distinguished himself by painting homely scenes, in which he reproduced articles of furniture, cooking utensils, &c., with marvellous fidelity, but he afterwards cultivated historical painting. Several of his best works—altar-pieces in various churches—were destroyed in the religious wars of the Netherlands. An excellent specimen of his style on a small scale, a picture of the crucifixion, may be seen in the Antwerp Museum. Ærtszen was a member of the Academy of St Luke, in whose books he is entered as *Langhe Peter, schilder*. Three of his sons attained to some note as painters.

ÆS is commonly translated *brass*, but the æs of the Romans, like the χαλκός of the Greeks, was used to signify not only pure copper, but also a *bronze*, or alloy of copper and tin. *Brass*, in the modern acceptation of an alloy of copper and *zinc*, was unknown to the ancients. The cutting instruments of the ancient Greeks, Romans, and Egyptians were originally of bronze. The Romans borrowed their arms, as well as their money, from the Etruscans. Analysis of the bronzes of these nations shows that they contained about 12 per cent. of tin, which gave them hardness and the capability of receiving a good edge. As the most ancient coined money of the Romans was of copper or bronze, *æs* came to be used for money in general, even after the introduction of silver and gold coinage; and *æs alienum* was used to signify *borrowed money, debt*. *Æs equestre, Æs hordearium, Æs militare*, were terms for the pay of Roman soldiers (previous to the introduction of the regular *stipendium*), which was furnished, it would appear, not from the public treasury, but by certain private persons as decreed by the state. The first, which amounted to 10,000 asses, was the purchase-money of the horse of an *eques*. The second, amounting to 2000 asses, was the pay of an *eques*, and was furnished by unmarried women, widows, and orphans, if possessed of a certain amount of property. The *æs militare*, reckoned by Niebuhr at 1000 asses a year, was the pay of a foot soldier.

ÆSCHINES, an Athenian philosopher, said to have been the son of a sausage-maker. He was continually with Socrates; which occasioned that philosopher to say that the sausage-maker's son was the only person who knew how to pay a due regard to him. It is alleged that poverty obliged him to go to Sicily to the court of Dionysius; and that he met with great contempt from Plato, but was extremely well received by Aristippus, to whom he showed some of his dialogues, receiving from him a handsome sum of money. He did not venture to profess philosophy at Athens, Plato and Aristippus being in such high esteem; but he opened a school, in which he taught philosophy to maintain himself He afterwards wrote orations for the forum. Phrynicus, in Photius, ranks him amongst the best orators, and mentions his orations as the standard of the pure Attic style. Hermogenes has also spoken very highly of him. He wrote, besides, several dialogues:—1. Concerning virtue, whether it can be taught; 2. Eryxias, or Erasistratus: concerning riches, whether they are good; 3. Axiochus: concerning death, whether it is to be feared,—but those extant on the several subjects are not genuine remains. M. le Clerc has given a Latin translation of them, with notes and several dissertations, entitled *Silvæ Philologicæ*.

ÆSCHINES, a celebrated Grecian orator, was born in Attica 389 years before the Christian era. According to his own account, he was of distinguished birth; according to that of Demosthenes, he was the son of a courtesan, and a humble performer in a company of comedians. But whatever was the true history of his birth and early life, his services as a soldier, and his talents, which were considerable, procured him great applause; and, as a public speaker, he became a formidable rival to Demosthenes himself. The two orators, inspired probably with mutual jealousy and animosity, became at last the strenuous leaders of opposing parties. Æschines had almost from the first advocated peace with Philip of Macedon, and having been sent on several embassies to negotiate with the king, had been treated with much respect. He was, in consequence, accused by Demosthenes of having received money as a bribe when he was employed on one of these embassies. He indirectly retaliated by bringing an accusation against Ctesiphon, the friend of Demosthenes, for having moved a decree, contrary to the laws, to confer on Demosthenes a golden crown as a mark of public approbation. A numerous assembly of judges and citizens met to hear and decide the question. Each orator employed all his powers of eloquence; but Demosthenes, with superior talents, and with more justice on his side, was victorious; whereupon Æschines went into exile. According to Plutarch, the resentment of Demosthenes was now softened into generous kindness: for when Æschines was going into banishment, he requested him to accept of a sum of money; which made him exclaim, "How do I regret leaving a country where I have found an enemy so generous, that I must despair of ever meeting with a friend who shall be like him!" But this story seems more than doubtful. Æschines, after staying some years in Asia Minor, opened a school of eloquence at Rhodes. He is said to have commenced his lectures by reading to his audience the two orations which had been the cause of his banishment. His own oration received great praise, but that of Demosthenes was heard with boundless applause. In so trying a moment, when vanity must be supposed to have been deeply wounded, he is reported to have said, with a noble generosity of sentiment, "What would you have thought if you had heard him thunder out the words himself!" Æschines afterwards removed to Samos, where he died in the 75th year of his age. Three only of his orations are extant. His eloquence is of a very high order, and as an orator he is second only to Demosthenes.

ÆSCHYLUS, the father of the Greek tragic drama, was born in the year 525 B.C., in the Attic demos of Eleusis. The period of his youth and manhood coincides, therefore, with that great uprising of the national spirit of the Greeks, caused by the successive attempts of Darius, king of Persia, and his son Xerxes, to enslave their European neighbours on the north and west shores of the Ægean; and it was no doubt as much for the advantage of his poetical faculty as for the development of his manhood, that he took an active part in those famous military achievements by which the march of the insolent Asiatic hosts was repelled. The father of Attic tragedy helped, in the year 490, to drive the captains of Darius into the marshes of Marathon, and, ten years later, encompassed with ruin the multitudinous armament of Xerxes within the narrow strait of Salamis. The glories of this naval achievement, the bard who had helped to win it with his sword afterwards lived to celebrate with the lyre, and left to the world the play of the *Persians*, as a great national record of combined poetry and patriotism almost unique in history. Of his subsequent career at Athens only a few scanty notices remain, and those chiefly connected with the representation of his plays. We know that he composed seventy plays, and that he gained the prize for dramatic excellence thirteen times; further, that the Athenians esteemed his works so highly as to allow some of them to be represented after his death,—a privilege, in their dramatic practice, altogether anomalous. We know, also, that in the course of his life he paid one or two visits to Sicily, to which country he was attracted,

no doubt, by the same literary influence in the person of its ruler Hiero, that drew thither Bacchylides, Simonides, and other notable men of that rich epoch. There can, at the same time, be little doubt that one cause of his visits to that island may have been a want of sympathy as to political matters between him and the Athenian public; for while the Athenians, from the time of Cleisthenes (A.C. 510), had been advancing by rapid and decided steps to the full expansion of the democratic principle, it is evident, from some passages in his plays, especially from the whole tone and tendency of the *Eumenides*, that the political leanings of the poet of the *Prometheus* were towards aristocracy, and that, in the days of Pericles, he foresaw, with a sorrowful fear, the ripeness of those democratic evils which within so short a period led Xenophon to seek a new fatherland in Sparta, and opened to the Macedonian a plain path to the sovereignty of Greece. But whatever may have have been his motives for retiring from the scene of so many literary triumphs (and the gossipers of ancient times have of course transmitted to us their pleasant inventions on this point), it is certain that, in the year A.C. 456, two years after the representation of his great trilogy, the *Orestiad*, he died at Gela, in Sicily, in the sixty-ninth year of his age; and the people of Gela, rejoicing in his bones, as Ravenna does in those of the banished Dante, inscribed the following memorial on his tomb:—

> "Here Æschylus lies, from his Athenian home
> Remote, 'neath Gela's wheat-producing loam;
> How brave in battle was Euphorion's son,
> The long-haired Mede can tell who fell at Marathon."

And thus he lives among posterity, celebrated more as a patriot than as a poet; as if to witness to all times that the great world of books, with all its power, is but a small thing unless it be the reflection of a greater world of action. Of the seventy plays which an old biographer reports him to have composed, only seven remain, with a few fragments of little significance save to the keen eye of the professed philologist. These fragments, however, are sufficient to justify the high esteem in which he was held by the Athenian public, and by that greatest of all the great wits of a witty age and a witty people, Aristophanes. In the grand trilogy which exhibits, in three consecutive tragedies, the story of the murder of Agamemnon, and its moral sequences, we have a perfect specimen of what the Greek tragedy was to the Greeks, as at once a complex artistic machinery for the exhibition of national legend, and a grave pulpit for the preaching of important moral truths; nor could a more worthy founder than Æschylus of such a "sacred opera" be imagined. His imagination dwells habitually in the loftiest region of the stern old religious mythology of primeval Greece; his moral tone is pure, his character earnest and manly, and his strictly dramatic power (notwithstanding the very imperfect form of the drama in his day), as exhibited more especially in the *Agamemnon*, in the *Eumenides*, and in some parts of the *Prometheus*, is such as none of his famous successors, least of all Euripides, could surpass. Of his other plays, the *Seven against Thebes* is a drama, as Aristophanes expressed it, "full of war," and breathes in every line the spirit of the age and of the people that saved Europe from the grasp of oriental despotism; the *Persians*, though weak in some parts, contains some fine choral poetry, and a description of the battle of Salamis, that will belong to the poetry of the world so long as the world lasts; while the *Suppliants* presents much in a tasteful translation that makes us lament the loss of the missing piece of the trilogy to which it belonged, no less than the blundering of the thoughtless copyists of the middle ages, by whose pen it has been so egregiously defaced. For in ancient times the flowing rhetorical Euripides was found a more useful model for the schools of eloquence than the lofty, stern, and sometimes harsh, and occasionally it may be obscure, Æschylus: therefore the text of the latter has been comparatively neglected, and much work was left for the tasteful philologist before many parts of his noblest choruses could be rendered legible. Of the editions of Æschylus, the most notable in the earlier times of modern scholarship is that of Stanley; in more recent times, that of Schütz, who undertook the work of restoration with much learning and great boldness. The impulse given by this scholar was moderated by Wellauer, who, in his edition, along with some happy emendations, principally endeavoured to vindicate the authority of the manuscript readings from the large license of conjectural critics; and now from the remains of the great Hermann has been published a text that should present the just medium between the timidity of Wellauer and the rashness of mere conjectural criticism, though it is much to be feared that the learned German has been not seldom led astray by the itch of emendation, which is the old besetting sin of critical scholarship. Of English poetical translations there are the old one by Potter, and recent ones by Blackie, Plumptre, and Swanwick. There is also a translation in literal prose by Buckley. (J. S. B.)

ÆSCULAPIUS, in the *Heathen Mythology*, the god of medicine, was the son of Apollo and the nymph Coronis. He was educated by the centaur Chiron, who taught him the art of healing; and his skill enabled him to cure the most desperate diseases. But Jupiter, enraged at his restoring to life Hippolytus, who had been torn in pieces by his own horses, killed him with a thunderbolt. According to Cicero, there were three deities of this name: the first, the son of Apollo, worshipped in Arcadia, who invented the probe and bandages for wounds; the second, the brother of Mercury, who was killed by lightning; and the third, the son of Arsippus and Arsinoe, who was the first to teach tooth-drawing and purging. At Epidaurus, Æsculapius's statue was of gold and ivory, with a long beard, the head surrounded with rays, a knotty stick in one hand, and the other entwined with a serpent: the figure was seated on a throne of the same materials as the statue, and had a dog lying at its feet. The Romans crowned him with laurel, to represent his descent from Apollo; and the Phliasians represented him as beardless. The cock, the raven, and the goat were sacred to this deity. His chief temples were at Pergamos, Smyrna, Tricca, a city in Thessaly, and the isle of Coos; in all which places votive tablets were hung up, showing the names of those cured and the diseases of which they were healed by his assistance. But his most famous shrine was at Epidaurus, where, every five years, games were celebrated in his honour, nine days after the Isthmian games at Corinth.

ÆSIR (plural of *As*, or *Ass*, god), the gods of the Northmen of Scandinavia and Iceland. There were twelve chief gods or Æsir besides Odin (the *All-faðir*, All-father), viz., Thor, Baldur, Niörd, Frey, Tŷ or Tŷr, Bragi, Heimdal, Höd, Vidar, Ull, Forsetti, Loki or Lopt. The chief goddesses of ASGARD (*q.v.*), the Odinic Olympus, were—Frigg, Freyia, Nanna, Sif, Saga, Hel, Gefion, Eir, Hlin, Lofn, Vör, Snotra. The names of the Æsir, considered in the primary old northern significance of the words, convey in most instances an allusion to their characteristics; but it is impossible to decide whether they merely personify certain physical powers in nature, and abstract ideas of definite mental conditions, or whether they were originally borne by individuals connected with the pre-historic ages of the people. It is probable that the ideas underlying the myths connected with the Æsir have a mixed origin, and may be referred to a blending of physical, material, and historical elements. Our knowledge of northern mythology has been derived principally

from the fragmentary remains of ancient Scandinavian songs, first collected in Iceland in the 11th century, and embodied in the 13th century with numerous other prose and poetic myths in a compilation now known to us as the *Eddas*. From these highly interesting but frequently obscure sources we are able to reproduce to a certain extent the image and conception of each of the Æsir, as they presented themselves to the imagination of their early northern worshippers.

In *Thor*, who seems to have been a god of that earlier Phœnician form of nature-worship which was superseded in Scandinavia and Northern Germany by the faith of Odin, we have the impersonation of the disturbing and destructive agencies in the universe. He is the son of heaven and earth—of Odin, the All-father, and of Frigg or Fiörgvin, the vivifying—and is the strongest of the Æsir. From his hammer flashed the lightning, and his chariot wheels sent thunder rolling through the clouds as he went on his way, cleaving mountains, loosening the pent-up streams and fires, and slaying all giants and misshapen monsters. Ever busily engaged in these labours, he seldom tarried in Asgard with the other Æsir, but dwelt in his mansion, Bilskirnir, in the densest gloom of the clouds. With his mallet he consecrated the newly-wedded, and hence the sign of the mallet or hammer was made by the Northmen when they took an oath and bound themselves by vows, whether of marriage or any other obligation. The early Christian missionaries of Norway, finding the faith in Thor too strong to be suddenly uprooted, tried to transfer many of his characteristics to their zealous royal convert, St Olaf, who was said to have resembled the old northern god in his comeliness of person, his bright red beard, hot, angry temper, and personal strength; while some of the monks of a later period endeavoured to persuade the Northmen that in Thor their forefathers had worshipped the Christ, the strong and mighty Saviour of the oppressed, and that his mallet was the rude image of the cross. Slaves and all thralls killed in battle were believed to be under the protection of Thor, who, as god of the Finns before the spread of the As religion, was honoured as their special guardian against the tyranny of their new masters.

In *Baldur* the Northmen honoured all that was beautiful, eloquent, wise, and good, and he was the spirit of activity, joy, and light; but his name signifies the strong in mind, and the earliest conception of Baldur is that of mental rather than physical or material perfection. His wife, Nanna, reflected these attributes in a less degree. On his life depended the activity and happiness of all the Æsir, excepting only Loki, the earthly fire or incarnation of evil, and hence this As, from envy of the beauty and innocence of Baldur, brought about his death, and hindered his release from the power of Hel, the goddess of death.

According to the myth, the Æsir, distressed at Baldur's presentiment of his own approaching end, joined his mother, Frigg, in exacting an oath from animals, plants, and minerals, not to injure him. The mistletoe alone among plants had been forgotten, and when this was discovered by Loki he pulled a wand of it, and hastening to the assembly of the Æsir, where all were engaged in the sport of shooting at Baldur, as he was supposed to be invulnerable, he gave it to Höd, the blind god of brute strength, and directed him how to aim it. The mistletoe pierced Baldur through, and he fell dead to the ground in the presence of the Æsir, who, foreseeing the evil that would befall them, since light and purity had been taken from them, gave way to sorrow and fear. When all their efforts to release Baldur from Hel had been thwarted by the machinations of Loki, they resolved to avenge themselves. Having captured their foe, they confined him within a mountain-cave, and hung above his head a venomous snake, to drop its poison on his face; but his wife, Sigyn, stood by him, and caught the drops in a cup, and it was only while she emptied the goblet that the venom touched him, when he shrank aside, and caused the earth to be shaken as with an earthquake. There Loki will remain till Ragnaröck, the twilight of the world, when the Æsir, the earth, and all dwellers therein, will be destroyed by the powers of evil, the rescuers and companions of Loki. Only Odin, the All-father, will survive, and gather around him on Ida's plain, where Asgard had once stood, the Æsir, regenerate and purified by Surt's black fire, and then a new and better world will arise, in which Baldur will again come with his unconscious slayer, Höd, and all evil will cease, and light and darkness will dwell together in unity.

Under one form of the myth of Baldur's death he is the bright god of day or summer, and Höd, the blind and the strong, is dark night or fiercely-raging winter, his pre-ordained foe and destroyer. After that final purification by suffering or fire, and the regeneration to which the Northmen looked as the means of the ultimate adjustment of the disturbed balance between evil and good, and from which they did not exempt their gods, the influence of good was to prevail. Baldur would reappear, and Loki, the consuming power of evil, be no more heard of.

Loki, in the beginning of time, under the name of Lodthur, flame, and as the foster-brother of the All-father, had united with him in imparting blessings to the universe, and had given blood and a fair colour to Ask and Embla, from which the first men were created. Afterwards he left the council of the Æsir, and like a fallen angel wandered away into regions of space, desolating and consuming all things that came in contact with his fierce flame. Descending into the bowels of the earth, where his presence is made manifest by volcanic fires, he consorted with evil giantesses, by whom he became the father of Hel, pallid death; of Augurboda, the announcer of sorrow; and of the wolf Fenrir, and the serpent of Midgard, which are ever threatening the destruction of the world and the peace of the Æsir.

Loki can assume all forms. As sensuality he courses through the veins of men, and as heat and fire he pervades nature, causing death and destruction. After the introduction of Christianity, the attributes and mystic deeds of Loki were transferred to Satan by the people of Scandinavia, amongst whose descendants his name still retains its evil reputation. In Iceland an *ignis fatuus* is known as Loki's burning; and in Jutland, when there is a dazzling light or a waving motion in the air which impedes the sight of distant objects, the peasants say, "Loki is *sowing his oats*."

Niörd, supposed to be the Nerthus known to the Romans, and his children Frey or Fricco and Freyia, appear to have been honoured in the north before the time of Odin, and to have been worshipped by peoples powerful enough to have been admitted into friendly alliance with his followers. Niörd is said to have lived in Vanaheim, and to have ruled over the Vanir, or light elves, long before he became one of the Æsir. He is god of the ocean, the ruler of winds and stiller of waves, and to him the seafarer and fisherman raise altars and make prayers. His attributes and powers seem to point to the existence of a superior knowledge of navigation among those ancient races of Scandinavia who have been idealised in the imagination of the Northmen as good, bright, and agile elves and water-sprites—the *Liós Alfar*—or Vanir of their mythology. Niörd's son *Frey* is the god of rain, plenty, and fruitfulness; and his worship, according to the early northern chronicler, Adam of Bremen, was accompanied with phallic rites. His sister and wife, Freyia, who holds a high place among the Æsir, is the goddess of love; but her influence, unlike her husband's, is not always beneficent, and varies with the form which she assumes in operating on the minds of men. Her chariot is drawn by cats, as emblematic of fondness and passion, and a hog attends upon her and upon Frey, whose name, like her own, implies fructification or enjoyment.

The Swedes paid especial honour to Frey, while the Norwegians worshipped Thor (who was in all respects his opposite) as their chief As. The latter must also have received divine honours amongst the Germans, as his name is included in the form of objurgation used by the early Saxon missionaries; but this fact and the German name of the fifth day of the week—Donners-tag, the Thunderer's day—are

the only evidences still extant of the early worship of Thor in Germany.

By their alliance with Niörd and his children the Æsir secured fertility to the earth and mankind, and the intervention of mild gentle agencies in nature to counteract the destructive influence of Thor's power.

In *Tŷ* or *Tŷr* we have the Mars of the Northmen. It is he who gives victory, and although he is as wise as he is brave, it is he who stirs men to strife, and not to peace. His name, which signifies honour, is found in the names of the days of the week in O. Nor., Dan., A.-S., and in our own "Tuesday;" and shows that, like Thor and Frey or Freyia, whose memory is perpetuated in our Thursday and Friday, the worship of this bravest of the Æsir was widely spread among peoples of Northern origin.

In *Bragi* the Northmen honoured the originator of their Skaldic poetry, the god of eloquence and wise utterances. At guilds and at grave-feasts the Bragi-cup was drunk; and at the funeral of kings or jarls the heir was not permitted to take his father's seat till the "Bragarfull" was brought in, when, rising to receive it, he drank the contents of the cup, and was led to the high seat of honour. At guild feasts the Bragi-cup was signed with Thor's mallet, and was drunk after the company had drained Odin's cup for victory, and Niörd's and Frey's cup for a bountiful year.

The peculiarity of Bragi's cup was that, on drinking it, a vow—held to be inviolable—was made to perform some deed worthy of a skald's song. Bragi's wife, Idun, as the guardian of the casket which contained apples that gave to those who ate them perpetual youth, was specially cherished by the other Æsir. In her abduction by the giant Thiassi, and her removal to the nether world through Loki's craft, her mute grief, and her release in the spring, we have an analogy with the myth of Proserpine; and like her she presides over fresh verdure.

Heimdal, whose attribute is the rainbow, is the god of watchfulness, the doorkeeper of the Æsir; while *Vidar*, the strongest of the gods after Thor, is the impersonation of silence and caution; *Ull* decides the issue of single combats, and *Forsetti* settles all quarrels.

In the goddesses *Lofn* and *Vör* lovers find protectors; the former unites the faithful, the latter punishes the faithless. *Gefion*, to whom the Danes owe the formation of the island Seeland, watches over maidens, and knows the decrees of fate. *Hlin* guards those whom *Frigg*, the queen and mother of heaven, is desirous of freeing from peril; Frigg herself, as Odin's wife and the mother of the Æsir, knows the destinies of men, but is silent in regard to them. As goddess of the earth, she is known as Frygga, the fertile summer earth, and Rinda the frost-hardened surface, and is attended by *Fulla*, the full, *Eir*, the young goddess of healing, and many other goddesses.

Saga, whose name is derived from *Segja*, to narrate, is the goddess of history and narration. Odin and she pledge each other daily in golden cups filled from the copious ever-flowing streams of her abode, *Sockquabek* (from Sökk, abyss, in allusion to the abundant streams of narrative). *Snotra* is the goddess of sagacity and elegance, from whom men and women seek good sense and refinement of manners. The Norns and the Valkyriur, if not actually goddesses, are closely connected with the Æsir. The three principal Norns or Nornir are Urd, past time; Verdandi, present time; and Skulld, future time. They and the Valkyriur, who are known under many names, twist and spin the threads of destiny, and make known what has been decreed from the beginning of time.

From this brief outline it may be seen that in their Æsir the Northmen recognised the creators, sustainers, and regulators of the world as it now is, from whom emanated the thought and life that pervade and animate all nature, and the efforts to subject it to the spiritual will. With Odin and the Æsir the intellectual life of the northern people began; and although they ascribed to them human forms and acts, these were seldom without something higher and nobler than what pertains to mortals; and while they recognised the existence of a state of chaos and darkness before this world began with the creation of the Æsir, they anticipated the advent of another state, in which gods, like men, would receive their award at the hands of a supreme All-father. (E. C. O.)

ÆSOP, the fabulist, is supposed to have been born about the year 620 B.C., but the place of his birth is uncertain, that honour being claimed alike by Samos, Sardis, Mesembria in Thrace, and Cotiæum in Phrygia. He was brought, while young, to Athens as a slave, and having served several masters, was eventually enfranchised by Iadmon the Samian. He thereupon visited Crœsus, king of Lydia, at whose court he is represented by Plutarch as reproving Solon for his discourteous manner towards the king. During the usurpation of Pisistratus he is said to have visited Athens, and composed the fable of *Jupiter and the Frogs* for the instruction of the citizens (Phædrus, i. 2). As the ambassador of Crœsus at Delphi he was charged with the payment of the large sum of four minæ to each of the citizens; but in consequence of some dispute, he declined to distribute the money. The Delphians, incensed at his conduct, accused him of sacrilege, and threw him headlong from a precipice, about 564 B.C. A pestilence which ensued being attributed to this crime, the people declared their willingness to make compensation for his death; which, in default of a nearer connection, was claimed and received by Iadmon, the grandson of his old master (Plut. *de sera Num. Vind.*, p. 556, Herodot. ii. 134). None of Æsop's works are extant. The popular stories regarding him are derived from a life prefixed to a book of fables purporting to be his, collected by Maximus Planudes, a monk of the 14th century, in which he is represented as a monster of ugliness and deformity, a notion utterly without foundation, and doubtless intended to heighten his wit by the contrast. That this life, however, was in existence a century before Planudes's time, appears by a manuscript of it found at Florence, and published in 1809. In Plutarch's *Convivium*, where Æsop is a guest, though there are many jests on his original servile condition, there are none on his appearance; and it would seem that the ancients were not usually restrained by delicacy in this point, since the personal defects of Socrates, and his resemblance to old Silenus, afford ample matter for merriment and raillery in the *Symposium* of Plato. We are told, besides, that the Athenians erected in honour of Æsop a noble statue by the famous sculptor Lysippus, a circumstance which alone would be sufficient to confute the absurd fiction of his deformity; but more to the point is the statement of Pliny (xxxvi. 12), that he was the *Contubernalis* of Rhodopis, his fellow-slave, whose extraordinary beauty passed into a proverb:

Ἄπανθ' ὅμοια, καὶ Ῥοδῶπις ἡ καλή·

The obscurity in which the history of Æsop is involved has induced some to deny his existence altogether; and Giambattista Vico, in his *Scienza Nuova*, chooses rather to consider him as an abstraction, an excess of scepticism which is quite unreasonable. Whether Æsop left any written fables has been more justly disputed, and Bentley inclines to the negative. Thus Aristophanes (*Vespæ*, v. 1259) represents Philocleon as learning his fables in conversation, and not from a book; and Socrates essayed to versify such as he remembered (Plat. *Phæd.* p. 61). Others, again, are of opinion that a collection had been made of them before the time of Socrates (*Mus. Crit.* i. 408). It is, however, certain that fables bearing Æsop's name were popular at Athens during the most brilliant period of its literary history; though the discrepancies of authors in quoting the same fables seem in favour of Bentley's hypothesis. (Compare Aristot. *De Part. Anim.*

iii. 2; and Lucian, *Nigr.* 32). The original fables were in prose, and were turned into verse by several writers; the first, after the example of Socrates, being Demetrius Phalereus. Next appeared an edition in elegiac verse, often cited by Suidas, but the author's name is unknown; then Babrius, an excellent Greek poet, turned them into choliambics (i.e. *limping* iambics); but of ten books, a few fables only are preserved entire. Of the Latin writers of Æsopean fables, Phædrus is the most celebrated.

> "Æsopus auctor quam materiam reperit,
> Hanc ego polivi versibus senariis."
> PHÆD.

The fables now extant in prose under Æsop's name are entirely spurious, as is proved by Bentley in his *Dissertation on the Fables of Æsop*, and have been assigned an oriental origin. The identification of Æsop with the Arabian philosopher and fabulist Lokman (who is made by some traditions the contemporary of the psalmist David) has frequently been attempted; and the Persian accounts of Lokman, which among other things describe him as an ugly black slave, appear to have been blended by the author of the *Life*, published by Planudes, with the classical stories respecting Æsop. The similarity of the fables ascribed to each renders it probable that they were derived from the same Indo-Persian source, or from the Chinese, who appear to have possessed such fables in very remote antiquity. A complete collection of the Æsopean fables, 231 in number, was published at Breslau by J. G. Schneider in 1810.

ÆSOP, a Greek historian, whose life of Alexander the Great is preserved in a Latin translation by Julius Valerius. It is a work of no credit, abounding in errors.

ÆSOP, CLODIUS, a celebrated actor, who flourished about the 670th year of Rome. He and Roscius were contemporaries, and the best performers who ever appeared upon the Roman stage; the former excelling in tragedy, the latter in comedy. Cicero was on intimate terms with both actors, and put himself under their direction to perfect his action. Æsop performed many friendly services to Cicero, especially during the period of his banishment. He appears to have spared no pains to improve himself in his art, and to have always studied his part with the greatest care. On the stage his declamation was emphatic and his action vehement, and he became entirely absorbed in his part. Plutarch mentions it as reported of him, that while he was representing Atreus deliberating how he should revenge himself on Thyestes, he forgot himself so far in the heat of action that with his truncheon he struck and killed one of the servants crossing the stage. His age and the time of his death are uncertain; but he made his last appearance on the stage in B.C. 55, at the dedication of Pompey's theatre, on which occasion his voice failed him. Æsop lived in a somewhat expensive manner; but he nevertheless contrived to leave an ample fortune to his spendthrift son. This is the son of Æsop mentioned by Horace (*Sat.* iii. 3, 239) as taking a pearl from the ear-drop of Cæcilia Metella, and dissolving it in vinegar, that he might have the satisfaction of swallowing eight thousand pounds' worth at a draught.

ÆSTHETICS is the term now employed to designate the theory of the Fine Arts—the science of the Beautiful, with its allied conceptions and emotions. The province of the science is not, however, very definitely fixed, and there is still some ambiguity about the meaning of the term, arising from its etymology and various use. The word æsthetic, in its original Greek form (αἰσθητικός), means anything that has to do with perception by the senses, and this wider connotation was retained by Kant, who, under the title Transcendental Æsthetic, treats of the *a priori* principles of all sensuous knowledge. The limitation of the term to the comparatively narrow class of sensations and perceptions occupied with the Beautiful and its allied properties is due to the Germans, and primarily to Baumgarten, who started from the supposition that, just as truth is the end and perfection of pure knowledge or the understanding, and good that of the will, so beauty must be the supreme aim of all sensuous knowledge. Yet, spite of these sources of vagueness in the subject and its name, some considerable part of the theory can be looked upon as pretty clearly defined, and it may be possible, by means of careful reflection on this ascertainable quantity, to indicate, roughly at least, the extent and boundaries of a complete system of æsthetic doctrine.

A very brief survey of what has been written under the name æsthetics is sufficient to show that it includes, as its first and foremost problem, the determination of the nature and laws of Beauty, including along with the Beautiful, in its narrower signification, its kindred subjects, the Sublime and the Ludicrous. To discover what it is in things which makes them beautiful or ugly, sublime or ludicrous, is one constant factor in the æsthetic problem. Intimately connected with this objective question is the subjective and psychological inquiry into the nature of the feelings and ideas that have beauty for their object. Further, it will be found that all attempts to construct a complete æsthetic theory aim at determining the highest ends of the Fine Arts (which obviously concern themselves largely, if not exclusively, with the Beautiful), and at marking out the distinctions and tracing the dependencies of natural and artistic beauty. All this part of the field of æsthetic inquiry seems fairly agreed on, and it is only when we approach other sides of the Fine Arts that the precise scope of the science appears obscure. But while there is this measure of agreement as to the proper subject matter of æsthetics, we find two diametrically opposed methods of approaching it, which distinctly colour all parts of the doctrine arrived at, and impose different limitations to the boundaries of the subject. The first is the metaphysical or *a priori* method; the second the scientific or empirical method. The one reasons deductively from ultra-scientific conceptions respecting the ultimate nature of the universe and human intelligence, and seeks to explain the phenomena of beauty and art by help of these. The other proceeds inductively from the consideration of these phenomena, as facts capable of being compared, classified, and brought under certain uniformities. At the same time, it must not be supposed that either method is customarily pursued in complete independence of the other. The most subtle exponent of transcendentalism in art appeals to generalisations drawn from the facts of art; nor have the professedly scientific critics often abstained from introducing conceptions and hypotheses of a metaphysical character.

(A.) METAPHYSICAL PROBLEMS.

Metaphysical speculation in æsthetics centres about the objective nature of beauty, and arises somewhat in the following manner:—The appreciation of the Beautiful is a mode of perception. In estimating a beautiful landscape or a beautiful statue, the mind perceives the beauty as a property of the object. It is, moreover, a single property; the name beautiful always denoting the same essential thing, whatever this may be. Now we find that it is not a simple property of matter known through one particular class of sensations, as colour; and the question arises, what it really is in itself, whether inherent in and inseparable from matter, or something superior to it, and if so, how revealed through it. The directions of this inquiry have been almost as numerous as the systems of metaphysical thought. On the supposition of a real substance matter, independent

of all intelligence, human or divine, writers have attempted to discover the essential principle which beautifies it. It has been universally considered by metaphysicians that matter in itself is devoid of beauty, if not positively ugly, and the only question arises as to the extraneous principle which imparts beauty to it. This has been conceived either as a simple force distinct from matter, yet setting it in motion, vivifying it, and reducing it to forms, as by Lévêque; or as a divine being, whose volition directly invests material objects with all their beautiful aspects, as by Reid; or, lastly, as self-existent forms or ideas superinduced upon matter, which are in truth the beauty of objects, as by Plato and his modern followers.

In the prevailing German systems of æsthetics, which are based on an ontological idealism, the independent existence of matter has been denied. These writers conceive an absolute Thought or Idea as the ultimate reality, of which matter and consciousness are but the two sides. Matter is conceived as the negative or limiting principle in the action or self-movement of the Absolute. The problem of objective beauty becomes on this hypothesis the determination of the particular mode in which the Beautiful is a manifestation of the supreme thought; for the Good and the True are equally revelations of the Unconditioned, and it is necessary to mark off beauty from these. Various definitions of the Beautiful, based on this mode of conception, may be found in the systems of Hegel, Weisse, and the Hegelians. The second great problem in the metaphysics of æsthetics is to co-ordinate the species of the æsthetic genus, namely, the Beautiful (in its narrow sense), the Ugly, the Sublime, and the Ridiculous. This has been undertaken by the Hegelians, and their attempts to construct what they call the dialectics of æsthetics are among the most curious products of metaphysical thought. It being assumed that there is some one ontological process running through every manifestation of the æsthetic Idea, these writers have sought to determine how each of the subaltern notions is related to this process. The last problem in the scheme of metaphysical æsthetics relates to the nature and functions of Art, looked at on one side as a reproduction in altered form of the beauty of Nature, and, on the other, as the conscious product of æsthetic intuition in the human mind. First of all, the arts are appreciated and classified according to the several modes in which they body forth the Idea to our minds. Secondly, since the Absolute may be spoken of as revealing itself to human intelligence, so human intelligence may be looked on as groping through long ages after the Absolute, and thus the historical evolution of art finds its place in a complete metaphysic of æsthetics. In concluding this preliminary sketch of the metaphysical systems, it should be added that they can be adequately estimated and criticised only in connection with the whole systems of thought of which they are organic parts. Within the scope of a purely scientific criticism it is only possible to point out any inconsistencies in the application of these ideas to beauty and art, and to show how much or how little they effect, as hypothetical instruments, in helping us more clearly to understand the phenomena.

(B.) Scientific Problems.

In the scientific discussion of æsthetic subjects, the antithesis of subject and object in human cognition is accepted as a phenomenal distinction, without any inquiry into its ontological meaning. Inquirers no longer discuss the essence of beauty, looked on as a transcendental conception above all experience, but seek to determine in what the Beautiful, as a series of phenomena, clearly and visibly consists. Æsthetic speculation becomes, accordingly, more purely psychological. First of all, the unity of beauty is questioned. It is asked whether all objects which appear beautiful are so because of some one ultimate property, or combination of properties, running through all examples of beauty, or whether they are so called simply because they produce some common pleasurable feeling in the mind. This is a question of induction from facts and consequent definition, lying at the very threshold of æsthetic science. It has been most vigorously disputed by British writers on the subject, and many of them have decided in favour of the plurality and diversity of elements in beauty. Again, it has been asked in which category of our experience, objective or subjective, beauty originates. By some it has been referred to an objective source, whether to sensation, as a direct result of physiological action, as by Burke, or to something distinctly perceived by means of sensation, as a certain relation of unity, symmetry, &c., among the parts of an object, its colours, forms, and so on, as probably by Aristotle, Diderot, Hogarth, and most writers. By others the source of beauty has been sought in the inner life of the mind itself, in certain ideas and emotions which have become reflected on external objects by association. This is the doctrine of Alison. A third class recognise both of these sources, attributing the effects of beauty partly to the pleasurable effects of external stimulation, partly to the activities of perception, and partly to multitudinous associations of ideas and feelings from past experience. This class includes Dugald Stewart, Professor Bain, and Mr Herbert Spencer. A third question in the general scientific theory of beauty which is closely related to the last and largely determined by it, is the precise nature of the mental faculty or activity concerned in the perception and appreciation of the Beautiful. This, too, has been widely discussed by English writers,—answers to the other two questions frequently appearing as the necessary implications of the solution of this one. By those who affirm that beauty is a simple property or conjunction of properties in external objects, the subjective perception of this property has been regarded either as a unique faculty (the internal sense), or as the rational principle acting in a certain way. By the school of Alison, who find the source of beauty in a certain flow of ideas suggested by an object, the perception of the same, as a property of the object, would be explained as the result of inseparable association, producing a kind of momentary delusion. And this same effect of association, in producing an apparent intuition of one simple property, would be made use of by those later writers who resolve the nature of beauty into both objective and subjective elements. It is noticeable, too, that while some writers have treated the appreciation of beauty as purely intellectual, others have confined themselves to the emotional element of pleasure. With respect to the Ludicrous and the Sublime, as distinguished from the Beautiful, there seems to have been a tacit agreement that both of these are unique and single properties, whether originally in the object of sense, or reflected on it from the mind; and various theories have been suggested in explanation of the characteristic effects of these properties on human sensibility and thought.

What strikes one most, perhaps, in these discussions is the vagueness due to the great diversity of conception as to the real extent of the Beautiful—the number of objects it may be supposed to denote. While one class of writers appears to limit the term to the highest and most refined examples of beauty in nature and art, others have looked on it as properly including the lower and more vulgarly recognised instances. There is certainly a great want of definiteness as to the legitimate scope of æsthetic theory. It will be seen, too, how closely this point bears on the question of the relativity of æsthetic impressions, whether there is any form of beauty which pleases universally and necessarily, as Kant affirms. The true method of resolving

this difficulty would appear to be to look on æsthetic impressions more as a growth, rising, with the advance of intellectual culture, from the crude enjoyments of sensation to the more refined and subtle delights of the cultivated mind. The problem of the universal and necessary would then resolve itself into an inquiry into a general tendency. It would be asked what kinds of objects, and what elements of sensation, idea, and emotion, tend to become conspicuous in æsthetic pleasures, in proportion as the mind advances in general emotional and intellectual culture. Another defect in nearly all the theories of the Beautiful that have been proposed, refers to the precise relation of the intellectual element in the æsthetic impression. In opposing the narrow view, that the appreciation of beauty is a purely intellectual act, a cold intuition of reason, writers have fallen sometimes into another narrowness, in resolving the whole of the effect into emotional elements, or certain species of pleasure. Unless beauty is, as Hutcheson affirmed, a simple property of objects like colour, the perception of it as objective, which all must allow to be a mental fact, can only be explained by means of certain intellectual activities, by force of which the pleasurable effects come to be referred to such a seemingly simple property. The solution of this point would doubtless be found in a more complete discussion of the perceptive or discriminative and assimilative activities of the intellect which are invariably called into play by complex objects, and which correspond to the attributes of proportion, unity in variety, &c., on which so much stress has been laid by the intuitivists. Not only so, but any theory of æsthetic operations must be incomplete which does not give prominence to those more subtle and exalted intellectual activities that are involved in the imaginative side of æsthetic appreciation, as in detecting the curious half-hidden implications which make up the essence of a refined humour, in constructing those vague yet impressive ideas which enter into our intuition of sublimity and infinity, and even in appreciating such seemingly simple qualities as purity of colour and tone, or the perfectly graduated blending of two adjacent colours. Such activities of the mind constitute, among other things, the symbolic aspect of the Beautiful, and give, as Mr Mill suggests, a basis of truth to such seemingly fanciful notions respecting the meaning of beautiful qualities as one finds in the works of Mr Ruskin.

But comparatively little has been done in a purely scientific manner to determine the nature and functions of Art so as to fix the relations of the different arts to simple or natural beauty. Aristotle supplied a few valuable doctrines, which have been rendered still more precise by Lessing and others. Yet there seems even now no consensus of opinion as to the precise aims of art, how far it has simply to reproduce and constructively vary the beauties of nature, or how far to seek modes of pleasurable effect wider than those supplied by natural objects. A theory of art at all comparable in scientific precision to existing theories of morals has yet to be constructed. The few attempts to establish a basis for art of a non-metaphysical kind are characterised by great one-sidedness. Thus, for example, the theory that the function of art is to imitate nature, has been broached again and again with scarcely any reference to music, merely, as it seems, out of an impatience for some one defining property. Without attempting to sketch a complete doctrine of art, a suggestion may be offered as to the right direction of inquiry. First of all, then, the widest possible generalisations on the various emotional susceptibilities to which art can appeal must be collected, from a study both of mental phenomena as a whole, and of all varieties of pleasurable feeling actually ministered by the several forms of art. This would fix the end of the fine arts in the widest sense, marking it off from the ends of utility and morality. Secondly, the highest aims of art, or the ideal of art, would have to be determined by a consideration of the laws of compatibility and incompatibility among these various orders of gratification, the requirements of quantity, variety, and harmony, in any lofty æsthetic impression, and the relative value of the sensational, intellectual, and emotional elements in æsthetic effect. This part of the subject would include the discussion of the value and universal necessity of the real and the ideal in art, truth to nature and imaginative transformation. These conclusions would require verification by means of the widest and most accurate study of the development of the arts, in which could be traced the gradual tentative progress of the artistic mind towards the highest achievements of art, as well as the permanent superiority of all those forms of art which most clearly embody this tendency. This part of the theory of art would clearly connect itself with the problem of the general law or tendency in æsthetic development already referred to. The proper determination of these two ideas, the whole range of possible æsthetic delight, and the direction of the highest, purest, and most permanent delight of cultivated minds, would at once dispose of many narrow conceptions of art, by recognising the need of the widest possible diversity and grades of artistic value, if only as experiments requisite to the discovery of its highest function. At the same time the meaning and limits of the universal and necessary in art would be defined, and the unsuggestive and dreary conflicts between an unbending absolutism and a lawless individualism shown to be irrelevant. The validity of canons of art, and their limitations, would in this manner be fixed, and the impatient exaltation of certain schools and directions of taste reduced to a modest assertion of a purely relative truth. The aims of art as a whole being thus determined, the next thing would be to define and classify the individual arts of painting, music, poetry, &c., according to their respective powers of embodying these aims. This would require a careful consideration of the material or medium of expression employed by each art, and the limitations imposed by it as to the mode of representation. The determination of this part of æsthetic theory, which Lessing commenced, would require not only technical but considerable psychological knowledge. Similarly, any conclusion arrived at on this subject would need to be verified by a reference to the history of the arts, as exemplifying both the successes of a right conception of the scope and possibilities of the particular art, and the failures resulting from a mistaken conception. Many other points, such as the nature of genius, the function and bounds of criticism, the relation of æsthetic culture to intellectual, moral, and social progress, would be included in a complete scheme of art doctrine.

(C.) History of Systems.

In the following brief account of the most important contributions to æsthetic doctrine, only such writings will be recognised as aim at some general conception of Art and the Beautiful. Much that passes in current literature for æsthetic speculation, namely, a certain thoughtful way of criticising special works of art, is simply the application of recognised principles to new cases. Sometimes, however, in the hands of a philosophic critic the mere appreciation of a single poem or the works of a particular artist may become a luminous discussion of some general principle, and this method of constructing æsthetic theory from the criticism of a single work or series of works was rendered very productive by Lessing.

I. *Greek Speculations.*—Ancient Greece supplies us with the first speculations on the Beautiful and the aims of the fine arts. Nor is it surprising that among a people

so productive of noble artistic creations, and at the same time so speculative, numerous attempts to theorise on these subjects should have been made. We have in classic writings many allusions to works of an æsthetic character now lost, such as a series on poetry, harmony, and even painting, by Democritus. It is to be gathered, too, from Plato's Dialogues that the Sophists made the principles of beauty a special department in their teaching. The first Greek thinker, however, whose views on these subjects are

Socrates.

at all known is Socrates. Accepting Xenophon's account of his views in the *Memorabilia* and the *Symposion*, we find that he regarded the Beautiful as coincident with the Good, and both of them as resolvable into the Useful. Every beautiful object is so called because it serves some rational end, whether the security or gratification of man. It looks as though Socrates rather disparaged the immediate gratification which a beautiful object affords to perception and contemplation, and emphasised rather its power of furthering the more necessary ends of life. Thus he said that pictures and other purposeless works of art, when used to adorn a house, hindered rather than furthered enjoyment, because of the space they took from useful objects. This mode of estimating the value of beauty is, however, no necessary consequence of the theory that the whole nature of beauty is to minister pleasure. It arises from undue attention to mere material comfort as a condition of happiness. The really valuable point which Socrates distinctly brought to light is the relativity of beauty. Unlike his illustrious disciple, he recognised no self-beauty (αὐτὸ τὸ καλόν) existing absolutely and out of all relation to a percipient mind.

Plato.

Of the precise views of Plato on this subject, even if they were really formed, it is very difficult to gain a just conception from the Dialogues. In some of these, called by Mr Grote the Dialogues of Research, as the *Hippias Major*, he ventures on no dogmatic theory of Beauty, and several definitions of the Beautiful proposed are rejected as inadequate by the Platonic Socrates. At the same time we may conclude that Plato's mind leaned decidedly to a theory of an absolute Beauty, this, indeed, being but one side of his remarkable scheme of Ideas or self-existing Forms. In the *Symposion* he describes how love (Eros) produces aspiration towards the pure idea of beauty. It is only this absolute beauty, he tells us, which deserves the name of beauty; and this is beautiful in every manner, and the ground of beauty in all things. It is nothing discoverable as an attribute in another thing, whether living being, earth, or heaven; for these are only beautiful things, not the Beautiful itself. It is the eternal and perfect existence contrasted with the oscillations between existence and non-existence in the phenomenal world. In the *Phædrus*, again, he treats the soul's intuition of the self-beautiful as a reminiscence of its præ-natal existence, undefiled by union with the body. With respect to the precise forms in which the idea of beauty reveals itself, Plato is very undecided. Of course his theory of an absolute Beauty is incompatible with the notion of its ministering simply a variety of sensuous pleasure, to which he appears to lean in the *Gorgias* and even the *Hippias Major*. Further, his peculiar system of ideas naturally led him to confuse the self-beautiful with other general conceptions of the true and the good, and so arose the Platonic formula καλοκἀγαθία, expressive of the intimate union of the two principles. So far as his writings embody the notion of any distinguishing element in beautiful objects, it is proportion, harmony, or unity among the parts of an object. The superior beauty of proportion is taught in the *Philebus*, and in the *Phædon* it is applied to virtue. As a closely-related view, we see him emphasising unity in its simplest aspect of evenness and purity, the need of variety being overlooked. Thus in the *Philebus* he states his preference for regular and mathematical forms, as the straight line and the circle. So he selected among colours pure white, among tones the pure and equal, and among impressions of touch the smooth. At the same time the Dialogues evince many other tentative distinctions in the Beautiful, as, for example, the recognition in the *Politics* of two opposed classes of beautiful things, those characterised by force and velocity, and those by a certain slowness and softness; which points to a contrast between the stimulative and the restful in sensation, since enlarged upon by English psychologists. Elsewhere he descants on the beauty of the mind, and seems to think, in the *Republic*, that the highest beauty of proportion is seen in the union of a beautiful mind with a beautiful body. In spite of his lofty theory of the origin and nature of beauty, Plato seems to have imperfectly appreciated the worth of art as an independent end in human life and culture. He found the end of art in imitation (μίμησις), but estimated the creative activity of art as a clever knack, little higher in intellectual value than the tricks of a juggler. He tended to regard the effects of art as devoid of all serious value, and as promoting indolence and the supremacy of the sensual elements of human nature. (See the *Sophistes*, *Gorgias*, and *Republic*.) Accordingly, in his scheme for an ideal republic, he provided for the most inexorable censorship on poets, &c., so as to make art as far as possible a mere instrument of moral and political training. As to particular arts, Plato appears to have allowed a certain ethical value to music, in combination with dance and song, if of a certain character, as expressing either the worthy and manly, or the quiet and orderly. With respect to poetry, his views, as expressed in the *Republic* and elsewhere, were very uncertain. Thus at times he condemns tragedy and comedy *in toto;* at other times he admits the claims of a lofty dramatic poetry. He seems not to have fully considered the aims and influences of painting and sculpture, which he constantly disparages.

Aristotle.

A loftier conception of the aims of poetry was afforded by the strictures of Aristophanes in the *Frogs* and elsewhere. But the one Greek who, as far as we know, fully appreciated and clearly set forth the ends of the fine arts, considered, independently of ethical and political aims, as the vehicles to the mind of the ideas and delights of beauty, was Aristotle. Unlike Plato, he proceeded less metaphysically and more scientifically to investigate the phenomena of beauty by a careful analysis of the principles of art. In his treatises on poetry and rhetoric, he gives us, along with a theory of these arts, certain principles of beauty in general; and scattered among his other writings we find many valuable suggestions on the same subject. First of all, Aristotle ignores all conceptions of an absolute Beauty, and at the same time seeks to distinguish the Beautiful from the Good. Thus, although in the more popular exposition, the *Rhetoric*, he somewhat incorrectly makes praiseworthiness a distinguishing mark of the Beautiful, regarded as a species of the Agreeable or Desirable, he seeks in the *Metaphysics* to distinguish the Good and the Beautiful thus: the Good is always in action (ἐν πράξει); the Beautiful, however, may exist in motionless things as well (ἐν ἀκινήτοις). Elsewhere he distinctly teaches that the Good and the Beautiful are different (ἕτερον), although the Good, under certain conditions, can be called beautiful. He thus looked on the two spheres as co-ordinate species, having a certain area in common. It should be noticed that the habit of the Greek mind, in estimating the value of moral nobleness and elevation of character by their power of gratifying and impressing a spectator, gave rise to a certain ambiguity in the meaning of τὸ καλόν, which accounts for the prominence the Greek thinkers gave to the connection between the

Beautiful and the Good or morally Worthy. Aristotle further distinguished the Beautiful from the Fit, and in a passage of the *Politics* set Beauty above the Useful and Necessary. Another characteristic of the Beautiful fixed by this thinker in the *Rhetoric* is the absence of all lust or desire in the pleasure it bestows. This is an important point, as suggesting the disinterested and unmonopolising side of æsthetic pleasure. The universal elements of beauty, again, Aristotle finds in the *Metaphysics* to be order (τάξις), symmetry, and definiteness or determinateness (τὸ ὡρισμένον). In the *Poetics* he adds another essential, namely, a certain magnitude, it being desirable, for a synoptic and single view of the parts, that the object, whether a natural body or a work of art, should not be too large, while clearness of perception requires that it should not be too small. At the same time he seems to think that, provided the whole be visible as such, the greater magnitude of an object is itself an element of beauty. This is probably to be understood by help of a passage in the *Politics*, which lays down the need of a number of beautiful parts or aspects in a highly beautiful object, as the human body. With respect to art, Aristotle's views are an immense advance on those of Plato. He distinctly recognised, in the *Politics* and elsewhere, that its aim is simply to give immediate pleasure, and so it does not need to seek the useful like the mechanical arts. The essence of art, considered as an activity, Aristotle found in imitation, which, unlike Plato, he considers not as an unworthy trick, but as including knowledge and discovery. The celebrated passage in the *Poetics* where he declares poetry to be more philosophic and serious a matter (σπουδαιότερον) than philosophy, best shows the contrast between Plato and Aristotle in their estimates of the dignity of artistic labour. In the *Poetics* he tells us that the objects to be imitated by the poet are of three kinds—(1.) Those things or events which have been or still are; (2.) The things which are said to be and seem probable; (3.) The things which necessarily are (εἶναι δεῖ). The last points, as Schasler supposes, to the ideal character of imitation as opposed to mere copying of individual objects or events, and accounts for the lofty value assigned to it by Aristotle. More particularly the objects of imitation in poetry and music, if not in all art, are dispositions (ἤθη), passions, and actions. Aristotle gives us some interesting speculations on the nature of the artist's mind, and distinguishes two varieties of the poetic imagination—the easy and versatile conceptive power of a man of natural genius (ἐνφυής), and the more emotional and lively temperament of an inspired man (μανικός). He gives us no complete classification of the fine arts, and it is doubtful how far his principles are to be taken as applicable to other than the poetic art. He seems, however, to distinguish poetry, music, and dancing—all of which are supposed to imitate some element of human nature, some feeling or action—by the means they employ, namely, rhythm, harmony, melody, and vocal sound. Painting and sculpture are spoken of as imitative arts, but their special aims are not defined. Architecture seems ignored by Aristotle as non-imitative. His peculiar theory of poetry can only be just glanced at here. Its aim, he says, is to imitate dispositions and actions. Metrical form is hardly looked on as an essential. Poetic imitation, as including the selection of the universal in human nature and history, is ably treated; and from this part of Aristotle's theory all modern ideas of poetic truth are more or less derivable. He distinguishes, somewhat superficially, the epic poem, the drama, and a third variety not named, but apparently lyric poetry, by the manner in which the poet speaks in each variety, whether in his own person, or in that of another, or in both alternately. The epic and the dramatic poem require unity of action, a certain magnitude, with beginning, middle, and end, and also those changes of fortune and recognitions that make up the thrilling character of plot. The end of tragedy Aristotle defines as the effecting, by means of pity and fear, of a purification of these passions; and this is perhaps the point of greatest interest for æsthetics in the whole of his theory of poetry. Whether he is referring to any moral influence of tragedy on the emotions, bringing both fear and pity in the spectator's mind to their proper ethical mean, as Lessing and others conceive; whether he simply means the elimination of all painful ingredients in these feelings, either by the recognition of the imaginary nature of the evil represented, or by the simultaneous satisfaction of other and deeper feelings as moral approval or wide human sympathy; or, finally, whether by "purification" we are to understand the grateful relief by artificial means of a recurring emotion needing periodic vent, as Ueberweg argues,—this subtle point may be left to the student to decide. It would be interesting to know how far Aristotle attributed something analogous to this κάθαρσις to the other arts. In the *Politics* he certainly speaks of a purifying effect in certain kinds of music in quieting the wilder forms of excitement. Finally, it might perhaps be conjectured from his definition of the Ludicrous, as something faulty and disgraceful, yet free from pain, and not destructive, that he would find in the laughter of comedy something analogous to this purification, namely, the gradual resolution of the more painful feelings of contempt or disgust into the genial moods of pure hilarity.

Plotinus.

Omitting to notice the few valuable remarks on æsthetic subjects of the later Greeks and their Roman contemporaries, one may briefly refer to the views of the Alexandrian mystic and Neo-Platonist Plotinus, not only because of their intrinsic interest, but on account of their resemblance to certain modern systems. His theory is to be found in an essay on the Beautiful in the series of discourses called *Enneades*. His philosophy differs from the Platonic in the recognition of an objective νοῦς, the direct emanation from the absolute Good, in which the ideas or notions (λόγοι), which are the prototypes of real things, are immanent. This Reason, as self-moving, becomes the formative influence reducing matter, which in itself is dead, to form. Matter thus formed becomes a notion (λόγος), and this form is beauty. Objects are ugly so far as they are unacted upon by Reason, and so remain formless. The creative νοῦς is absolute Beauty, and is called the more than beautiful (τὸ ὑπέρκαλλον). There are three degrees or stages of the Beautiful in manifestation, namely, the beauty of subjective νοῦς, or human reason, which is the highest; that of the human soul, which is less perfect through the connection of the soul with a material body; and that of real objects, which is the lowest manifestation of all. As to the characteristic form of beauty, he supposed, in opposition to Aristotle, that a single thing not divisible into parts might be beautiful through its unity and simplicity. He attached special worth to the beauty of colours in which material darkness is overpowered by light and warmth. In reference to artistic beauty, he said that when the artist has λογοι as models for his creations, these may become more beautiful than natural objects. This is a very curious divergence of opinion from the Platonic.

St. Augustine. Transition to modern systems.

After Plotinus there is little speculation on æsthetic subjects till we come to modern writers. St Augustine wrote a treatise on the Beautiful, now lost, in which he appears to have reproduced Platonic ideas under a Christian guise. He taught that unity is the form of all beauty ("omnis porro pulchritudinis forma unitas est"). Infinite goodness, truth, and beauty are the attributes of the Deity, and communicated by him to things. But passing from these fragmentary utterances, we may consider more fully

the modern theories, beginning with the German systems, as being the most metaphysical, and having most affinity with ancient speculation. In German literature the two divisions of metaphysical deduction and critical construction of æsthetic principles are very sharply contrasted, and nearly every writer on the subject is easily referred to one or other of the classes. On the one hand, we have the laborious systematic philosophers, as Kant and Hegel; and on the other, men who entered upon æsthetic speculation either as connoisseurs of some special department, as Winckelmann and Lessing, or even as productive artists—for example, Schiller and Goethe.

Systematic treatises:— Baumgarten.

II. *German Writers.*—The first of the Germans who attempted to fit a theory of the Beautiful and of Art into a complete system of philosophy was Baumgarten. Adopting the Wolffian principles of knowledge, as modified by Leibnitz, he thought he was completing that system by setting over against logical knowledge, whose object is truth, æsthetic knowledge, which has to do with beauty. The former is conceptive knowledge (*begreifendes Erkennen*), the act of the understanding, and its result as the science of clear conceptions is embodied in logic. Æsthetic has to do, not with clear, but confused conceptions (*verworrene Vorstellungen*), namely, sensuous knowledge. The beautiful is defined by Baumgarten as the perfection of sensuous knowledge, and the ugly is that which struggles against this perfection; and, consistently with this view, he first employed the term æsthetic (*æsthetica*) to denote a theory of the Beautiful. He held that perfection, as harmony of object with its conception or notion (*Begriff*), presents itself under three aspects:—(1.) As truth for pure knowledge; (2.) As beauty for obscure perception; (3.) As goodness for the capacities of desire or will. It will be seen at once by the thoughtful student that this mode of dealing with impressions of beauty, &c., simply as intellectual elements (confused conceptions), must fail to account for their emotional aspects—feeling, which is the very soul of the æsthetic impression, being radically distinct from conception and knowledge. Still Baumgarten did service in separating so sharply the provinces of logic, ethics, and æsthetics, and in connecting the latter with the impressions of the senses. The details of his æsthetics are mostly unimportant. From Leibnitz's theory of a pre-established harmony, and its consequence that the world is the best possible, Baumgarten concluded that nature is the highest embodiment of beauty, and that art must seek as its highest function the strictest possible imitation of nature. Baumgarten had several disciples in this conception of æsthetics, as Sulzer and Moses Mendelssohn.

Kant.

The next original philosophical scheme of æsthetics is that of Kant. His system of knowledge falls into three branches—the critique of pure reason, which has to determine what are the *a priori* elements in the knowledge of objects; the critique of practical reason, which inquires into the *a priori* determinations of the will; and the critique of judgment, which he regards as a connecting link between the other two, and which has to do with any *a priori* principles of emotion (pleasure and pain), as the middle term between cognition and volition. This judgment Kant divides into the æsthetic, when pleasure or pain is felt immediately on presentation of an object; and the teleological, which implies a pre-existing notion, to which the object is expected to conform. He attempts, in a somewhat strained manner, to define the Beautiful by help of his four categories. In *quality* beauty is that which pleases without interest or pleasure in the existence of the object. This distinguishes it from the simply Agreeable and the Good, the former stimulating desire, and the latter giving motive to the will. In *quantity* it is a universal pleasure. Under the aspect of *relation*, the Beautiful is the form of adaptation (*Zweckmässigkeit*) without any end being conceived. Finally, in *modality* it is a necessary satisfaction, pleasing not by a universal rule, this being unassignable, but by a *sensus communis*, or agreement of taste. Kant is not very consistent in carrying out these distinctions. Thus, for example, he recognises in fitness a particular species of beauty, namely, "adhering" as distinguished from "free" or intrinsic beauty, without recognising that this implies the presence of a notion. So, in discussing the objective validity of our æsthetic impressions, he decides that the highest meaning of beauty is to symbolise moral good; and, in even a more fanciful manner than that of Mr Ruskin, he attaches moral ideas, as modesty, frankness, courage, &c., to the seven primary colours of the Newtonian system. Yet he does not admit that the perception of this symbolic function involves any notion. Once more, he attributes beauty to a single colour or tone by reason of its purity. But such a definition of the form of the Beautiful clearly involves some notion in the percipient mind. Kant further applies his four categories, with still less of fruitful suggestion, to the Sublime. The satisfaction of the Sublime is a kind of negative pleasure created through the feeling of a momentary restraint (*Hemmung*) of vital force, and of a subsequent outpouring of the same in greater intensity. The feeling of the inadequacy of the imagination is succeeded by a consciousness of the superiority of reason to imagination. The sentiment is thus a kind of wonder or awe. Sublimity is either mathematical, that of magnitude, or dynamical, that of nature's might. He allows no sublimity to passions, as rage or revenge. Kant has, too, a theory of the Ridiculous, the effect of which he lays, oddly enough in respect to the rest of his doctrine, in a grateful action of the body, the muscles of the diaphragm, &c., giving a sense of health. This action takes place on the sudden relaxation of the understanding when kept in a state of tension by expectation. The cause of laughter, or the Ridiculous, may hence be defined as "the sudden transformation of a tense expectation into nothing." He placed the beauty of nature above that of art, which can be of value only mediately, not as an end in itself. He classifies the arts according as they express the æsthetic idea—whatever this may mean after his exclusion of all definite conception from the perception of beauty. Just as expression in speech consists of articulation, gesticulation, and modulation, answering to thought, intuition (*Anschauung*), and feeling, so we have three kinds of art—(1.) Those proceeding orally (*redende*), oratory and poetry; (2.) Those of visible image (*bildende*), plastic art and painting; and (3.) "the art of the play of feelings," namely, music and "colour art," which last is not defined. Kant's system is very defective, and some of its inconsistencies were pointed out by Herder in his *Kalligone*, who lacked, however, philosophic accuracy. Herder denied Kant's distinctions between the Beautiful, the Good, and the Agreeable, saying that the first must be desired as well as satisfying, and the second be loved as well as prized. Yet herein Kant is decidedly superior to his critic. Herder held, in opposition to Kant, that all beauty includes significance (*Bedeutsamkeit*), and cannot affect us apart from a notion of perfection. But here, too, Kant is to be preferred, since his theory does not assume all beautiful objects to contain some one element or form capable of being detected. Kant's real additions to æsthetic theory consist in the better separation of the Beautiful from the Good and Agreeable, in the prominence given to the emotional side of æsthetic impressions, and in the partial recognition of the relativity of æsthetic judgment, more especially in the case of the Sublime.

Schelling.

After Kant the next philosopher to discuss the metaphysics of the Beautiful and art is Schelling. He sought

to engraft art upon his curious system of transcendental idealism in a manner which can only be faintly indicated here. In Schelling's metaphysical system the relation of subject and object is conceived as identity. Each exists, yet not independently of the other, but identified in a higher, the absolute. They may be conceived as two poles representing different directions, but yet inseparably joined. All knowledge rests on this agreement. Either nature, the object, may be conceived as the *prius*, and the subject constructed out of it; or the subject may be taken as the *prius*, and the object constructed from it. These are the two poles of knowledge, and constitute the philosophy of nature and the transcendental philosophy. The latter, like Kant's philosophy of mind, is based on a threefold conception of the powers of human nature. It consists of—(1.) Theoretic philosophy, dealing with perception; (2.) Practical philosophy, discussing the will and freedom; and (3.) The philosophy of art. The aim of the last is thus expressed: The *ego* must succeed in actually perceiving the concord of subject and object, which is half disguised in perception and volition. This concord is seen within the limits of the *ego* in artistic perception only. Just as the product of nature is an unconscious product like a conscious one, in its designfulness, so the product of art is a conscious product like an unconscious one. Only in the work of art does intelligence reach a perfect perception of its real self. This is accompanied by a feeling of infinite satisfaction, all mystery being solved. Through the creative activity of the artist the absolute reveals itself in the perfect identity of subject and object. Art is therefore higher than philosophy. Schelling thus sets the beauty of art far above that of nature. As to the form of the beautiful he is very vague, leaning now to a conception of harmony in the totality of the world (*Weltall*), and now to a Platonic conception of primitive forms (*Urbilder*) of perfection. He has a very intricate classification of the arts, based on his antithesis of object and subject, reality and ideality. A curious feature of Schelling's theory is his application of his one fundamental idea to tragedy. The essence of tragedy is, he thinks, an actual conflict of liberty in the subject with objective necessity, in which both being conquered and conquering, appear at once in the perfect indifference. Antique tragedy he holds, accordingly, to be the most perfect composition of all arts.

Hegel. Passing over Solger, whose æsthetic doctrine is little more than a revival of Platonism, we come to Hegel. His system of philosophy falls into three parts, all based on the self-movement of the idea or absolute:—(1.) The logic discussing the pure universal notions which are the logical evolution of the absolute, as pure thought; (2.) Philosophy of nature—the disruption of thought, the idea, into the particular and external; (3.) Philosophy of the spirit—the return of thought or the absolute from this self-alienation to itself in self-cognisant thought. Just as the absolute, so has spirit a series of three grades to traverse—(*a.*) Subjective spirit or intelligence, relating itself to the rational object as something given; (*b.*) Objective spirit or will, which converts the subjectivised theoretical matter (truth) into objectivity; (*c.*) Absolute spirit, which is the return of the spirit from objectivity to the ideality of cognition, to the perception of the absolute idea. This again has three stages—(1.) Art, in which the absolute is immediately present to sensuous perception; (2.) Religion, which embodies certainty of the idea as above all immediate reality; and (3.) Philosophy, the unity of these. According to this conception, the beautiful is defined as the shining of the idea through a sensuous medium (as colour or tone). It is said to have its life in shining or appearance (*Schein*), and so differs from the true, which is not real sensuous existence, but the universal idea contained in it for thought. He defines the form of the Beautiful as unity of the manifold. The notion (*Begriff*) gives necessity in mutual dependence of parts (unity), while the reality demands the appearance or semblance (*Schein*) of liberty in the parts. He discusses very fully the beauty of nature as immediate unity of notion and reality, and lays great emphasis on the beauty of organic life. But it is in art that, like Schelling, he finds the highest revelation of the Beautiful. Art makes up the deficiencies of natural beauty by bringing the idea into clearer light, by showing the external in its life and spiritual animation. The various forms of art depend on the various combinations of matter and form. In Oriental or symbolical art matter is predominant, and the thought is struggling through with pain so as to reveal the ideal. In the classical form the ideal has attained an adequate existence, form and matter being absolutely commensurate. Lastly, in the romantic form, the matter is reduced to a mere show, and the ideal is supreme. Hegel classifies the individual arts according to this same principle of the relative supremacy of form and matter—(1.) The beginning of art is architecture, in which as a symbolic art the sensuous material is in excess. (2.) Sculpture is less subjected to matter, and, as representing the living body, is a step towards a higher ideality. (3.) Painting, which is the romantic art κατ' ἐξοχήν, expresses the full life of the soul. By the elimination of the third dimension of space, and the employment of a coloured plane, painting rids itself of the coarse material substrate of sculpture, and produces only a semblance of materiality. (4.) In music, which employs pure tone, all the elements of space are suppressed, and hence its content is the inner emotional nature (*Gemüth*). Music is the most subjective of the arts. (5.) Poetry has the privilege of universal expression. It contains all the other arts in itself, namely, the plastic art in the epos, music in the ode, and the unity of both in the drama.

Dialectic of the Hegelians. Several systems of æsthetics, more or less Hegelian in character, can only be referred to in passing. Weisse defined æsthetics as the science of the idea of beauty, and explained the Beautiful as the entrance of the universal or of the essence into the limited and finite, that is, the cancelling or annulling of truth (*die aufgehobene Wahrheit*). By thus recognising an internal contradiction in all beauty, he sought to develope, by a curious dialectical process, the ideas of the Ugly, the Sublime, and the Ludicrous. He treats each of these three in immediate contrast to beauty. Ugliness is the immediate existence of beauty. It appears as the negative moment in the Sublime, and in the Ludicrous this negativity is again cancelled and resolved into affirmation so as to constitute a return to the Beautiful. A like attempt to determine the relations of the Ugly, Comic, &c., as moments of the self-revealing idea was made by several Hegelians. Thus Ruge, in his *Abhandlung über das Komische*, teaches that sublimity is the æsthetic idea striving to find itself, together with the satisfaction of this striving. If, however, the idea lose itself, sinking away in a kind of swoon, we have the Ugly. Finally, when the idea recovers from the swoon, its new birth is attended with a feeling of amusement (*Erheiterung*), and then we have the effect of the Ludicrous. Rosenkranz, in his *Æsthetik des Hässlichen*, conceives the Ugly as the negation of the Beautiful, or as the middle between the Beautiful and the Ludicrous, and seeks to trace out its various manifestations in formlessness in nature, incorrectness in artistic representation, and deformity or the disorganisation of the Beautiful in caricature. Schasler, again, seems to hold that the Ugly is co-ordinate with the Beautiful, being the motor principle that drives the Beautiful from the unconditioned rest of the Platonic idea, from the sphere of empty abstractness to actuality. This fundamental contradiction reveals itself

as the contrast of matter and spirit, rigid motionlessness and motion, and appears in art as the antithesis of the sublime and graceful (*das Anmuthige*), the latter containing the Naïf, the Pretty, and the Ridiculous. Finally, Theodor Vischer seeks to settle these subtle relationships in this manner: He supposes the Sublime to be the sundering of the æsthetic idea and its sensuous image (*Gebild*) from the state of unity constituting the Beautiful, the idea reaching as the infinite over against the finite of the image. The image now resists the sudden rupture, and in asserting itself as a totality in defiance of the idea becomes the Ugly. The Comic, again, is the result of some partial and apparently involuntary recognition of the rights of the idea by the rebellious image. Schasler says, in criticising the views of Vischer, that it is difficult not to be satirical in describing the dialectic artifices to which the idea is here compelled, little suspecting how easily any similar attempt to adjust relations between these ideas, looked at objectively as movements of the supreme idea, may appear equally naïf and funny to a mind not already oppressed with the resisting burden of its own abstractions.

Vischer.

Theodor Vischer, the last of the Hegelians named here, has produced the largest and most laborious system of metaphysical æsthetics, and a brief account of its scope must be given to complete our history of the German systems. He defines æsthetics as the science of the Beautiful. His system falls into three parts: (1.) Metaphysic of the Beautiful; (2.) The Beautiful as one-sided existence—beauty of nature and the human imagination; (3.) The subjective-objective actuality of the Beautiful—Art. The metaphysic again falls into two parts—the theory of simple beauty, and that of the Beautiful in the resistance of its moments (the Sublime and Ridiculous). He defines the Beautiful as "the idea in the form of limited appearance." His discussions of the various beauties of nature, the organic and inorganic world, are very full and suggestive, and his elaboration of the principles of art (excepting those of music, which he left another to elucidate), is marked by a wide and accurate knowledge. He divides the arts into—(1.) The objective, or eye arts (architecture, sculpture, and painting); (2.) Subjective, or ear arts (music); (3.) Subjective-objective arts, or those of sensuous conception (poetry). He subdivides the first into those of measuring sight (architecture), touching sight (sculpture), and sight proper (painting). Vischer's style is very laboured. His propositions fall into the form of mathematical theorems, and are made exceedingly incomprehensible by the excessive subtleties of his metaphysical nomenclature.

Other German systems.

There are several other systems of æsthetics which deserve mention here, but space does not allow of a full account of them. Of these the most important are the theories of Herbart, Schopenhauer, and von Kirchmann. Herbart's views are based on his curious psychological conceptions. He ignores any function in the Beautiful as expressive of the idea, and seeks simply to determine the simplest forms or the elementary judgments of beauty. Schopenhauer's discussions, connecting beauty with his peculiar conception of the universe as volition, are a curious contribution to the subject. As a specimen of his speculations, one may give his definition of tragedy as the representation of the horrible side of life, the scornful dominion of accident, and the inevitable fall of the just and innocent, this containing a significant glimpse into the nature of the world and existence. Von Kirchmann has written a two-volume work on æsthetics, which is interesting as a reaction against the Hegelian method. It professes to be an attempt to base the science on a realistic foundation, and to apply the principles of observation and induction long acted upon in natural science.

Incomplete German systems. Winckelmann.

The German æsthetic speculations not elaborated into complete systems are too numerous to be fully represented here. Only a few of the most valuable contributions to the theory will be alluded to. Winckelmann's services to the development of plastic art do not directly concern us. Of his theory of plastic beauty, based exclusively on the principles of Greek sculpture, little requires to be said. He first pointed to the real sources of superiority in antique creations, by emphasising the distinction between natural and ideal beauty, the æsthetic value of contour as an ideal element, the beauty of expression as the manifestation of an elevated soul, and consisting of a noble simplicity and a quiet grandeur. But by too exclusive an attention to Greek art, and indeed to sculpture, his theory, as an attempt to generalise on art, lacks completeness, making little room for the many-sidedness of art, and narrowing it down to one, though an exalted, ideal.

Lessing.

Lessing's services to the scientific theory of art are far greater than those of Winckelmann. He is the first modern who has sought to deduce the special function of an art from a consideration of the means at its disposal. In his *Laokoon* he defines the boundaries of poetry and painting in a manner which has scarcely been improved on since. In slight divergence from Winckelmann, who had said that the representation of crying was excluded from sculpture by the ancients as unworthy of a great soul, Lessing sought to prove that it was prohibited by reason of its incompatibility with the conditions of plastic beauty. He reasoned from the example of the celebrated group, the Laokoon. Visible beauty was, he said, the first law of ancient sculpture and painting. These arts, as employing the co-existent and permanent in space, are much more limited than poetry, which employs the transitory and successive impressions of sound. Hence, expression is to poetry what corporeal beauty is to the arts of visible form and colour. The former has to do with actions, the latter with bodies,—that is, objects whose parts co-exist. Poetry can only *suggest* material objects and visible scenery by means of actions; as for example, when Homer pictures Juno's chariot by a description of its formation piece by piece. Painting and sculpture, again, can only suggest actions by means of bodies. From this it follows that the range of expression in poetry is far greater than in visible art. Just as corporeal beauty loses much of its charm, so the visible Ugly loses much of its repulsiveness by the successive and transient character of the poetic medium. Hence poetry may introduce it, while painting is forbidden to represent it. Even the Disgusting may be skilfully employed in poetry to strengthen the impression of the Horrible or Ridiculous; while painting can only attempt this at its peril, as in Pordenone's Interment of Christ, in which a figure is represented as holding its nose. Visible imitation being immediate and permanent, the painful element cannot be softened and disguised by other and pleasing ingredients (the Laughable, &c.), as in poetry. As Schasler says, Lessing's theory hardly makes room for the effects of individuality of character as one aim of pictorial as well as of poetic art. Yet as a broad distinction between the two heterogeneous arts, limiting, on the one hand, pictorial description in poetry, and the representation of the painful, low, and revolting in the arts of vision, it is unassailable, and constitutes a real discovery in æsthetics. Lessing's principles of the drama, as scattered through the critiques of the *Hamburg Dramaturgy*, are for the most part a further elucidation of Aristotelian principles, of great value to the progress of art, but adding comparatively little to the theory. Its conspicuous points are the determination of poetic truth as shadowed forth by Aristotle, and the difference between tragedy and comedy in respect to liberty of invention both of fable and of character; secondly, the reassertion that both fear and pity, and not simply one of

these, are the effects of every tragedy, and that it is false dramatic art to attempt to represent either the sufferings of a perfect martyr, or the actions of some monstrous horror of wickedness, as Corneille and the French school had urged; lastly, the interpretation of Aristotle's purification of the passions as referring to this very fear and pity, and pointing to a certain desirable mean between excessive sensibility and excessive callousness. Schasler says that if Lessing had had an Aristotle to lean on in the *Laokoon* as in the *Dramaturgy*, it would have been more valuable. Others might be disposed to say that if he had been as free from the traditions of authority in the *Dramaturgy* as he was in the *Laokoon*, the former might have contained as much in the way of real discovery as the latter.

Goethe. The partial contributions to æsthetics after Lessing need not long detain us. Goethe wrote several tracts on æsthetic topics, as well as many aphorisms. He attempts to mediate between the claims of ideal beauty, as taught by Winckelmann, and the aims of individualisation. Schiller. Schiller discusses, in a number of disconnected essays and letters, some of the principal questions in the philosophy of art. He looks at art as a side of culture and the forces of human nature, and finds in an æsthetically cultivated soul the reconciliation of the sensual and rational. His letters on æsthetic education (*Ueber die æsthetische Erziehung des Menschen*) are very valuable, and bring out the connection between æsthetic activity and the universal impulse to play (*Spieltrieb*). This impulse is formed from the union of two other impulses—the material (*Stofftrieb*) and the formal (*Formtrieb*)—the former of which seeks to make real the inner thought, the latter to form or fashion this reality. Schiller's thoughts on this topic are cast in a highly metaphysical mould, and he makes no attempt to trace the gradual development of the first crude play of children into the æsthetic pleasures of a cultivated maturity. He fixes as the two conditions of æsthetic growth, moral freedom of the individual and sociability. The philosophic basis of Schiller's speculation is the system of Kant. Another example of this kind of reflective discussion of art by literary men is afforded us in the *Vorschule* Jean Paul. *der Æsthetik* of Jean Paul Richter. This is a rather ambitious discussion of the Sublime and the Ludicrous, and contains much valuable matter on the nature of humour in romantic poetry. Jean Paul is by no means exact or systematic, and his language is highly poetic. His definitions strike one as hasty and inadequate: for example, that the Sublime is the applied Infinite, or that the Ludicrous is the infinitely Small. Other writers. Other writers of this class, as Wilhelm von Humboldt, the two Schlegels, Gervinus, though they have helped to form juster views of the several kinds of poetry, &c., have contributed little to the general theory of art. F. Schlegel's determination of the principle of romantic poetry as the Interesting, in opposition to the objectivity of antique poetry, may be cited as a good example of this group of speculations.

Attempts to determine the instinctive or sensational element in beauty. No account of German æsthetics can be complete without some reference to the attempts recently made by one or two naturalists to determine experimentally the physical conditions and the net sensational element of artistic impression. Of these, the most imposing is the development by Helmholtz of a large part of the laws of musical composition, harmony, tone, modulation, &c., from a simple physical hypothesis as to the complex character of what appear to us as elementary tones. Another interesting experimental inquiry has been instituted by Fechner into the alleged superiority of "the golden section" as a visible proportion. Zeising, the author of this theory, asserts that the most pleasing division of a line, say in a cross, is the golden section, where the smaller division is to the larger as the latter to the sum. Fechner describes in his contribution *Zur experimentalen Æsthetik* a series of experiments on a large number of different persons, in which he supposes he eliminated all effects of individual association, and decides in favour of the hypothesis. He, however, assumes that this visible form must please primarily, and does not recognise that any constant association growing up in all minds alike would give precisely the same results. Finally, allusion may be made to some ingenious but very forced attempts of Unger and others to discover harmonic and melodious relations among the elementary colours.

Partial discussions of the problem. III. *French writers on Æsthetics.*—In passing from German to French writers on æsthetical topics we find, as might be expected, much less of metaphysical assumption and a clearer perception of the scientific character of the problem. At the same time, the authors are but few, and their works mostly of a fragmentary character. Passing by the Jesuit André, who sought to rehabilitate Augustin's theory of the Beautiful, we first light on the name of Batteux. Batteux. In his *Cours de Belles Lettres* (1765) he seeks to determine the aims of art by elucidating the meaning and value of the imitation of nature. He classifies the arts according to the forms of space and time, those of either division being capable of combining among themselves, but not with those of the other. Thus architecture, sculpture, and painting may co-operate in one visible effect; also music, poetry, and the dance. Diderot. Diderot, again, in the *Encyclopédie*, sought to define beauty by making it to consist in the perception of relations. In his *Essais sur la Peinture* he follows Batteux in extolling naturalness, or fidelity to nature. Another very inadequate theory of beauty was propounded by Père Buffier. Buffier. He said it is the type of a species which gives the measure of beauty. A beautiful face, though rare, is nevertheless the model after which the largest number is formed. Not unlike this theory is a doctrine propounded by H. Taine. Taine. In his work, *De l'Ideal dans l'Art*, he proceeds in the manner of a botanist to determine a scale of characters in the physical and moral man, according to the embodiment of which a work of art becomes ideal. The degree of universality or importance, and the degree of beneficence or adaptation to the ends of life in a character, give it its measure of æsthetic value, and render the work of art, which seeks to represent it in its purity, an ideal work.

The systems of the spiritualistes. The only elaborated systems of æsthetics in French literature are those constructed by the *spiritualistes*, that is, the philosophic followers of Reid and D. Stewart on the one hand, and the German idealists on the other, who constituted a reaction against the crude sensationalism of the 18th century. They aim at elucidating what they call the higher and spiritual element in æsthetic impressions, and wholly ignore any capability in material substance or external sensation of affording the peculiar delights of beauty. The lectures of Cousin, entitled *Du Vrai, du Beau, et du Bien*, the *Cours d'Esthétique* of Jouffroy, and the systematic treatise of Lévêque, *La Science du Beau*, are the principal works of this school. Lévêque. The last, as the most elaborate, will afford the student the best insight into this mode of speculation. The system of Lévêque falls into four parts—(1.) The psychological observation and classification of the effects of the Beautiful on human intelligence and sensibility; (2.) The metaphysic of beauty, which determines whether it has a real objective existence, and if so, what is the internal principle or substance of this objective entity; and further seeks to adjust the relations of the Beautiful, the Sublime, the Ugly, and the Ridiculous in relation to this principle; (3.) The application of these psychological and metaphysical principles to the beauty of nature, animate and inanimate, and to that of the Deity; (4.) Their application to the arts. The influence of the

Germans in this mode of systematising is apparent. All the characters of beauty in external objects, as a flower, of which the principal are size, unity and variety of parts, intensity of colour, grace or flexibility, and correspondence to environment, may be summed up as the ideal grandeur and order of the species. These are perceived by reason to be the manifestations of an invisible vital force. Similarly the beauties of inorganic nature are translatable as the grand and orderly displays of an immaterial physical force. Thus all beauty is in its objective essence either spirit or unconscious force acting with fulness and in order. It is curious that Lévêque in this way modifies the strictly spiritual theory of beauty by the admission of an unconscious physical force, equally with spirit or mind, as an objective substratum of the Beautiful. He seeks, however, to assimilate this as nearly as possible to conscious energy, as immaterial and indivisible. The aim of art is to reproduce this beauty of nature in a beautiful manner, and the individual arts may be classified according to the degree of beautiful force or spirit expressed, and the degree of power with which this is interpreted. Accordingly, they are arranged by Lévêque in the same order as by Hegel.

IV. *Italian and Dutch Writers.*—There are a few writers on æsthetic subjects to be found in Italian and Dutch literature, but they have little of original speculation. The Italian, as Pagano and Muratori, follow French and English writers. One Dutch writer, Franz Hemsterhuis (18th century), is worth naming. His philosophic views are an attempt at reconciliation between the sensational and the intuitive systems of knowledge. The only faculty of true knowledge is an internal sense, nevertheless all true knowledge comes *through* the senses. The soul, desiring immediate and complete knowledge, and being limited by its union with the senses, which are incapable of perfectly simultaneous action, strives to gain the greatest number of the elements of cognition or ideas in the shortest possible time. In proportion as this effort is successful, the knowledge is attended with enjoyment. The highest measure of this delight is given by beauty, wherefore it may be defined as that which affords the largest number of ideas in the shortest time.

V. *English Writers.*—In the æsthetic speculations of English writers, we find still less of metaphysical construction and systematisation than in those of French thinkers. Indeed, it may be said that there is nothing answering to the German conception of æsthetic in our literature. The inquiries of English and Scotch thinkers have been directed for the most part to very definite and strictly scientific problems, such as the psychological processes in the perception of the Beautiful. The more moderate metaphysical impulses of our countrymen have never reached beyond the bare assertion of an objective and independent beauty. Hence we find that the German historians regard these special and limited discussions as so many empirical reflections, wholly devoid of the rational element in true philosophy. Schasler speaks of these essays as "empiristic æsthetics," tending in one direction to raw materialism, in the other, by want of method, never lifting itself above the plane of "an æstheticising dilettanteism." English writers are easily divisible into two groups—(1.) Those who lean to the conception of a primitive objective beauty, not resolvable into any simpler ingredients of sensation or simple emotion, which is perceived intuitively either by reason or by some special faculty, an internal sense; (2.) Those who, tracing the genesis of beauty to the union of simple impressions, have been chiefly concerned with a psychological discussion of the origin and growth of our æsthetic perceptions and emotions.

Lord Shaftesbury is the first of the intuitive writers on beauty. His views are highly metaphysical and Platonic in character. The Beautiful and the Good are combined in one ideal conception, much as with Plato. Matter in itself is ugly. The order of the world, wherein all beauty really resides, is a spiritual principle, all motion and life being the product of spirit. The principle of beauty is perceived not with the outer senses, but with an internal—that is, the moral—sense (which perceives the Good as well). This perception affords the only true delight, namely, spiritual enjoyment. Shaftesbury distinguishes three grades of the Beautiful, namely, (1.) Inanimate objects, including works of art; (2.) Living forms, which reveal the spiritual formative force; and (3.) The source from which these forms spring, God. The intuitivists. Shaftesbury.

Hutcheson. In his *Inquiry into the Original of our Ideas of Beauty and Virtue*, Hutcheson follows many of Shaftesbury's ideas. Yet he distinctly disclaims any independent self-existing beauty in objects apart from percipient minds. "All beauty," he says, "is relative to the sense of some mind perceiving it." The cause of beauty is not any simple sensation from an object, as colour, tone, but a certain order among the parts, or "uniformity amidst variety." The faculty by which this principle is known is an internal sense which is defined as "a passive power of receiving ideas of beauty from all objects in which there is uniformity in variety." Thus Hutcheson seems to have supposed that beauty, though always residing in uniformity in variety as its form, was still something distinct from this, and so in need of a peculiar sense distinct from reason for the appreciation of it. But his meaning on this point is not clear. This faculty is called a sense, because it resembles the external senses in the immediateness of the pleasure it experiences. The perception of beauty, and the delight attending it, are quite as independent of considerations of principles, causes, or usefulness in the object, as the pleasurable sensation of a sweet taste. Further, the effect of a beautiful object is like the impression of our senses in its necessity; a beautiful thing being always, whether we will or no, beautiful. In the second place, this sense is called internal, because the appreciation of beauty is clearly distinct from the ordinary sensibility of the eye and ear, whether emotional or intellectual and discriminative, many persons who possess the latter intact being totally destitute of the former. Another reason is, that in some affairs which have little to do with the external senses, beauty is perceived, as in theorems, universal truths, and general causes. Hutcheson discusses two kinds of beauty—absolute or original, and relative or comparative. The former is independent of all comparison of the beautiful object with another object of which it may be an imitation. The latter is perceived in an object considered as an imitation or resemblance of something else. He distinctly states that "an exact imitation may still be beautiful though the original were entirely devoid of it;" but, curiously enough, will not allow that this proves his previous definition of beauty as "uniformity amidst variety" to be too narrow. He seems to conceive that the original sense of beauty may be "varied and overbalanced" with the secondary and subordinate kind. Hutcheson spends a good deal of time in proving the universality of this sense of beauty, by showing that all men, in proportion to the enlargement of their intellectual capacity, are more delighted with uniformity than the contrary. He argues against the supposition that custom and education are sources of our perception of beauty, though he admits that they may enlarge the capacity of our minds to retain and compare, and so may add to the delight of beauty.

The next writer of consequence on the intuitive side is Reid. Reid. In the eighth of his *Essays on the Intellectual Powers* he discusses the faculty of taste. He held, on the

ground of common sense, that beauty must exist in objects independently of our minds. As to the nature of the Beautiful, he taught that all beauty resides primarily in the faculties of the mind, intellectual and moral. The beauty which is spread over the face of visible nature is an emanation from this spiritual beauty, and is beautiful because it symbolises and expresses it. Thus the beauty of a plant resides in its perfection for its end, as an expression of the wisdom of its Creator. Reid's theory of beauty is thus purely spiritual.

Sir W. Hamilton. The celebrated *Lectures on Metaphysics* of Sir W. Hamilton do not, unfortunately, contain more than a slight preliminary sketch of the writer's theory of the emotional activities. He defines pleasure, following very closely the theory of Aristotle, as "a reflex of the spontaneous and unimpeded exertion of a power of whose energy we are conscious" (vol. ii. p. 440). And, in perfect agreement with this conception, he divides the various feelings according to the faculties or powers, bodily or mental, of which they are the concomitants. In the scheme thus faintly shadowed forth, the sentiments of Taste are regarded as subserving both the subsidiary and the elaborative faculties in cognition, in other words, the Imagination and the Understanding. The activity of the former corresponds to the element of variety in the beautiful object, while that of the latter is concerned with its unity. A beautiful thing is accordingly defined "as one whose form occupies the Imagination and Understanding in a free and full, and, consequently, in an agreeable activity" (p. 512). In this way, the writer conceives, he comprehends all pre-existing definitions of beauty. He explicitly excludes all other varieties of pleasure, such as the sensuous, from the proper gratification of beauty. The æsthetic sentiment is thus regarded as unique and not resolvable into simpler feelings. Similarly, he denies any proper attribute of beauty to fitness. The essence of the sentiment of sublimity he finds, much in the same way as Kant, in a mingled pleasure and pain; "of pleasure in the consciousness of the strong energy, of pain in the consciousness that this energy is vain." He recognises three forms of Sublimity: those of Extension or space, of Protension or time, and of Intension or power. Finally, he thinks that the Picturesque differs from the Beautiful in appealing simply to the imagination. A picturesque object is one whose parts are so palpably unconnected that the understanding is not stimulated to the perception of unity.

Ruskin. A very like interpretation of beauty, as spiritual and typical of divine attributes, has been given by Mr Ruskin in the second volume of his *Modern Painters*. This part of his work, bearing the title "Of Ideas of Beauty," has a very systematic appearance, but is in fact a singularly desultory series of æsthetic ideas put into a very charming language, and coloured by strong emotion. Mr Ruskin distinguishes between the theoretic faculty concerned in the moral perception and appreciation of ideas of beauty and the imaginative or artistic faculty, which is employed in regarding in a certain way and combining the ideas received from external nature. The former, he thinks, is wrongly named the *æsthetic* faculty, as though it were a mere operation of sense. The object of the faculty is beauty, which Mr Ruskin divides into typical and vital beauty. The former is the external quality of bodies that typifies some divine attribute. The latter consists in "the appearance of felicitous fulfilment of function in living things." The forms of typical beauty are—(1.) Infinity, the type of the divine incomprehensibility; (2.) Unity, the type of the divine comprehensiveness; (3.) Repose, the type of the divine permanence; (4.) Symmetry, the type of the divine justice; (5.) Purity, the type of the divine energy; and (6.) Moderation, the type of government by law. Vital beauty, again, is regarded as relative when the degree of exaltation of the function is estimated, or generic if only the degree of conformity of an individual to the appointed functions of the species is taken into account. Mr Ruskin's wide knowledge and fine æsthetic perception make his works replete with valuable suggestions, though he appears wanting in scientific accuracy, and lacks, as Mr Mill has pointed out, all appreciation of the explanatory power of association with respect to the ideal elements of typical beauty.

The analytical theorists. Addison. Of the more analytic writers on the effects of the Beautiful, Addison deserves a passing mention, less, however, for the scientific precision of his definitions, than for the charm of his style. His Essays on the Imagination, contributed to the *Spectator*, are admirable specimens of popular æsthetic reflection. Addison means by the pleasures of imagination those which arise originally from sight, and he divides them into two classes—(1.) Primary pleasures, which entirely proceed from objects before our eyes; and (2.) Secondary pleasures, flowing from ideas of visible objects. The original sources of pleasure in visible objects are greatness, novelty, and beauty. This, it may be said, is a valuable distinction, as pointing to the plurality of sources in the æsthetic impression, but the threefold division is only a very rough tentative, and destitute of all logical value, novelty of impression being always a condition of beauty. The secondary pleasures, he rightly remarks, are rendered far more extended than the original by the addition of the proper enjoyment of resemblance, which is at the basis of all mimicry and wit. Addison recognises, too, the effects of association in the suggestion of whole scenes, and their accompaniments by some single circumstance. He has some curious hints as to the physiological seat of these mental processes, and seeks, somewhat naïvely, to connect these pleasures with teleological considerations.

Lord Kames. In the *Elements of Criticism* of Lord Kames, another attempt is made to affiliate æsthetic phenomena to simpler pleasures of experience. Beauty and ugliness are simply the pleasant and the unpleasant in the higher senses of sight and hearing. By "higher" he means more intellectual, and he conceives these two senses to be placed midway between the lower senses and the understanding. He appears to admit no more general feature in beautiful objects than this pleasurable quality. Like Hutcheson, he divides beauty into intrinsic and relative, but understands by the latter ideas of fitness and utility, which were excluded from the Beautiful by Hutcheson. He illustrates the English tendency to connect mental processes with physiological conditions, by referring the main elements of the feeling of sublimity to the effect of height in objects in compelling the spectator to stand on tiptoe, by which the chest is expanded and muscular movements produced which give rise to the peculiar emotion.

Hogarth. Passing by the name of Sir Joshua Reynolds, whose theory of beauty closely resembles that of Père Buffier, we come to the speculations of another artist and painter, Hogarth. He discusses in his *Analysis of Beauty* all the elements of visible beauty, both form and colour, often manifesting great speculative skill, and always showing a wide and accurate knowledge of art. He finds altogether six elements in beauty, namely—(1.) Fitness of the parts to some design, as of the limbs for support and movement; (2.) Variety in as many ways as possible, thus in form, length, and direction of line, shape, and magnitude of figure, &c.; (3.) Uniformity, regularity, or symmetry, which is only beautiful when it helps to preserve the character of fitness; (4.) Simplicity or distinctness, which gives pleasure not in itself, but through its enabling the eye to enjoy variety with ease; (5.) Intricacy, which provides employment for our active energies, ever eager for pursuit, and leads the eye "a wanton kind of chase"; (6.) Quantity

or magnitude, which draws our attention, and produces admiration and awe. The beauty of proportion he very acutely resolves into the needs of fitness. Hogarth applies these principles to the determination of degrees of beauty in lines, and figures, and compositions of forms. Among lines he singles out for special honour the serpentine (formed by drawing a line once round from the base to the apex of a long slender cone) as the line of grace or beauty *par excellence*. Its superiority he places in its many varieties of direction or curvature, though he adds that more suddenly curving lines displease by their grossness, while straighter lines appear lean and poor. In this last remark Hogarth tacitly allows another principle in graceful line, namely, gentleness, as opposed to suddenness, of change in direction, though he does not give it distinct recognition in his theory, as Burke did. Hogarth's opinions are of great value as a set off against the extreme views of Alison and the association school, since he distinctly attributes a great part of the effects of beauty in form, as in colour, to the satisfaction of primitive susceptibilities of the mind, though he had not the requisite psychological knowledge to reduce them to their simplest expression. In his remarks on intricacy he shows clearly enough that he understood the pleasures of movement to be involved in all visual perception of form.

Burke.

Burke's speculations on the Beautiful, in his *Philosophical Inquiry into the Origin of our Ideas of the Sublime and Beautiful*, are curious as introducing physiological considerations into the explanation of the feelings of beauty. They illustrate, moreover, the tendency of English writers to treat the problem as a psychological one. He finds the elements of beauty to be—(1.) Smallness of size; (2.) Smoothness of surface; (3.) Gradual variation of direction of outline, by which he means gentle curves; (4.) Delicacy, or the appearance of fragility; (5.) Brightness, purity, and softness of colour. The Sublime he resolves, not very carefully, into astonishment, which he thinks always contains an element of terror. Thus "infinity has a tendency to fill the mind with a delightful horror." Burke seeks what he calls "efficient causes" for these phenomena in certain affections of the nerves of sight, which he compares with the operations of taste, smell, and touch. Terror produces "an unnatural tension and certain violent emotions of the nerves," hence any objects of sight which produce this tension awaken the feeling of the Sublime, which is a kind of terror. Beautiful objects affect the nerves of sight just as smooth surfaces the nerves of touch, sweet tastes and odours the corresponding nerve fibres, namely, by relaxing them, and so producing a soothing effect on the mind. The arbitrariness and narrowness of this theory, looked at as a complete explanation of beauty, cannot well escape the reader's attention.

Alison.

Alison, in his well-known *Essays on the Nature and Principles of Taste*, proceeds on an exactly opposite method to that of Hogarth and Burke. He considers and seeks to analyse the mental process which goes on when we experience the emotion of beauty or sublimity. He finds that this consists in a peculiar operation of the imagination, namely, the flow of a train of ideas through the mind, which ideas are not arbitrarily determined, but always correspond to some simple affection or emotion (as cheerfulness, sadness, awe), awakened by the object. He thus makes association the sole source of the Beautiful, and denies any such attribute to the simple impressions of the senses. His exposition, which is very extensive, contains many ingenious and valuable contributions to the ideal or association side of æsthetic effects, both of nature and of art; but his total exclusion of delight (by which name he distinguishes æsthetic pleasure) from the immediate effects of colour, visible form, and tone, makes his theory appear very incomplete. This is especially applicable to music, where the delight of mere sensation is perhaps most conspicuous. He fails, too, to see that in the emotional harmony of the ideas, which, according to his view, make up an impression of beauty, there is a distinct source of pleasure over and above that supplied by the simple feeling and by the ideas themselves.

Jeffrey.

Jeffrey's *Essay on Beauty* is little more than a modification of Alison's views. He defines the sense of beauty as consisting in the suggestion of agreeable and interesting sensations previously experienced by means of our various pleasurable sensibilities. He thus retains the necessity of ideal suggestion, but at the same time discards the supposed requirement of a *train* of ideas. Jeffrey distinctly saw that this theory excludes the hypothesis of an independent beauty inherent in objects. He fails as completely as Alison to disprove the existence of a sensuous or organic beautiful, and, like him, is avowedly concerned to show the presence of some one, and only one, determining principle in all forms of the Beautiful.

Dugald Stewart.

D. Stewart's chief merit in the æsthetic discussions, contained in his *Philosophical Essays*, consists in pointing out this unwarranted assumption of some single quality (other than that of producing a certain refined pleasure) running through all beautiful objects, and constituting the essence of beauty. He shows very ingeniously how the successive transitions and generalisations in the meaning of the term beauty may have arisen. He thinks it must originally have connoted the pleasure of colour, which he recognises as primitive. His criticisms on the one-sided schemes of other writers, as Burke and Alison, are very able, though he himself hardly attempts any complete theory of beauty. His conception of the Sublime, suggested by the etymology of the word, renders prominent the element of height in objects, which he conceives as an upward direction of motion, and which operates on the mind as an exhibition of power, namely, triumph over gravity.

Professor Bain.

Of the association psychologists James Mill did little more towards the analysis of the sentiments of beauty than re-state Alison's doctrine. On the other hand, Professor Bain, in his treatise *The Emotions and the Will*, carries this examination considerably further. He asserts with Stewart that no one generalisation will comprehend all varieties of beautiful objects. He thinks, however, that the æsthetic emotions, those involved in the fine arts, may be roughly circumscribed and marked off from other modes of enjoyment by means of three characteristics—(1.) Their not serving to keep up existence, but being gratifications sought for themselves only; (2.) Their purity from all repulsive ingredients; (3.) Their eminently sympathetic or sharable nature in contrast to the exclusive pleasures of the individual in eating, &c. The pleasures of art are divided, according to Mr Bain's general plan of the mind, into (1.) The elements of sensation—sights and sounds; (2.) The extension of these by intellectual revival—ideal suggestions of muscular impression, touch, odour, and other pleasurable sensations; (3.) The revival, in ideal form also, of pleasurable emotions, as tenderness and power, and in a softened measure of emotions painful in reality, as fear; (4.) The immediate gratification, that is in actual form, of certain wide emotional susceptibilities reaching beyond art, namely, the elating effect of all change of impression under the forms of artistic contrast and variety; and, secondly, the peculiar delight springing from harmony among impressions and feelings, under its several æsthetic aspects, musical harmony and melody, proportion, &c. The details in Mr Bain's exposition are rich and varied in relation to the psychology of the subject. He finds the effect of sublimity in the manifestation of superior power in its highest degrees, which manifestation excites a sympathetic

elation in the beholder. The Ludicrous, again, is defined by Mr Bain, improving on Aristotle and Hobbes, as the degradation of something possessing dignity in circumstances that excite no other strong emotion. The pleasure accompanying the impression may be referred either to the elation of a sense of power or superiority ideally or sympathetically excited, or to a sense of freedom from restraint, both of which have in common the element of a joyous rebound from pressure. Thus it will be seen that Professor Bain recognises no new mental principle in æsthetic effects, but regards them as peculiar combinations and transformations, according to known psychological laws, of other and simpler feelings.

Herbert Spencer.

An interesting turn has been given to the psychology of æsthetics by Mr Herbert Spencer. In some of his essays, as the one entitled "The Origin and Function of Music," and more fully in the concluding chapter of his *Psychology* (second edition), on the Æsthetic Sentiments, he offers a new theory of the genesis of the pleasures of beauty and art, based on his doctrine of evolution. He takes up Schiller's idea of the connection between æsthetic activity and play, only he deals with this latter not as an ideal tendency, but as a phenomenal reality, seeking to make it the actual starting-point in the order of evolution of æsthetic action. Play or sport is defined as the superfluous and useless exercise of faculties that have been quiescent for a time, and have in this way become so ready to discharge as to relieve themselves by *simulated* actions. Æsthetic activities yield to the higher powers of perception and emotion the substituted exercise which play yields to the lower impulses, agreeing with play in not directly subserving any processes conducive to life, but being gratifications sought for themselves only. This point of affinity between the two classes of pleasures is a valuable addition to æsthetic theory, and helps one to understand how the artistic impulse first arose. At the same time it is doubtful how far all present æsthetic pleasures, as the passive enjoyments of colour and tone, can be interpreted as substituted activities in Mr Spencer's sense. They seem rather to be original and instinctive modes of gratification not dependent on any previous exercises of life-function, except so far as the structure and functions of the senses as a whole may be viewed as the product of multitudinous life-processes in animal evolution. Mr Spencer, moreover, forms a hierarchy of æsthetic pleasures, the standard of height being either the number of powers duly exercised, or what comes to the same thing, the degree of complexity of the emotional faculty thus exercised. The first, and lowest class of pleasures, are those of simple sensation, as tone and colour, which are partly organic and partly the results of association. The second class are the pleasures of perception, as employed upon the combination of colours, &c. The highest order of pleasures are those of the æsthetic sentiments proper, consisting of the multitudinous emotions ideally excited by æsthetic objects, natural and artistic. Among these vaguely and partially revived emotions Mr Spencer reckons not only those of the individual, but also many of the constant feelings of the race. Thus he would attribute the vagueness and apparent depth of musical emotion to associations with vocal tones, built up during the course of vast ages. This graduated scheme is evidently dictated by the assumption that the higher the stage of evolution, the higher the pleasure. Yet Mr Spencer admits that this measure of æsthetic value will not suffice alone, and he adds, that the most perfect form of æsthetic gratification is realised when sensation, perception, and emotion, are present in fullest and most pleasurable action. Mr Spencer's supposition, that much of the pleasure of æsthetic emotion is referrible to transmitted experience, offers a very ingenious, even if not very definite, mode of explaining many of the mysterious effects of tone, and even of colour.

Among works on the history of æsthetic doctrines, the student may be referred to the following:—

In German literature, which contains the most complete histories, Max Schasler's *Kritische Geschichte der Æsthetik*, forming the first two volumes of an æsthetic system, is the fullest. Still he hardly does justice to English writers, there being no mention of Alison and recent thinkers. His stand-point is only definable as a new modification of Hegelianism. Zimmermann's *Geschichte der Æsthetik* is also to be recommended. Lotze's *Geschichte der Æsthetik in Deutschland* is a highly critical *résumé* of German systems, characterised by a good deal of caution, and a desire to mediate between opposing views, and if not very definite in its result, very appreciative and suggestive of the many-sidedness of the subject. In French, Lévêque's work, *La Science du Beau*, contains a very fair account of the most conspicuous systems, ancient and modern. In our own literature, numerous references to other systems are to be found in the essays of Alison; and Jeffrey attempts a brief historical survey of the doctrines of beauty in his article on the subject. Dugald Stewart's essays mostly fall into critical examination of the chief theories of beauty. Finally, Professor Bain, in his *Compendium of Mental and Moral Science*, supplies a brief but careful account of most of the known theories of the Beautiful. (J. S.)

AETION, a painter, whose famous picture of the marriage of Roxana and Alexander was exhibited at the Olympic games, and gained Aëtion so much reputation that the president of the games gave him his daughter in marriage. The picture is minutely described by Lucian. Aëtion appears from that author to have flourished in the times of Hadrian and the Antonines.

AETIUS, a Roman general of the closing period of the western empire, born at Dorostolus in Mœsia, late in the 4th century. While detained for some time as a hostage in the camp of Rhuas, king of the Huns, he acquired an influence with the barbarians that was afterwards of much advantage to himself, though the same cannot be said of it as regards the empire. He led into Italy an army of 60,000 Huns, which he employed first to support the usurping Emperor John, and, on the death of the latter, to enforce his claim to the supreme command of the army in Gaul upon Placidia, the empress-mother and regent for Valentinian III. Afterwards, when he incurred the disfavour of Placidia for the death of his rival Boniface, he again employed an army of Huns to compel her to reinstate him in his former position. In Gaul he won his military reputation, upholding for nearly twenty years, by combined policy and daring, the falling fortunes of the western empire. His greatest victory was that of Chalons-sur-Marne (20th Sept. 451), in which he utterly routed Attila and the Huns—the number slain on both sides being, according to one computation, 300,000, though this is obviously an exaggeration. This was the last triumph of the empire. Three years later (454) Aëtius presented himself at court to claim the emperor's daughter in marriage for his son Gaudentius; but Valentinian, suspecting him of designs upon the crown, slew him with his own hand.

AETIUS, surnamed "the Atheist," founder of an extreme sect of the Arians, was a native of Cœle-Syria. After working for some time as a coppersmith, he became a travelling doctor, and displayed great skill in disputations on medical subjects; but his controversial power soon found a wider field for its exercise in the great theological question of the time. He studied successively under the Arians, Paulinus, bishop of Antioch, Athanasius, bishop of Anazarbus, and the presbyter Antonius of Tarsus. In 350 he was ordained a deacon by Leontius of Antioch, but was shortly afterwards forced by the orthodox party to leave that town. At the first synod of Sirmium, he won a dialectic victory over the homoiousian bishops Basilius and Eustathius, who sought in consequence to stir up against him the enmity of Cæsar Gallus. In 356 he went to

Alexandria with Eunomius in order to advocate Arianism, but he was banished by Constantius. Julian the apostate recalled him from exile, bestowed upon him an estate in Lesbos, and retained him for a time at his court in Constantinople. Being consecrated a bishop, he used his office in the interests of Arianism by creating other bishops of that party. At the accession of Valens (364) he retired to his estate at Lesbos, but soon returned to Constantinople, where he died in 367. The Anomœan sect of the Arians, of whom he was the leader, are sometimes called after him *Aëtians*. His work *De Fide* has been preserved in connection with a refutation written by Epiphanius.

AETIUS, a Greek physician, born at Amida in Mesopotamia, who lived at the end of the 5th or the beginning of the 6th century. Of his personal history little is known, except that he studied at Alexandria, and was physician to the court at Constantinople with the title *comes obsequii.* He wrote a work entitled Βιβλία Ἰατρικὰ Ἑκκαίδεκα, which is mainly a compilation from the works of previous authors. Eight books of this were issued from the Aldine press at Venice in 1534; various other parts have been frequently published; and a Latin translation of the whole, by Cornarius, appeared at Basle in 1542.

ÆTNA. See ETNA.

ÆTOLIA, a country of ancient Greece, bounded on the N. by Epirus and Thessaly, on the E. by the provinces of Doris and Locris, on the S. by the Gulf of Corinth, and separated on the W. from Acarnania by the river Achelous. The part which lay westward of the river Evenus, and south of a line joining Thermum and Stratus in Acarnania, was called old Ætolia, the rest of the country new or acquired Ætolia. The country is in general mountainous and woody, but along the coast from the Achelous to the Evenus, and northward to Mount Aracynthus, is a plain of great fertility; while another extensive and fertile plain stretches north from this mountain along the east bank of the Achelous as far as the northern limit of old Ætolia. The Ætolians were a restless and turbulent people, strangers to friendship or principles of honour, and they were consequently regarded by the other states of Greece as outlaws and public robbers. On the other hand, they were bold and enterprising in war, undaunted in the greatest dangers, and jealous defenders of their liberties. They distinguished themselves above all the other nations of Greece in opposing the ambitious designs of the Macedonian princes, who, after having reduced most of the other states, were forced to grant them a peace upon very honourable terms. The constitution of the Ætolian league was copied from that of the Achæans, and with a view to form, as it were, a counter alliance. The Cleomenic war, and that of the allies, called the Social War, were kindled by the Ætolians with the express purpose of humbling the Achæans. In the latter they held out, with the assistance only of the Eleans and Lacedemonians, for the space of three years, against the united forces of Achaia and Macedon, but were obliged at last to purchase a peace by yielding up to Philip all Acarnania. In order to regain this province they entered into an alliance with Rome against Philip, and proved of great service to the Romans in their war with him; but being dissatisfied with the terms of peace granted by Flaminius, they made war upon the Romans themselves. They were speedily overcome, and only obtained peace on very humiliating terms. After the conquest of Macedon by Æmilius Paullus the Ætolians were reduced to a much worse condition; for not only those among them who had openly declared for Perseus, but those who were only suspected to have secretly favoured him, were sent to Rome to clear themselves before the senate. There they were detained, and never afterwards permitted to return to their native country. Five hundred and fifty of the chief men were barbarously assassinated by the partisans of Rome solely on the suspicion of favouring the designs of Perseus. The Ætolians appeared before Æmilius Paullus in mourning habits, and made loud complaints of such inhuman treatment, but could obtain no redress; on the contrary, ten commissioners, who had been sent by the senate to settle the affairs of Greece, enacted a decree, declaring that those who were killed had suffered justly, since it appeared to them that they had favoured the Macedonian party. From this time those only were raised to the chief honours and employments in the Ætolian republic who were known to prefer the interest of Rome to that of their country, and thus all the magistrates of Ætolia became the creatures and mere tools of the Roman senate. In this state of servile subjection they continued till the destruction of Corinth and the dissolution of the Achæan league, when Ætolia, with the other free states of Greece, was reduced to a Roman province, commonly called the *province of Achaia.* In this state, with little alteration, Ætolia continued under the emperors till the reign of Constantine the Great, who, in his new partition of the provinces of the empire, divided the western parts of Greece from the rest, calling them *New Epirus*, and subjecting the whole country to the *præfectus prætorio* for Illyricum. Under the successors of Constantine Greece was parcelled out into several principalities, especially after the taking of Constantinople by the western princes. About the beginning of the 13th century Theodorus Angelus, a noble Grecian of the imperial family, seized on Ætolia and Epirus. The former he left to Michael his son, who maintained it against Michael Palæologus, the first emperor of the Greeks, after the expulsion of the Latins. Charles, the last prince of this family, dying in 1430 without lawful issue, bequeathed Ætolia to his brother's son, named also Charles; and Acarnania to his natural sons Memnon, Turnus, and Hercules. But great disputes arising about this division, Amurath II., after the reduction of Thessalonica, laid hold of so favourable an opportunity, and expelled all the contending heirs in 1432. The Mahometans were afterwards dispossessed of this country by the famous prince of Epirus, George Castriot, commonly called Scanderbeg, who with a small army opposed the whole power of the Ottoman empire, and was victorious in twenty-two pitched battles. That hero at his death left great part of Ætolia to the Venetians; but they not being able to make head against such a mighty power, the whole country was soon reduced by Mahommed II. It is now included in the kingdom of Greece.

AFANASIEF, ALEKSANDR NIKOLAEVICH, a Russian scholar, distinguished for his researches in Slavonic literature and archæology, was born about 1825. He contributed many valuable articles to the serial literature of his country, but his reputation rests chiefly on two works of more permanent interest. The first was an extensive collection, in eight parts, of *Russian Popular Stories;* the other a treatise, in three volumes, on the *Poetical Views of the Old Slavonians about Nature*, completed just before the author's death, which occurred in the autumn of 1871.

AFER, DOMITIUS, orator, born at Nismes, flourished under Tiberius and the three succeeding emperors. Quintilian makes frequent mention of him, and commends his pleadings. But he disgraced his talents by acting as public accuser in behalf of the emperors against some of the most distinguished personages in Rome. Quintilian, in his youth, assiduously cultivated the friendship of Domitius. He tells us that his pleadings were superior in point of eloquence to any he had ever heard, and that there were public collections of his witty sayings (*dicta*), some of which he quotes. He also mentions two books of his, *On*

Witnesses. Domitius erected a statue in honour of Caligula, on which there was an inscription to the effect that this prince was a second time consul at the age of 27. This he intended as an encomium; but Caligula regarding it as a sarcasm upon his youth and his infringement of the laws, raised a process against him, and pleaded himself in person. Domitius, instead of making a defence, repeated part of the emperor's speech with the highest marks of admiration; after which he fell upon his knees, begged pardon, and declared that he dreaded Caligula's eloquence more than his imperial power. This piece of flattery succeeded so well, that the emperor not only pardoned him, but raised him to the consulship. Afer died in the reign of Nero, A.D. 60.

AFFIDAVIT means a solemn assurance of a matter of fact known to the person who states it, and attested as his statement by some person in authority. Evidence is chiefly taken by means of affidavits in the practice of the Court of Chancery in England. By 3 and 4 Will. IV. c. 42, s. 42, provision is made for appointing commissioners in Scotland and Ireland to take affidavits. The term is generally applied to a statement certified by a justice of peace or other magistrate. Affidavits are sometimes necessary as certificates that certain formalities have been duly and legally performed. They are extensively used in the practice of bankruptcy, and in the administration of the revenue. At one time they were invariably taken on oath, but this practice has been much narrowed. Quakers, Moravians, and Separatists have long been privileged in all cases to make a solemn declaration or affirmation; and now, if any persons called as witnesses, or required or desiring to make an affidavit or deposition, shall refuse or be unwilling from alleged conscientious motives to be sworn, the court or justice may, on being satisfied of the sincerity of such objection, allow such person to make a solemn affirmation or declaration—by 17 and 18 Vict. c. 125, s. 20, extended to all counties in England, Ireland, and Scotland by subsequent statutes. An Act of 1835 (5 and 6 Will. IV. c. 62) substituted declarations for oaths in certain cases; and this statute is extensively observed. The same Act prohibited justices of peace from administering oaths in any matter in which they had not jurisdiction as judges, except when an oath was specially authorised by statute, as in the bankrupt law, and excepting criminal inquiries, Parliamentary proceedings, and instances where oaths are required to give validity to documents abroad. But justices are permitted to take affidavits in any matter by declaration, and a person making a false affidavit in this way is liable to punishment. Affidavits may be made abroad before any British ambassador, envoy, minister, *chargé d'affaires*, secretary of embassy or legation, consul, or consular agent (18 and 19 Vict. c. 42, s. 1).

AFFINITY, in *Law*, as distinguished from consanguinity, is applied to the relation which each party to a marriage, the husband and the wife, bears to the kindred of the other. The marriage having made them one person, the blood relations of each are held as related by affinity in the same degree to the one spouse as by consanguinity to the other. But the relation is only with the married parties themselves, and does not bring those in affinity with them in affinity with each other; so a wife's sister has no affinity to her husband's brother. The subject is chiefly important from the matrimonial prohibitions by which the canon law has restricted relations by affinity. Taking the table of degrees within which marriage is prohibited on account of consanguinity, the rule has been thus extended to affinity, so that wherever relationship to a man himself would be a bar to marriage, relationship to his deceased wife will be the same bar, and *vice versa* on the husband's decease. This rule has been founded chiefly on interpretations of the eighteenth chapter of Leviticus. Formerly by law in England, marriages within the degrees of affinity were not absolutely null, but they were liable to be annulled by ecclesiastical process during the lives of both parties; in other words, the incapacity was only a canonical, not a civil, disability. By an Act passed in 1835 (5 and 6 Will. IV. c. 54), all marriages of this kind not disputed before the passing of the Act are declared absolutely valid, while all subsequent to it are declared null. This renders null in England, and not merely voidable, a marriage with a deceased wife's sister or niece. The Act does not extend to Scotland; but it was made quite clear by a leading decision in 1861 (Fenton *v.* Livingston) that, as "the degrees forbidden in consanguinity are also forbidden in affinity," the marriage of a sister-in-law with a brother-in-law is absolutely null in that country. Nor can a man contract a marriage with his wife's sister so as to be valid in Great Britain, by celebrating his marriage with her in a country where such marriages are lawful (Brook *v.* Brook, 9 *H. L. Cases*, 193).

AFFINITY, CHEMICAL, the property or relation in virtue of which dissimilar substances are capable of entering into chemical combination with each other. Substances that are so related combine always in fixed and definite proportions; the resulting compound differs from its components in its physical properties, with the exception that its weight is exactly the sum of their weights; and the combination is always accompanied with the evolution of heat. In these respects it differs from a mere mechanical mixture; in the latter there is contact without combination, and its properties are a mean or average of those of the substances that compose it. That effect may be given to chemical affinity, the substances must be placed in contact; but mere contact is often insufficient, and combination only takes place on the application of heat, light, electric agency, &c., or through the interposition of some foreign substance. Generally speaking, the affinity is less between substances that closely resemble each other than between those whose properties are altogether dissimilar. The term *elective affinity*, now generally disused, has been employed to indicate the greater affinity which a substance, when brought into contact with other substances, often has for one in preference to another. Advantage is frequently taken of this greater affinity to decompose compound substances. For a full treatment of chemical affinity and combination, see CHEMISTRY.

AFFIRMATION. See AFFIDAVIT.

AFFRE, DENIS AUGUSTE, Archbishop of Paris, was born at St Rome, in the department of Tarn, on the 27th Sept. 1793. When fourteen years of age, having expressed his desire to enter the church, he became a student at the seminary of St Sulpice, of which his maternal uncle, Denis Boyer, was director. His studies being completed before he had reached the age necessary for ordination, he was occupied for some time as professor of philosophy in the seminary at Nantes. He was ordained a priest in 1818, and held his first charge in connection with the church of St Sulpice. After filling a number of ecclesiastical offices, he was elevated to the Archbishopric of Paris in 1840. His tenure of this office, though it was marked by great zeal and faithfulness, will be chiefly remembered by its tragic close. During the insurrection of 1848 the archbishop was led to believe that by his personal interference peace might be restored between the soldiery and the insurgents. He accordingly applied to General Cavaignac, who warned him of the risk he incurred. "My life," the archbishop answered, "is of little importance." Soon afterwards, the firing having ceased at his request, he appeared on the barricade at the entrance to the Faubourg St Antoine, accompanied by M. Albert, of the national guard,

bearing a green branch as a sign of peace, and by Sellier, an attached servant. His reception was not very favourable, and he had spoken only a few words, when the insurgents, hearing some shots, and fancying they were betrayed, opened fire upon the national guard, and the archbishop fell. He was removed to his palace, where he died on the 27th June 1848. Next day the National Assembly issued a decree expressing their great sorrow on account of his death; and the public funeral on the 7th July was one of the most striking spectacles of its kind. The archbishop wrote several treatises of considerable value, including one on Egyptian hieroglyphics.

AFGHÂNISTÂN

THIS is the name applied, originally in Persian, to that mountainous region between N.W. India and Eastern Persia, of which the Afghâns are the most numerous and the predominant inhabitants. Afghans, under that and other names, have played no small part in Asiatic history. But the present extensive application of the name *Afghânistân* is scarcely older than the shortlived empire founded by Ahmed Khan in the middle of last century. The Afghans themselves are not in the habit of using the term.

In treating of this country we include a part of the Hazâra mountain region, but not that part of the Oxus basin which is now under Afghan rule, for which see AFGHAN TURKESTAN.

Afghanistan generally may be regarded as a great quadrilateral plateau,—using that term in the technical sense of a region whose lowest tracts even are considerably elevated above the sea-level,—extending from about 62° to 70° E. long., and from 30° to 35° N. lat. This territory corresponds fairly to the aggregate of the ancient provinces of *Aria* (Herât), *Drangiana* (Seistân), the region of the *Paropamisadæ* (Kâbul), and *Arachosia* (Kandahâr), with *Gandaritis* (Peshâwar and Yûzufzai). Though the last territory belongs ethnically to Afghanistan, an important part of it now forms the British district of Peshâwar, whilst the remainder acknowledges no master.

The boundaries of Afghanistan can be stated here only roughly; and, from the area thus broadly defined, many portions will have to be deducted as occupied by independent or semi-independent tribes. But, so understood, they may be thus stated:—

On the north: beginning from east, the great range of Hindu Kush, a western offshoot of the Himâlya, parting the Oxus basin from the Afghan basins of the Kabul river and Helmand. From long. 68° this boundary continues westward in the prolongation of Hindu Kush called Koh-i-Bâbâ. This breaks into several almost parallel branches, enclosing the valleys of the river of Herat and the Murghâb or river of Merv. The half-independent Hazara tribes stretch across these branches and down into the Oxus basin, so that it is difficult here to assign a boundary. We assume it to continue along the range called Safed Koh or "White Mountain," which parts the Herat river valley from the Murghab.[1]

On the east: the eastern base of the spurs of the Sulimâni and other mountains which limit the plains on the west bank of Indus, and the lower valleys opening into these, which plains (the "Derajât") and lower valleys belong to British India. North of Peshâwar district the boundary will be, for a space, the Indus, and then the limit, lying in unknown country, between the Afghan and Dard tribes.

On the south: the eastern part of the boundary, occupied by practically independent tribes, Afghan and Bilûch, is hard to define, having no marked natural indication. But from the Shâl territory (long. 67°), belonging to the Bilûch state of KELAT, westward, the southern limits of the valleys of the Lora river, and then of the Helmand, as far as the Lake of Seistan in lat. 30°, will complete the southern boundary. Thus the whole breadth of Bilûchistân, the ancient *Gedrosia*, a dry region occupying 5° of latitude, intervenes between Afghanistan and the sea.

The western boundary runs from the intersection of the Lake of Seistan with lat. 30°, bending eastward, so as to exclude a part of the plain of Seistan on the eastern bank of the lake, and then crosses the lake to near the meridian of 61°. Thence it runs nearly due north, near this meridian, to a point on the Hari-Rûd, or river of Herat, about 70 miles below that city, where it encounters the spurs of the Safed Koh, which has been given as the northern boundary.

But if we take the limits of the entire Afghan *dominions*, as they at present exist, the western boundary will continue north along the Hari-Rûd to lat. 36°, and the northern boundary will run from this point along the borders of the Turkman desert, so as to include Andkhoi, to Khoja Sâleh ferry on the Oxus. The Oxus, to its source in Great Pamîr, forms the rest of the northern boundary. These enlarged limits would embrace the remainder of the Hazara mountain tracts, and the whole of what is now called AFGHAN TURKESTAN, as well as BADAKHSHAN with its dependencies, now tributary to the Afghan Amir.

The extreme dimensions of Afghanistan, as at first defined, will be about 600 miles from east to west, and 450 miles from north to south; and, if we take the whole Afghan dominion, the extent from north to south will be increased to 600 miles. Within both the areas so defined, however, we have included some territory over which the Afghan government has no control whatever, and much over which its authority is respected only when backed by a special exertion of force. Under the former head come the valleys of the Yusufzai clan north of Peshâwar, the Momands, Afrîdîs, Vazîrîs, &c., adjoining that district on the west and south-west, the high-lying valleys of Chitrâl or Kâshkâr, and of the independent Pagans or Kâfirs, among the loftier spurs of Hindu Kush. Under the latter head come the eastern districts of Khost and (partially) of Kurram, the Kâkar country in the extreme south-east, much of the country of the tribes called Eimâk and Hazara in the north-west, and probably Badakhshân with its dependencies.

If we suppose the sea to rise 4000 feet above its existing level, no part of the quadrilateral plateau that we have defined would be covered, except portions of the lower valley of the Kabul river, small tracts towards the Indus, and a triangle, of which the apex should be at the Lake of Seistan in the extreme south-west, and the base should just include Herat and Kandahar, passing beyond those cities to intersect the western and southern boundaries respectively. Isolated points and ridges within this triangle would emerge.

Further, let us suppose the sea to rise 7000 feet above its existing level. We should still have a tract emerging so large that a straight line of 200 miles could be drawn, from the Kûshân Pass of Hindu Kush, passing about 35 miles west of Kabul, to Rangak on the road between Ghazni and Kandahar, which nowhere should touch the submerged portion. And we believe it is certain that a line under

[1] Not to be confounded with the more easterly *Safed Koh* of the Kabul basin.

like conditions, but 250 miles in length, could be drawn at right angles to the former, passing about 25 miles south of Ghazni. The greater part of this latter line, however, would lie in the Hazara country, in which we have no observations.

In the triangular tract that would be submerged according to our first supposition, the lowest level is the Lake of Seistan, 1280 feet above the sea. Herat is 2650; Kandahar, 3490.

The Afghans themselves make a broad distinction between *Kabul*, meaning thereby the whole basin of the Kabul river, and the rest of their country, excluding the former from the large and vague term KHORASAN, under which they consider the rest to be comprehended. There is reason for such a distinction in history as well as nature. For the Kabul basin was in old times much more intimately connected with India, and to the beginning of the 11th century was regarded as Indian territory.

NATURAL DIVISIONS.—Of these, this Kabul basin (1) forms the first. As others we may discriminate—(2.) The lofty central part of the table-land on which stand Ghazni and Kala't-i-Ghilzai, embracing the upper valleys of ancient *Arachosia;* (3.) The upper Helmand basin; (4.) The lower Helmand basin, embracing Girishk, Kandahar, and the Afghan portion of Seistan; (5.) The basin of the Herat river; and (6.) The eastern part of the table-land, draining by streams, chiefly occasional torrents, towards the Indus.

Kabul Basin.—Its northern limit is the range of Hindu Kush, a name which properly applies to the lofty, snow-clad crest due north of Kabul, and perhaps especially to one pass and peak. But it has been conveniently extended to the whole line of alpine watershed, stretching westward from the southern end of Pamir, and represents the Caucasus of Alexander's historians. Its peaks throughout probably rise to the region of perpetual snow, and even on most of the passes beds of snow occur at all seasons, and, on some, glaciers. We find no precise height stated for any of its peaks, but the highest probably attain to at least 20,000 or 21,000 feet. The height of the Kushan *Pass* is estimated by Lord at 15,000 feet.

The Kabul river (the ancient *Kophes*) is the most important river of Afghanistan. It may be considered as fully formed about 30 miles east of Kabul, by the junction thereabouts (the confluence does not seem to have been fixed by any traveller) of the following streams:—(*a.*) The *Kabul* stream, rising in the Unai pass towards the Helmand, which, after passing through the city, has been joined by the Logar river flowing north from the skirts of the Ghilzai plateau; (*b.*) A river bringing down from the valleys Ghorband, Parwân, and Panjshîr, a large part of the drainage of Hindu Kush, and watering the fruitful plain of Dâman-i-Koh (the "Hill-skirt"), intersected by innumerable brooks, and studded with vineyards, gardens, and fortalices. This river was formerly called *Bûrân*, a name apparently obsolete, but desirable to maintain; (*c.*) The river of *Tagao*, coming down from the spurs of Hindu Kush on the Kafir borders.

Some 30 miles further east, the *Alishang* enters on the left bank, from Laghmân, above which this river and its confluents drain western KAFIRISTAN. Twenty miles further, and not far beyond Jalâlâbâd, the Kabul river receives from the same side a confluent entitled, as regards length, to count as main stream. In some older maps this bears the name of *Kâmo*, from a place near the confluence, and in more recent ones *Kûner*, from a district on its lower course. Higher it is called the *river of Kashkar*, and the *Beilam.* It seems to be the *Choaspes*, and perhaps the *Malamantus* of the ancients. It rises in a small lake near the borders of Pamir, and flows in a south-west direction through the length of Kashkar or Chitral, an independent valley-state, whose soil lies at a height of 6000 to 11,000 feet. The whole length of the river to its confluence with the Kabul river cannot be less than 250 miles, *i.e.*, about 80 miles longer than that regarded as the main stream, measured to its most remote source.

The basin of the Kabul river is enclosed at the head by the Paghman range, an offshoot of Hindu Kush, which divides the Kabul valleys from the Helmand. Up the head-waters of the stream that passes Kabul, leads the chief road to Turkestan, crossing for a brief space into the Helmand basin by the easy pass of Unai (11,320 feet), and then over the Koh-i-Baba, or western extension of Hindu Kush, by the Hajjigak passes (12,190 and 12,480 feet), to Bâmiân.

The most conspicuous southern limit of the Kabul basin is the Safed Koh, Spin-gar of the Afghans ("White Mountain," not to be confounded with the western Safed Koh already named), an alpine chain, reaching, in its highest summit, Sîta Râm, to a height of 15,622 feet, and the eastern ramifications of which extend to the Indus at and below Attok. Among the spurs of this range are those formidable passes between Kabul and Jalalabad, in which the disasters of 1841–42 culminated, as well as the famous Khybar passes between Jalalabad and Peshâwar. This southern watershed formed by the Safed Koh is so much nearer the Kabul river than that on the north, that the tributaries from this side, though numerous, are individually insignificant.

After flowing 60 miles (in direct measurement) eastward from the Kuner confluence, the Kabul river issues from the mountains which have hemmed it in, and enters the plain of Peshâwar, receiving, soon after, the combined rivers of Swât (*Soastus*) and Panjkora (*Guræus*), two of the great valleys of the Yusufzai. This combined river is called by the Afghans *Landai Sîn* or Little river, in distinction from the *Abba Sîn* or Indus, and the name seems often to adhere to the lower course of the Kabul river. Both rivers on entering the plain ramify, in delta fashion, into many natural channels, increased in number by artificial cuts for irrigation. Finally the river enters the Indus immediately above the gorge at Attok.

The lowest ford on the Kabul river is a bad one, near Jalalabad, only passable in the dry season. Below the Kuner confluence the river is deep and copious, crossed by ferries only, except at Naoshera, below Peshâwar, where there is usually a bridge of boats. The rapid current is unfavourable to navigation, but from Jalalabad downwards the river can float boats of 50 tons, and is often descended by rafts on blown skins. The whole course of the river, measured by a five-mile opening of the compasses, is as follows:—From source of Kabul stream in Unai pass to Attok, 250 miles; from source either of Logar or of Panjshir to the same, 290 miles; from source of Kashkar river to the same, 370 miles.

A marked natural division of the Kabul basin occurs near Gandâmak, above Jalalabad, where a sudden descent takes effect from a minimum elevation of 5000 feet to one of only 2000. The Emperor Baber says of this:—"The moment you descend, you see quite another world. The timber is different; its grains are of another sort; its animals are of a different species; and the manners and customs of its inhabitants are of a different kind." Burnes, on his first journey, left the wheat harvest in progress at Jalalabad, and found the crop at Gandamak, only 25 miles distant, but 3 inches above ground. Here, in truth, nature has planted the gates of India. The valleys of the upper basin, though still in the height of summer affected by a sun of fierce power, recall the climate and products of the finest part of temperate Europe; the region below is a chain of narrow, low, and hot plains, with climate and vegetation of an Indian character.

Accounts of Kabul strike us by apparent contradiction. Some give scarcely any impression but that of extreme ruggedness and desolation, awful defiles, and bare black crags; others dwell on the abounding orchards, green sward, charming dells, and purling streams. But both aspects are characteristic. The higher spurs, both of Hindu Kush and Safed Koh, are often clad with grand forests of pine, oak, and other alpine trees, and resemble the wooded ranges of Himalya. But the lower hills generally are utterly woodless, and almost entirely naked. In the bottoms, often watered by clear and copious streams, we have those beauties of verdure and fertility on which some writers dwell, and which derive new charms from contrast with the excessive sterility of the hills that frame them.

We cannot speak at equal length of the other natural divisions of Afghanistan, but some chief points will be noticed with the rivers. In general the remainder of the country, regarded by the Afghans as included in Khorasan, exhibits neither the savage sublimity of the defiles of the Kabul region, the alpine forests of its higher ranges, nor its nests of rich vegetation in the valleys, save in the north-east part adjoining Safed Koh, where these characters still adhere, and in some exceptional localities, such as the valley of Herat, which is matchless in richness of cultivation. Generally the characteristics of this country are elevated plateaux of sandy or gravelly surface, broken by ranges of rocky hills, and often expanding in wide spaces of arid waste, which terminate to the south-west in a regular desert of shifting sand. Even in cultivated parts there is a singular absence of trees, and when the crops are not visible this imparts an aspect of great desolation and emptiness to the landscape. Natural wood, however, is found in some parts of West Afghanistan, as in the almost tropical delta of the Helmand, in the Ghûr territory, and on the Herat river below Herat. Generally, indeed, in such cases the trees appear to be mimosas, tamarisks, and the like, with little body of foliage.

RIVERS.—Next to the Kabul river in importance, and probably much exceeding it in volume as it certainly does in length, is the *Helmand* (*Etymander*), the only considerable river in its latitude from the Tigris to the Indus. The Helmand has its highest sources in the Koh-i-Baba and Paghman hills, between Kabul and Bamian. Its succeeding course is through the least known tract of Afghanistan, chiefly occupied by Hazaras; indeed, for a length of nearly 300 miles no European has seen the river. This unvisited space terminates at Girishk, where the river is crossed by the principal route from Herat to Kandahar. Till about 40 miles above Girishk the character of the Helmand is said to be that of a mountain river, flowing between scarped rocks, and obstructed by enormous boulders. At that point it enters on a flat country, and extends over a gravelly bed. Here, also, it begins to be used in irrigation. Forty-five miles below Girishk the Helmand receives its greatest tributary, the Arghand-âb, coming past Kandahar from the high Ghilzai country. It here becomes a very considerable river, said to have a width of 300 or 400 yards, and a depth of 9 to 12 feet. But this cannot be at all seasons, as there are fords at long intervals as far down as Pûlalik, 100 miles from the mouth. The desert draws near the left bank in the lower course, and for the last 150 miles the moving sands approach within $1\frac{1}{4}$ mile. The vegetation on the banks is here of luxuriant tropical character. The whole of the lower valley seems to have been once the seat of a prosperous population, and there is still a good deal of cultivation for 100 miles below Girishk. Even this, however, is much fallen off, and lower down still more so, owing to disorders and excessive insecurity.

The course of the river is more or less south-west from its source till in Seistan it approaches meridian 62°, when it turns nearly north, and so flows on for 70 or 80 miles till it falls into the lake of Seistan by various mouths. The whole length of the river, measured as before, is about 615 miles. Ferrier considers that it has water enough for navigation at all seasons, from Girishk downwards. At present boats are rarely seen, and those in use are most clumsy; rafts are employed for crossing.

Arghand-âb.—Of this tributary of the Helmand little is known except in its lower course. It rises in the Hazara country, N.W. of Ghazni. It is said to be shallow, and to run nearly dry in height of summer; but when its depth exceeds 3 feet its great rapidity makes it a serious obstacle to travellers. In its lower course it is much used for irrigation, and the valley is cultivated and populous; yet the water is said to be somewhat brackish. Its course may be reckoned about 235 miles.

It is doubtful whether the ancient *Arachotus* is to be identified with the Arghand-ab or with its chief confluent the *Tarnak*, which joins it on the left about 30 miles S.W. of Kandahar. The two rivers run nearly parallel, inclosing the backbone of the Ghilzai plateau. The Tarnak is much the shorter (length about 197 miles) and less copious. The ruins at Ulân Robât, supposed to represent the city *Arachosia*, are in its basin; and the lake known as *Ab-i-Istâda*, the most probable representative of *Lake Arachotus*, is near the head of the Tarnak, though not communicating with it. The Tarnak is dammed for irrigation at intervals, and in the hot season almost exhausted. There is a good deal of cultivation along the river, but few villages. The high road from Kabul to Kandahar passes this way (another reason for supposing the Tarnak to be *Arachotus*), and the people live off the road to eschew the onerous duties of hospitality.

The *Lora* is the most southerly river of Afghanistan, and may be regarded as belonging to the Helmand basin, though it is not known that its waters ever reach that river. It rises near the Kand and Joba peaks in a branch of the Sulimani, and flows nearly east, passing through the large valley of Pishin, but lying too deep for irrigation. The river has a course of nearly 200 miles, and considerable breadth, but is never for a week together unfordable. In the Shorâwak district (long. 65°–66°) a good deal of irrigation is drawn from it. The river is said to terminate in a lake, on the verge of the sandy desert.

Rivers belonging to the basin of Seistan and the Lower Helmand are the Khash-Rud, the Farrah-Rud, and the Harut.

The *Khâsh-rûd* rises in or near the southern slopes of Siah-Koh (Black Mountain), which forms the southern wall of the valley of Herat, and flows south, in flood reaching the Lake of Seistan, but generally exhausted in irrigation. It is named from Khâsh, a village in the Seistan plain. In the dry season it is everywhere fordable, but in floods caravans may be detained by it several days.

The *Farrah* river flows from the same quarter, and has the same character in floods. It is a larger stream, and at Farrah is said to have a width of 150 yards, with 2 feet of water, and a clear, swift stream. In flood, Khanikoff was struck with the resemblance of this river, rolling its yellow waves violently between steep banks of clay, to the Cyrus at Tiflis.

The *Harût* rises in the mountains S.E. of Herat, and has a course of about 245 miles to the Lake of Seistan. Canals from it supply abundant irrigation to the plains of Sabzvâr and Anârdarah. The river forms a true delta with fifteen branches, giving rise to marsh and much vegetation, especially tamarisk, willow, and poplar. The Harut receives in the plain a considerable affluent, the Khushkek river.

It is possible that confusion of the name of this river with the Hari-Rud, or river of Herat, led to the long prevalent mistake that the latter river flowed south into the Seistan Lake—a mistake as old as Ptolemy, if his *Aria Lacus* be (as it seems) that of Seistan.

The *Hari-rûd* is formed by two chief confluents in the lofty Hazara country, not far from the sources of the river of Balkh. Its early course is, for more than 100 miles and as far as the village of Jâor, westward, at a height of many thousand feet above the sea. It then descends rapidly (it is said with cataracts), but continues in the same direction, receiving numerous streams, to Obeh, where much water begins to be drawn off. Sixty-five miles further it flows past *Herat*, 3 miles to the south of the city. Hereabouts the Kandahar road crosses the river by a masonry bridge of 26 arches. Near this fifteen deep canals are drawn off. A few miles below Herat the river begins to turn N.W.; and after passing for many miles through a woody tract, abounding in game, in which are the preserves of the Herat princes, at the ancient and now nearly deserted town of Kassan, 70 miles from Herat, it turns due north. Though the drainage brought down by this river must be large, so much is drawn off that, below Herat, reaches of it are at times quite dry. Below Kassan it receives fresh supplies, and eventually the Meshed stream. It flows on towards Sarakhs, and dwindles away; but accurate information regarding it is still wanting. The channel is shown, in a map lately published, as passing Sarakhs for some 250

miles, and ending in a swamp adjoining the Daman-i-Koh, on the border of the Turkman desert.

Of the rivers that run towards the Indus, south of the Kabul river, the chief are the Kurram and the Gomal.

The *Kurram* drains the southern flanks of Safed Koh. The middle valley of Kurram, forming the district so called, is highly irrigated, well peopled, and crowded with small fortified villages, orchards, and groves, to which a fine background is afforded by the dark pine forests and alpine snows of Safed Koh. The beauty and climate of the valley attracted some of the Mogul emperors of Delhi, and the remains exist of a garden of Shah Jahan's. The river passes the British frontier, and enters the plain country a few miles above Banu, spreading into a wide bed of sand and boulders, till it joins the Indus near Isa-Khel, after a course of more than 200 miles. By the Kurram valley is one of the best routes from India into Afghanistan. It was travelled by Major Lumsden's party in 1857-58.

The *Gomal*, rising in the Sulimani mountains, though in length equal to the Kurram, and draining, with its tributaries, a much larger area, is little more than a winter torrent, diminishing to a mere rivulet, till December, when it begins to swell. At its exit into the plain of the Derajat a local chief threw a dam across its channel; and it is now only in very wet seasons that its waters reach the Indus, near Dera Ismael Khan. Not long before leaving the hills it receives from the S.W. a tributary, the Zhōb, of nearly equal length and size, coming from the vicinity of the Kand and Joba peaks, in long. 68°.

LAKES.—As we know nothing of the lake in which the Lora is said to end, and the greater part of the lake of SEISTAN (see that article) is excluded from Afghanistan, there remains only the *Ab-i-Istada*, on the Ghilzai plateau. This is about 65 miles S.S.W. of Ghazni, and stands at a height of about 7000 feet, in a site of most barren and dreary aspect, with no tree or blade of grass, and hardly a habitation in sight. It is about 44 miles in circuit, and very shallow; not more than 12 feet deep in the middle. The chief feeder is the Ghazni river. The Afghans speak of a stream draining the lake, but this seems to be unfounded, and the saltness and bitterness of the lake is against it. Fish entering the salt water from the Ghazni river sicken and die.

PROVINCES AND TOWNS.—The chief political divisions of Afghanistan in recent times are stated to be Kabul, Jalalabad, Ghazni, Kandahar, Herat, and AFGHAN TURKESTAN (*q.v.*), to which are sometimes added the command of the Ghilzais and of the Hazaras. This list seems to omit the unruly districts of the eastern table-land, such as Kurram, Khost, &c. But we must not look for the precision of European administration in such a case.

In addition to KABUL, GHAZNI, KANDAHAR, HERAT, described under those articles, there are not many places in Afghanistan to be called towns. We notice the following:—

Jalâlâbâd lies, at a height of 1946 feet, in a plain on the south of the Kabul river. It is by road 100 miles from Kabul, and 91 from Peshawar. Between it and Peshawar intervene the Khybar and other adjoining passes; between it and Kabul the passes of Jagdalak, Khurd-Kabul, &c. The place has been visited by no known European since Sir G. Pollock's expedition in 1842. As it then existed, the town, though its walls had an extent of 2100 yards, contained only 300 houses, and a permanent population of 2000. The walls formed an irregular quadrilateral in a ruinous state, surrounded on all sides by buildings, gardens, the remains of the ancient walls, &c., affording cover to an assailant. The town walls were destroyed by Pollock, but have probably been restored.

The highly-cultivated plain is, according to Wood, 25 miles in length by 3 or 4 miles in breadth; the central part covered with villages, castles, and gardens. It is abundantly watered.

The province under Jalalabad is about 80 miles in length by 35 in width, and includes the large district of Laghman, north of the Kabul river, as well as that on the south, which is called Nangnihâr. The former name, properly Lamghân, the seat of the ancient *Lampagæ*, is absurdly derived by the Mahommedans from the patriarch Lamech, whose tomb they profess to show; the latter name is interpreted (in mixed Pushtu and Arabic) to mean "nine rivers," an etymology supported by the numerous streams. The word is, however, really a distortion of the ancient Indian name *Nagarahâra*, borne by a city in this plain long before Islam, and believed to have been the *Nagara* or *Dionysopolis* of Ptolemy. Many topes and other Buddhist traces exist in the valley, but there are no unruined buildings of any moment. Baber laid out fine gardens here; and his grandson (Jalâluddîn) Akbar built Jalalabad. Hindus form a considerable part of the town population, and have a large temple. The most notable point in the history of Jalalabad is the stout and famous defence made there, from November 1841 till April 1842, by Sir Robert Sale.

Istâlif is a town in the Koh Daman, 20 miles N.N.W. of Kabul, which was stormed and destroyed, 29th September 1842, by a force under General M'Caskill, to punish the towns-people for the massacre of the garrison at Charikar, and for harbouring the murderers of Burnes. The place is singularly picturesque and beautiful. The rude houses rise in terrace over terrace on the mountain-side, forming a pyramid, crowned by a shrine embosomed in a fine clump of planes. The dell below, traversed by a clear rapid stream, both sides of which are clothed with vineyards and orchards, opens out to the great plain of the Daman-i-Koh, rich with trees and cultivation, and dotted with turreted castles; beyond these are rocky ridges, and over all the eternal snows of Hindu Kush. Nearly every householder has his garden with a tower, to which the families repair in the fruit season, closing their houses in the town. The town is estimated, with seven villages depending on it, to contain about 18,000 souls.

Chârîkâr (population 5000) lies about 20 miles north of Istalif, at the north end of Koh Daman, and watered by a canal from the Ghorband branch of the Baran river. Hereabouts must have been the *Triodon*, or meeting of the three roads from Bactria, spoken of by Strabo and Pliny. It is still the seat of the customs levied on trade with Turkestan, and also of the governor of the Kohistân or hill country of Kabul, and is a place of considerable trade with the regions to the north. During the British occupation a political agent (Major Eldred Pottinger, famous in the defence of Herat) was posted here with a Gûrkha corps under Captain Codrington and Lieutenant Haughton. In the revolt of 1841, after severe fighting, they attempted to make their way to Kabul, and a great part was cut off. Pottinger, Haughton (with the loss of an arm), and one sepoy only, reached the city then; though many were afterwards recovered.

Kala't-i-Ghilzai has no town, but is a fortress of some importance on the right bank of the Tarnak, on the road between Ghazni and Kandahar, 89 miles from the latter, and at a height of 5773 feet. The repulse of the Afghans in 1842 by a sepoy garrison under Captain Craigie, was one of the most brilliant feats of that war.

Girishk is also a fort rather than a town, the latter being insignificant. It is important for its position on the high road between Kandahar and Herat, commanding the ordinary passage and summer ford of the Helmand. It was held by the British from 1839 till August 1842, but during the latter nine months, amid great difficulties, by a native garrison only, under a gallant Indian soldier, Balwant Singh.

Farrah belongs to the Seistan basin, and stands on the river that bears its name, and on one of the main routes from Herat to Kandahar, 164 miles from the former, 236 miles from the latter. The place is enclosed by a huge earthen rampart, crowned with towers, and surrounded by a wide and deep ditch, which can be flooded, and with a covered way. It has the form of a parallelogram, running north

and south, and only two gates. As a military position it is of great importance, but it is excessively unhealthy. Though the place would easily contain 4500 houses, there were but 60 habitable when Ferrier was there in 1845, nor was there much change for the better when Colonel Pelly passed in 1858. Farrah is a place of great antiquity; certainly, it would seem, the *Phra* of Isidore of Charax (1st century), and possibly *Prophthasia*, though this is more probably to be sought in the great ruins of Peshâwarân, farther south, near Lâsh. According to Ferrier, who alludes to "ancient chronicles and traditions," the city on the present site within the great rampart was sacked by the armies of Chinghiz, and the survivors transported to another position, one hour further north, where there are now many ruins and bricks of immense size (a yard square), with cuneiform letters, showing that site again to be vastly older than Chinghiz. The population came back to the southern site after the destruction of the mediæval city by Shah Abbas, and the city prospered again till its bloody siege by Nadir Shah. Since then, under constant attacks, it has declined, and in 1837 the remaining population, amounting to 6000, was carried off to Kandahar. Such are the vicissitudes of a city on this unhappy frontier.

Sabzvâr, the name of which is a corruption of old Persian, *Isphizar*, "horse-pastures," is another important strategic point, 93 miles from Herat and 71 miles north of Farrah, in similar decay to the latter. The present fort, which in 1845 contained a small bazar and 100 houses, must once have been the citadel of a large city, now represented by extensive suburbs, partly in ruins. Water is conducted from the Harut by numerous canals, which also protect the approaches.

Zarni is a town in the famous but little known country of Ghur, to the east of Herat, the cradle of a monarchy (the Ghurid dynasty) which supplanted the Ghaznevides, and ruled over an extensive dominion, including all Afghanistan, for several generations. Zarni, according to Ferrier, was the old capital of Ghur. Ruins abound; the town itself is small, and enclosed by a wall in decay. It lies in a pleasant valley, through which fine streams wind, said to abound with trout. The hills around are covered with trees, luxuriantly festooned with vines. The population in 1845 was about 1200, among whom Ferrier noticed (a remarkable circumstance) some Gheber families. The bulk of the people are *Sûris* and *Taimûnis*, apparently both very old Persian tribes.

CLIMATE.—The variety of climate is immense, as might be expected. At Kabul, and over all the northern part of the country to the descent at Gandamak, winter is rigorous, but especially so on the high Arachosian plateau. In Kabul the snow lies for two or three months; the people seldom leave their houses, and sleep close to stoves. At Ghazni the snow has been known to lie long beyond the vernal equinox; the thermometer sinks to 10° and 15° below zero (Fahr.); and tradition relates the entire destruction of the population of Ghazni by snow-storms more than once.

At Jalalabad the winter and the climate generally assume an Indian character, and the hot weather sometimes brings the fatal *simûm*. The summer heat is great everywhere in Afghanistan, but most of all in the districts bordering on the Indus, especially Sewi, on the lower Helmand, and in Seistan. All over Kandahar province the summer heat is intense, and the simum is not unknown. The hot season throughout the "Khorasan" part of the country is rendered more trying by frequent dust-storms and fiery winds; whilst the bare rocky ridges that traverse the country, absorbing heat by day and radiating it by night, render the summer nights most oppressive. At Girishk, Ferrier records the thermometer in August to have reached 118° to 120° (Fahr.) in the shade. At Kabul the summer sun has much of its Indian power, though the heat is tempered occasionally by breezes from Hindu Kush, and the nights are usually cool. Baber says that, even in summer, one could not sleep at Kabul without a sheepskin, but this seems exaggerated. At Kandahar snow seldom falls on the plains or lower hills; when it does, it melts at once.

At Herat, though 800 feet lower than Kandahar, the summer climate appears to be more temperate; and, in fact, the climate altogether is one of the most agreeable in Asia. In July, Ferrier says he found the heat never to pass 98°, and rarely 91° to 93° (Fahr.) These are not low figures, but must be compared with his register at Girishk, just given. From May to September the wind blows from the N.W. with great violence, and this extends across the country to Kandahar. The winter is tolerably mild; snow melts as it falls, and even on the mountains does not lie long. Three years out of four at Herat it does not freeze hard enough for the people to store ice; yet it was not very far from Herat, and could not have been at a greatly higher level (at Kafir Kala', near Kassan) that, in 1750, Ahmed Shah's army, retreating from Persia, is said to have lost 18,000 men from cold in a single night.

The summer rains that accompany the S.W. monsoon in India, beating along the southern slopes of the Himalya, travel up the Kabul valley, at least to Laghman, though they are more clearly felt in Bajaur and Panjkora, under the high spurs of the Hindu Kush, and in the eastern branches of Safed Koh. Rain also falls at this season at the head of Kurram valley. South of this the Sulimani mountains may be taken as the western limit of the monsoon's action. It is quite unfelt in the rest of Afghanistan, in which, as in all the west of Asia, the winter rains are the most considerable. The spring rain, though less copious, is more important to agriculture than the winter rain, unless where the latter falls in the form of snow. Speaking generally, the Afghanistan climate is a dry one. The sun shines with splendour for three-fourths of the year, and the nights are even more beautiful than the days. Marked characteristics are the great differences of summer and winter temperature and of day and night temperature, as well as the extent to which change of climate can be attained by slight change of place. As Baber again says of Kabul, at one day's journey from it you may find a place where snow never falls, and at two hours' journey, a place where snow almost never melts!

The Afghans vaunt the salubrity and charm of some local climates, as of the Tobah hills above the Kakar country, and of some of the high valleys of the Safed Koh.

The people have by no means that immunity from disease which the bright dry character of the climate and the fine physical aspect of a large proportion of them might lead us to expect. Intermittent and remittent fevers are very prevalent: bowel complaints are common, and often fatal in the autumn. The universal custom of sleeping on the house-top in summer promotes rheumatic and neuralgic affections; and in the Koh Daman of Kabul, which the natives regard as having the finest of climates, the mortality from fever and bowel complaint, between July and October, is great; the immoderate use of fruit predisposing to such ailments. Stone is frequent; eye disease is very common, as are hæmorrhoidal affections and syphilitic diseases in repulsive forms. A peculiar skin disease of syphilitic origin prevails at Kandahar, and native physicians there are said by Bellew to admit that hardly one person in twenty is free from the taint in some form.

NATURAL PRODUCTIONS—*Minerals*.—Afghanistan is believed to be rich in minerals, but few are wrought. Some small quantity of gold is taken from the streams in Laghman and the adjoining districts. Famous silver mines were formerly wrought near the head of the Panjshir valley, in Hindu Kush. Iron of excellent quality is pro-

duced in the (independent) territory of Bajaur, north-west of Peshawar, from magnetic iron sand, and is exported. Kabul is chiefly supplied from the Permûli (or Farmûli) district, between the Upper Kurram and Gomal, where it is said to be abundant. Iron ore is most abundant near the passes leading to Bamian, and in other parts of Hindu Kush. Copper ore from various parts of Afghanistan has been seen, but it is nowhere worked.

Lead is found, *e.g.*, in Upper Bangash (Kurram district), and in the Shinwari country (also among the branches of Safed Koh), and in the Kakar country. There are reported to be rich lead mines near Herat scarcely worked. Lead, with antimony, is found near the Arghand-ab, 32 miles north-west of Kala't-i-Ghilzai; in the Wardak hills, 24 miles north of Ghazni; in the Ghorband valley, north of Kabul; and in the Afridi country, near our frontier. Most of the lead used, however, comes from the Hazara country, where the ore is described as being gathered on the surface. An ancient mine of great extent and elaborate character exists at Feringal, in the Ghorband valley. Antimony is obtained in considerable quantities at Shah-Maksud, about 30 miles north of Kandahar.

Silicate of zinc in nodular fragments comes from the Zhob district of the Kakar country. It is chiefly used by cutlers for polishing.

Sulphur is said to be found at Herat, dug from the soil in small fragments, but the chief supply comes from the Hazara country, and from Pirkisri, on the confines of Seistan, where there would seem to be a crater, or fumarole. Sal-ammoniac is brought from the same place. Gypsum is found in large quantities in the plain of Kandahar, being dug out in fragile coralline masses from near the surface.

Coal (perhaps lignite) is said to be found in Zurmat (between the Upper Kurram and the Gomal) and near Ghazni.

Nitre abounds in the soil over all the south-west of Afghanistan, and often affects the water of the *kârez*, or subterranean canals.

VEGETABLE KINGDOM.[1]—The characteristic distribution of vegetation on the mountains of Afghanistan is worthy of attention. The great mass of it is confined to the main ranges and their immediate offshoots, whilst on the more distant and terminal prolongations it is almost entirely absent; in fact, these are naked rock and stone.

Take, for example, the Safed Koh. On the alpine range itself and its immediate branches, at a height of 6000 to 10,000 feet, we have abundant growth of large forest trees, among which conifers are the most noble and prominent, such as *Cedrus Deodara*, *Abies excelsa*, *Pinus longifolia*, *P. Pinaster*, *P. Pinea* (the edible pine), and the larch. We have also the yew, the hazel, juniper, walnut, wild peach, and almond. Growing under the shade of these are several varieties of rose, honeysuckle, currant, gooseberry, hawthorn, rhododendron, and a luxuriant herbage, among which the ranunculus family is important for frequency and number of genera. The lemon and wild vine are also here met with, but are more common on the northern mountains. The walnut and oak (evergreen, holly-leaved, and kermes) descend to the secondary heights, where they become mixed with alder, ash, khinjak, *Arbor-vitæ*, juniper, with species of *Astragalus*, &c. Here also are *Indigoferæ* and dwarf laburnum.

Lower again, and down to 3000 feet, we have wild olive, species of rock-rose, wild privet, acacias and mimosas, barberry, and *Zizyphus;* and in the eastern ramifications of the chain, *Chamærops humilis* (which is applied to a variety of useful purposes), *Bignonia* or trumpet flower, sissu, *Salvadora persica*, verbena, acanthus, varieties of *Gesneræ*.

The lowest terminal ridges, especially towards the west, are, as has been said, naked in aspect. Their scanty vegetation is almost wholly herbal; shrubs are only occasional; trees almost non-existent. Labiate, composite, and umbelliferous plants are most common. Ferns and mosses are almost confined to the higher ranges

[1] Chiefly from Bellew.

In the low brushwood scattered over portions of the dreary plains of the "Khorasan" table-lands, we find leguminous thorny plants of the papilionaceous sub-order, such as camel-thorn (*Hedysarum Alhagi*), *Astragalus* in several varieties, spiny rest-harrow (*Ononis spinosa*), the fibrous roots of which often serve as a tooth-brush; plants of the sub-order *Mimoseæ*, as the sensitive mimosa; a plant of the Rue family, called by the natives *lipâd;* the common wormwood; also certain orchids, and several species of *Salsola*. The rue and wormwood are in general use as domestic medicines—the former for rheumatism and neuralgia; the latter in fever, debility, and dyspepsia, as well as for a vermifuge. The *lipad*, owing to its heavy nauseous odour, is believed to keep off evil spirits. In some places, occupying the sides and hollows of ravines, are found the rose bay (*Nerium Oleander*), called in Persian *khar-zarah*, or assbane, the wild laburnum, and various *Indigoferæ*.

In cultivated districts the chief trees seen are mulberry, willow, poplar, ash, and occasionally the plane; but these are due to man's planting.

Uncultivated Products of Value.—One of the most important of these is the gum-resin of *Narthex assafœtida*, which grows abundantly in the high and dry plains of Western Afghanistan, especially between Kandahar and Herat. The depot for it is Kandahar, whence it finds its way to India, where it is much used as a condiment. It is not so used in Afghanistan, but the Seistan people eat the green stalks of the plant preserved in brine. The collection of the gum-resin is almost entirely in the hands of the Kakar clan of Afghans.

In the highlands of Kabul edible rhubarb is an important local luxury. The plants grow wild in the mountains. The bleached rhubarb, which has a very delicate flavour, is altered by covering the young leaves, as they sprout from the soil, with loose stones or an empty jar. The leaf-stalks are gathered by the neighbouring hill people, and carried down for sale. Bleached and unbleached rhubarb are both largely consumed, both raw and cooked.

The walnut and edible pine-nut are both wild growths, which are exported.

The *sanjît* (*Elæagnus orientalis*), common on the banks of water-courses, furnishes an edible fruit. An orchis found in the mountains yields the dried tuber which affords the nutritious mucilage called *salep;* a good deal of this goes to India.

Pistacia khinjak affords a mastic. The fruit, mixed with its resin, is used for food by the Achakzais in Southern Afghanistan. The true pistachio is found only on the northern frontier; the nuts are imported from Badakhshan and Kunduz.

Mushrooms and other fungi are largely used as food, especially by the Hindus of the towns, to whom they supply a substitute for meat.

Manna, of at least two kinds, is sold in the bazaars. One, called *turanjbîn*, appears to exude, in small round tears, from the camel-thorn, and also from the dwarf tamarisk; the other, *sir-kasht*, in large grains and irregular masses, or cakes, with bits of twig imbedded, is obtained from a tree which the natives call *siah chob* (black wood), thought by Bellew to be a *Fraxinus* or *Ornus*.

AGRICULTURE.—In most parts of the country there are two harvests, as generally in India. One of these, called by the Afghans *bahârak*, or the spring crop, is sown in the end of autumn, and reaped in summer. It consists of wheat, barley, and a variety of lentils. The other, called *pâizah* or *tîrmâi*, the autumnal, is sown in the end of spring, and reaped in autumn. It consists of rice, varieties of millet and sorghum, of maize, *Phaseolus Mungo*, tobacco, beet, turnips, &c. The loftier regions have but one harvest.

Wheat is the staple food over the greater part of the country. Rice is largely distributed, but is most abundant in Swat (independent), and best in Peshawar (British). It is also the chief crop in Kurram. In much of the eastern mountainous country *bâjra* (*Holcus spicatus*) is the chief grain. Most English and Indian garden-stuffs are cultivated; turnips in some places very largely, as cattle food.

The growth of melons, water-melons, and other cucurbitaceous plants is reckoned very important, especially near towns; and this crop counts for a distinct harvest.

Sugar-cane is grown only in the rich plains; and though cotton is grown in the warmer tracts, most of the cotton cloth is imported.

Madder is an important item of the spring crop in Ghazni and Kandahar districts, and generally over the west, and supplies the Indian demand. It is said to be very profitable, though it takes three years to mature.

Saffron is grown and exported. The castor-oil plant is everywhere common, and furnishes most of the oil of the country. Tobacco is grown very generally; that of Kandahar has much repute, and is exported to India and Bokhara. Two crops of leaves are taken.

Lucerne and a trefoil called *shaftal* form important fodder crops in the western parts of the country, and, when irrigated, are said to afford ten or eleven cuttings in the season. The *komal* (*Prangos pabularia*) is abundant in the hill country of Ghazni, and is said to extend through the Hazara country to Herat. It is stored for winter use, and forms an excellent fodder. Others are derived from the *Holcus sorghum*, and from two kinds of panick. It is common to cut down the green wheat and barley before the ear forms, for fodder, and the repetition of this, with barley at least, is said not to injure the grain crop. Bellew gives the following statement of the manner in which the soil is sometimes worked in the Kandahar district:—Barley is sown in November; in March and April it is twice cut for fodder; in June the grain is reaped, the ground is ploughed and manured, and sown with tobacco, which yields two cuttings. The ground is then prepared for carrots and turnips, which are gathered in November or December.

Of great moment are the fruit crops. All European fruits are produced profusely, in many varieties, and of excellent quality. Fresh or preserved, they form a principal food of a large class of the people, and the dry fruit is largely exported. In the valleys of Kabul, mulberries are dried, and packed in skins for winter use. This mulberry cake is often reduced to flour, and used as such, forming in some valleys the main food of the people.

Grapes are grown very extensively, and the varieties are very numerous. The vines are sometimes trained on trellises, but most frequently over ridges of earth 8 or 10 feet high. The principal part of the garden lands in villages round Kandahar is vineyard, and the produce must be enormous.

Open canals are usual in the Kabul valley, and in eastern Afghanistan generally; but over all the western parts of the country much use is made of the *karez*, which is a subterranean aqueduct uniting the waters of several springs, and conducting their combined volume to the surface at a lower level. Elphinstone had heard of such conduits 36 miles in length.

Animal Kingdom.—As regards vertebrate zoology, Afghanistan lies on the frontier of three regions, viz., the *Eurasian*, the *Ethiopian* (to which region Biluchestan seems to belong), and the *Indo-Malayan*. Hence it naturally partakes somewhat of the forms of each, but is in the main *Eurasian*.

Mammals.—Monkeys are stated by Mr Bellew to exist in Yusufzai, and perhaps extend to some other districts north of the Kabul river; but no species has been named.

Felidæ.—*F. catus*, *F. chaus* (both Eurasian); *F. caracal* (Eur., Ind., Ethiop.), about Kandahar; a small leopard, stated to be found almost all over the country, perhaps rather the cheeta (*F. jubatus*, Ind. and Eth.); *F. pardus*, the common leopard (Eth. and Ind.) The tiger is said to exist in the north-eastern hill country, which is quasi-Indian.

Canidæ.—The jackal (*C. aureus*, Euras., Ind., Eth.) abounds on the Helmand and Argand-ab, and probably elsewhere. Wolves (*C. Bengalensis*) are formidable in the wilder tracts, and assemble in troops on the snow, destroying cattle, and sometimes attacking single horsemen. The hyæna (*H. striata*, Africa to India) is common. These do not hunt in packs, but will sometimes singly attack a bullock: they and the wolves make havoc among sheep. A favourite feat of the boldest of the young men of southern Afghanistan is to enter the hyæna's den, single-handed, muffle and tie him. There are wild dogs, according to Elphinstone and Conolly. The small Indian fox (*Vulpes Bengalensis*) is found; also *V. flavescens*, common to India and Persia, the skin of which is much used as a fur.

Mustelidæ.—Species of Mungoose (*Herpestes*), species of otter, *Mustela erminea*, and two ferrets, one of them with tortoise-shell marks, tamed by the Afghans to keep down vermin; a marten (*M. flavigula*, Indian).

Bears are two: a black one, probably *Ursus torquatus;* and one of a dirty yellow, *U. Isabellinus*, both Himalyan species.

Ruminants.—*Capra ægagrus* and *C. megaceros;* a wild sheep (*Ovis cycloceros* or *Vignei*); *Gazella subgutturosa*—these are often netted in batches when they descend to drink at a stream; *G. dorcas*, perhaps; *Cervus Wallichii*, the Indian barasingha, and probably some other Indian deer, in the north-eastern mountains.

The wild hog (*Sus scrofa*) is found on the Lower Helmand. The wild ass, *Gorkhar* of Persia (*Equus onager*), is frequent on the sandy tracts in the south-west. Neither elephant nor rhinoceros now exists within many hundred miles of Afghanistan; but there is ample evidence that the latter was hunted in the Peshawar plain down to the middle of the 16th century.

Talpidæ.—A mole, probably *T. Europæa; Sorex Indicus; Erinaceus collaris* (Indian), and *Er. auritus* (Eurasian).

Bats, believed to be *Phyllorhinus cineraceus* (Panjab species), *Scotophilus Bellii* (W. India), *Vesp. auritus* and *V. barbastellus*, both found from England to India.

Rodentia.—A squirrel (*Sciurus Syriacus?*); *Mus Indicus* and *M. Gerbillinus;* a gerboa (*Dipus telum?*); *Alactaga Bactriana; Gerbillus Indicus*, and *G. erythrinus* (Persian and Indian); *Lagomys Nepalensis*, a central Asian species. A hare, probably *L. ruficaudatus.*

Birds.—The largest list of Afghan birds that we know of is given by Captain Hutton in the *J. As. Soc. Bengal*, vol. xvi. p. 775, *seqq.;* but it is confessedly far from complete. Of 124 species in that list, 95 are pronounced to be Eurasian, 17 Indian, 10 both Eurasian and Indian, 1 (*Turtur risorius*) Eur., Ind., and Eth.; and 1 only, *Carpodacus* (*Bucanetes*) *crassirostris*, peculiar to the country. Afghanistan appears to be, during the breeding season, the retreat of a variety of Indian and some African (desert) forms, whilst in winter the *avifauna* becomes overwhelmingly Eurasian.

Reptiles.—The following particulars are from Gray:—Lizards—*Pseudopus gracilis* (Eur.), *Argyrophis Horsfieldii, Salea Horsfieldii, Calotes Mariæ, C. versicolor, C. minor, C. Emma, Phrynocephalus Tickelii*—all Indian forms. A tortoise (*T. Horsfieldii*) appears to be peculiar to Kabul. There are apparently no salamanders or tailed Amphibia. The frogs are partly Eurasian, partly Indian. And the same may be said of the fish; but they are as yet most imperfectly known.

Domestic Animals.—The camel is of a more robust and compact breed than the tall beast used in India, and is more carefully tended. The two-humped Bactrian camel is sometimes seen, but is not a native.

Horses form a staple export to India. The best of these, however, are brought from Maimana and other places on the Khorasan and Turkman frontier. The indigenous horse is the *yâbû*, a stout, heavy-shouldered animal, of about 14 hands high, used chiefly for burden, but also for riding. It gets over incredible distances at an ambling shuffle; but is unfit for fast work, and cannot stand excessive heat. The breed of horses was improving much under the Amir Dost Mahommed, who took much interest in it. Generally, colts are sold and worked too young.

The cows of Kandahar and Seistan give very large quantities of milk. They seem to be of the humped variety, but with the hump evanescent. Dairy produce is important in Afghan diet, especially the pressed and dried curd called *krût* (an article and name perhaps introduced by the Mongols).

There are two varieties of sheep, both having the fat tail. One bears a white fleece, the other a russet or black one. Much of the white wool is exported to Persia, and now largely to Europe by Bombay. Flocks of sheep are the main wealth of the nomad population, and mutton is the chief animal food of the nation. In autumn large numbers are slaughtered, their carcases cut up, rubbed with salt, and dried in the sun. The same is done with beef and camel's flesh.

The goats, generally black or parti-coloured, seem to be a degenerate variety of the shawl-goat.

The climate is found to be favourable to dog-breeding. Pointers are bred in the Kohistan of Kabul and above Jalalabad—large, heavy, slow-hunting, but fine-nosed and staunch; very like the old double-nosed Spanish pointer. There are greyhounds also, but inferior in speed

to second-rate English dogs. The *khandi* is another sporting dog, most useful, but of complex breed. He is often used for turning up quail and partridge to the hawk.

Industrial Products.—These are not important. Silk is produced in Kabul, Jalalabad, Kandahar, and Herat, and chiefly consumed in domestic manufactures, though the best qualities are carried to the Panjab and Bombay.

Excellent carpets—soft, brilliant, and durable in colour—are made at Herat. They are usually sold in India as Persian. Excellent felts and a variety of woven goods are made from the wool of the sheep, goat, and Bactrian camel. A manufacture, of which there is now a considerable export to the Panjab for the winter clothing of our irregular troops, besides a large domestic use, is that of the *postîn*, or sheepskin pelisse. The long wool remains on, and the skin is tanned yellow, with admirable softness and suppleness. Pomegranate rind is a chief material in the preparation.

Rosaries are extensively made at Kandahar from a soft crystallised silicate of magnesia (chrysolite). The best are of a semi-transparent straw colour, like amber. They are largely exported, especially to Mecca.

Trade.—Practically, there are no navigable rivers in Afghanistan, nor does there exist any wheeled carriage. Hence goods are carried on beasts of burden, chiefly camels, along roads which often lie through close and craggy defiles, and narrow stony valleys among bare mountains, or over waste plains. Though from time immemorial the larger part of the products of India destined for western Asia and Europe has been exported by sea, yet at one time valuable caravans of these products, with the same destination, used to traverse these rugged Afghan roads.

The great trade routes are the following:—

1. From Persia by Mesh'hed to Herat.
2. From Bokhara by Merv to Herat.
3. From the same quarter by Karshi, Balkh, and Khulm, to Kabul.
4. From the Panjab by Peshawar and the Tatara or Abkhanah Passes to Kabul.
5. From the Panjab by the Ghawalâri Pass towards Ghazni.
6. From Sind by the Bolan Pass to Kandahar.

There is also a route from eastern Turkistan by Chitral to Jalalabad, or to Peshawar by Dîr; but it is doubtful how far there is any present traffic by it.

Towards Sind the chief exports from or through Afghanistan are wool, horses, silk, fruit, madder, and assafœtida. The staple of local production exported from Kandahar is dried fruit. The horse trade in this direction is chiefly carried on by the Syads of Pishin, Kakars, Bakhtiyaris, and Biluchis. The Syads also do, or did, dabble largely in slave-dealing. The Hazaras furnished the largest part of the victims.

Burnes's early anticipation of a large traffic in wool from the regions west of the Indus has been amply verified, for the trade has for many years been of growing importance; and in 1871–72 2,000,000 ℔ were shipped from Karâchi. The importation to Sind is chiefly in the hands of Shikarpûr merchants. Indeed, nearly all the trade from southern Afghanistan is managed by Hindus. That between Mesh'hed, Herat, and Kandahar is carried on by Persians, who bring down silk, arms, turquoises, horses, carpets, &c., and take back wool, skins, and woollen fabrics.

The chief imports by Peshawar from India into Afghanistan are cotton, woollen, and silk goods; from England, coarse country cloths, sugar and indigo, Benares brocades, gold thread and lace, scarves, leather, groceries, and drugs. The exports are raw silk and silk fabrics of Bokhara, gold and silver wire (Russian), horses, almonds and raisins, and fruits generally, furs (including dressed fox skins and sheep skins), and bullion.

The trade with India was thus estimated in 1862:—

	Exports to India.	Imports from India.	Totals.
By Peshawar............	£156,513	£120,643	£277,156
By Ghawalari Pass.....	130,000	164,000	294,000
By Bolan Pass..........	31,870	18,892	50,762
	£318,383	£303,535	£621,918

But this omits some passes, and the Bolan exports do not include the large item of wool which enters Sind further south.

A relic of the old times of Asiatic trade has come down to our day in the habits of the class of Lohâni Afghan traders, commonly called *Povindahs*, who spend their lives in carrying on traffic between India, Khorasan, and Bokhara, by means of their strings of camels and ponies, banded in large armed caravans, in order to restrict those recurring exactions that would render trade impossible. Bullying, fighting, evading, or bribing, they battle their way twice a year between Bokhara and the Indus. Their summer pastures are in the highlands of Ghazni and Kala't-i-Ghilzai. In the autumn they descend the Sulimani passes. At the Indus, in these days, they have to deposit all weapons; but once across that, they are in security. They leave their families and their camels in the Panjab plains, and take their goods by rail to all the Gangetic cities, or by boat and steamer to Karachi and Bombay. Even in Asam or in distant Rangoon the Povindah is to be seen, pre-eminent by stature and by lofty air, not less than by rough locks and filthy clothes. In March they rejoin their families, and move up again to the Ghilzai highlands, sending on caravans anew to Kabul, Bokhara, Kandahar, and Herat, the whole returning in time to accompany the tribe down the passes in the autumn. The Povindah trade by all the passes is now estimated to reach £1,500,000 in value annually.

Inhabitants of Afghanistan.—These may first be divided into Afghan and non-Afghan, of whom the Afghan people are predominant in numbers, power, and character.

The Afghans themselves do not recognise as entitled to that name all to whom we give it. According to Bellew they exclude certain large tribes, who seem, nevertheless, to be essentially of the same stock, speaking the same language, observing the same customs, and possessing the same moral and physical characteristics. These are recognised as *Pathâns*, but not as *Afghans*, and are all located in the vicinity of the Sulimani mountains and their offshoots towards the east. We do not attempt to name them, because the information on the subject seems contradictory. There are tribes of somewhat similar character elsewhere, such as the Wardaks, to the south of Kabul; and there are again some tribes, in contact with these and with Afghan tribes, who speak the Afghan language, and have many Afghan customs, but are different in aspect, and seem not to be regarded as Pathan at all. Such are the Tûris and Jâjis of Kurram.

Of the Afghans proper there are about a dozen great clans, with numerous subdivisions. Of the great clans the following are the most important:—

The *Durrânis*, originally called Abdalis, received the former name from a famous clansman, Ahmed Shah. Their country may be regarded as the whole of the south and south-west of the Afghan plateau.

The *Ghilzais* are the strongest of the Afghan clans, and perhaps the bravest. They were supreme in Afghanistan in the beginning of last century, and for a time possessed the throne of Ispahan. They occupy the high plateau north of Kandahar, and extend, roughly speaking, eastward to the Sulimani mountains, and north to the Kabul river (though in places passing these limits), and they extend down the Kabul river to Jalalabad. On the British

invasion the Ghilzais showed a rooted hostility to the foreigner, and great fidelity to Dost Mahommed, though of a rival clan. It is remarkable that the old Arab geographers of the 10th and 11th centuries place in the Ghilzai country a people called *Khilijis*, whom they call a tribe of *Turks*, to which belonged a famous family of Dehli kings. The probability of the identity of Khilijis and Ghilzais is obvious, and the question touches others regarding the origin of the Afghans, but it does not seem to have been gone into.

The *Yusufzais* occupy an extensive tract of hills and valleys north of Peshawar, including part of the Peshawar plain. Except those within our Peshawar district, they are independent; they are noted even among Afghans for their turbulence.

The *Kakars*, still retaining in great measure their independence, occupy a wide extent of elevated country in the south-east of Afghanistan, among the spurs of the Toba and Sulimani mountains, bordering on the Biluch tribes. But the region is still very imperfectly known.

Of the non-Afghan population associated with the Afghans, the *Tâjiks* come first in importance and numbers. They are intermingled with the Afghans over the country, though their chief localities are in the west. They are regarded as descendants of the original occupants of that part of the country, of the old Iranian race; they call themselves Parsiwân, and speak a dialect of Persian. They are a fine athletic people, generally fair in complexion, and assimilate in aspect, in dress, and much in manners to the Afghans. But they are never nomadic. They are mostly agriculturists, whilst those in towns follow mechanical trades and the like, a thing which the Afghan never does. They are generally devoid of the turbulence of the Afghans, whom they are content to regard as masters or superiors, and lead a frugal, industrious life, without aspiring to a share in the government of the country. Many, however, become soldiers in the Amir's army, and many enlist in our local Panjab regiments. They are zealous Sunnis. The Tajiks of the Daman-i-Koh of Kabul are said to be exceptional in turbulent and vindictive character.

The *Kizilbâshes* may be regarded as modern Persians, but more strictly they are Persianised Turks, like the present royal race and predominant class in Persia. They speak pure Persian. Their immigration dates only from the time of Nadir Shah (1737). They are chiefly to be found in towns as merchants, physicians, scribes, petty traders, &c., and are justly looked on as the more educated and superior class of the population. At Kabul they constitute the bulk of the Amir's cavalry and artillery. Many serve in our Indian regiments of irregular cavalry, and bear a character for smartness and intelligence, as well as good riding. They are Shîahs, and heretics in Afghan eyes.

It is to the industry of the Parsiwans and Kizilbashes that the country is indebted for whatever wealth it possesses, but few of them ever attain a position which is not in some degree subservient to the Afghan.

The *Hazâras* have their stronghold and proper home in the wild mountainous country on the north-west of Afghanistan proper, including those western extensions of Hindu Kush, to which modern geographers have often applied the ancient name of *Paropamisus*. In these their habitations range generally from a height of 5000 feet to 10,000 feet above the sea.

The Hazaras generally have features of Mongol type, often to a degree that we might call exaggerated, and there can be no doubt that they are mainly descended from fragments of Mongol tribes who came from the east with the armies of Chinghiz Khan and his family, though other races may be represented among the tribes called Hazaras. The Hazaras generally are said by Major Leech to be called *Moghals* by the Ghilzais; and one tribe, still bearing the specific name of Mongol, and speaking a Mongol dialect, is found near the head waters of the Murghab, and also further south on the skirts of the Ghur mountains. But it is remarkable that the Hazaras generally speak a purely Persian dialect. The Mongols of the host of Chinghiz were divided into *tomans* (ten thousands) and *hazaras* (thousands), and it is probably in this use of the word that the origin of its present application is to be sought. The oldest occurrence of this application that M. de Khanikoff has met with is in a rescript of Ghazan Khan of Persia, regarding the security of roads in Khorasan, dated A.H. 694 (A.D. 1294–95).

Though the Hazaras pay tribute to the Afghan chiefs, they never do so unless payment is enforced by arms. The country which they occupy is very extensive, embracing the upper valleys of the Arghand-ab and the Helmand, both sides of the main range of Hindu Kush, nearly as far east as the longitude of Andarâb, the hill country of Bamian, and that at the head waters of the Balkh river, the Murghab, and the Hari-Rud; altogether an area of something like 30,000 square miles. The Hazaras are accused of very loose domestic morals, like the ancient *Massagetæ*, and the charge seems to be credited, at least of certain tribes. They make good powder, are good shots, and, in spite of the nature of their country, are good riders, riding at speed down very steep declivities. They are said to have a *yodel* like the Swiss. They are often sold as slaves, and as such are prized. During the winter many spread over Afghanistan, and even into the Panjab, in search of work. Excepting near Ghazni, where they hold some lands and villages, the position of the Hazaras found in the proper Afghan country is a menial one. They are Shiahs in religion, with the exception of one fine tribe called the Zeidnat Hazaras, occupying the old territory of Badghîs, north of Herat.

Eimâk is a term for a sept or section of a tribe. It has come to be applied, much as *hazara*, to certain nomadic or semi-nomadic tribes west of the Hazaras of whom we have been speaking, and immediately north of Herat. These tribes, it is said, were originally termed "the four Eimaks." It is difficult in the present state of information regarding them, sometimes contradictory, to discern what is the broad distinction between the Eimaks and the Hazaras, unless it be that the Eimaks are predominantly of Iranian or quasi-Iranian blood, the Hazaras Turanian. The Eimaks are also Sunnis. Part of them are subject to Persia.

Hindkis.—This is the name given to people of Hindu descent scattered over Afghanistan. They are said to be of the *Kshatri* or military caste. They are occupied in trade; they are found in most of the large villages, and in the towns form an important part of the population, doing all the banking business of the country, and holding its chief trade in their hands. They pay a high poll-tax, and are denied many privileges, but thrive notwithstanding. The *Jats* of Afghanistan doubtless belong to the same vast race as the Jats and Jâts who form so large a part of the population of the territories now governed from Lahore and Karachi, and whose origin is so obscure. They are a fine athletic, dark, handsome race, considerable in numbers, but poor, and usually gaining a livelihood as farm-servants, barbers, sweepers, musicians, &c.

Bilûchis.—Many of these squat among the abandoned tracts on the lower Helmand; a fierce and savage people, professing Islam, but not observing its precepts, and holding the grossest superstitions; *vendetta* their most stringent law; insensible to privation, and singularly tolerant of heat; camel-like in capacity to do without drink; superior to the Afghans in daring and address, which are displayed in robber raids carried into the very heart of Persia.

There remain a variety of tribes in the hill country north of the Kabul river, speaking various languages, seemingly of *Prakritic* character, and known as Kohistanis, Laghmanis, Pashais, &c.; apparently converted remnants of the aboriginal tribes of the Kabul basin, and more or less kindred to the still unconverted tribes of Kafiristan, to the Chitral people, and perhaps to the Dard tribes who lie to the north of the Afghan country on the Indus.

An able officer of the staff in India (Col. Macgregor) has lately made a diligent attempt to estimate the population of Afghanistan, which he brings to 4,901,000 souls. This includes the estimated population of Afghan Turkestan, the people of Chitral, the Kafirs, and the independent Yusufzais. We shall deduct the three first:—

		4,901,000
Afghan Turkestan	642,000	
Chitralis and Kafirs	150,000	
		792,000
		4,109,000

which may be thus roughly divided—

Eimaks and Hazaras	400,000
Tajiks	500,000
Kizilbashes	150,000
Hindkis and Jats	500,000
Kohistanis, &c.	200,000
Afghans and Pathans, including 400,000 independent Yusufzais, &c.	2,359,000
Total	4,109,000

The Afghans, in government and general manners, have a likeness to other Mahommedan nations; but they have also many peculiarities.

Besides their division into clans and tribes, the whole Afghan people may be divided into dwellers in tents and dwellers in houses; and this division is apparently not coincident with tribal divisions, for of several of the great clans, at least a part is nomad and a part settled. Such, *e.g.*, is the case with the Durrani and with the Ghilzai.

Nomad Afghans exist in the Kabul basin, but their proper field is that part of their territory which the Afghans include in Khorasan, with its wide plains. These people subsist on the produce of their flocks, and rarely cultivate. They may, perhaps, pay something to the Kabul government through their chief, and they contribute soldiers to the regular army, besides forming the bulk of the militia; but they have little relation to the government, and seldom enter towns unless to sell their produce. They are under some indefinite control by their chiefs, to whom serious disputes are referred. Petty matters are settled by the "greybeards" of the community, guided by the Afghan traditional code. Many of the nomad tribes are professed and incorrigible thieves. Among certain tribes the ceremony of naming a male child is accompanied by the symbolical act of passing him through a hole made in the wall of a house, whilst a volley of musketry is fired overhead.[1]

The settled Afghans form the village communities, and in part the population of the few towns. Their chief occupation is with the soil. They form the core of the nation and the main part of the army. Nearly all own the land on which they live, and which they cultivate with their own hands or by hired labour. Roundly speaking, agriculture and soldiering are their sole occupations. No Afghan will pursue a handicraft or keep a shop, though, as we have seen, certain pastoral tribes engage largely in travelling trade and transport of goods.

As a race, the Afghans are very handsome and athletic, often with fair complexion and flowing beard, generally black or brown, sometimes, though rarely, red; the features highly aquiline. The hair is shaved off from the forehead to the top of the head, the remainder at the sides being allowed to fall in large curls over the shoulders. Their step is full of resolution; their bearing proud and apt to be rough.

The women have handsome features of Jewish cast (the last trait often true also of the men); fair complexions, sometimes rosy, though usually a pale sallow; hair braided and plaited behind in two long tresses terminating in silken tassels. They are rigidly secluded, but intrigue is frequent. In some parts of the country the engaged lover is admitted to visits of courtship, analogous to old Welsh customs.

The Afghans, inured to bloodshed from childhood, are familiar with death, and are audacious in attack, but easily discouraged by failure; excessively turbulent and unsubmissive to law or discipline; apparently frank and affable in manner, especially when they hope to gain some object, but capable of the grossest brutality when that hope ceases. They are unscrupulous in perjury, treacherous, vain, and insatiable, passionate in vindictiveness, which they will satisfy at the cost of their own lives and in the most cruel manner. Nowhere is crime committed on such trifling grounds, or with such general impunity, though when it is punished the punishment is atrocious. Among themselves the Afghans are quarrelsome, intriguing, and distrustful; estrangements and affrays are of constant occurrence; the traveller conceals and misrepresents the time and direction of his journey. The Afghan is by breed and nature a bird of prey. If from habit and tradition he respects a stranger within his threshold, he yet considers it legitimate to warn a neighbour of the prey that is afoot, or even to overtake and plunder his guest after he has quitted his roof. The repression of crime and the demand of taxation he regards alike as tyranny. The Afghans are eternally boasting of their lineage, their independence, and their prowess. They look on the Afghans as the first of nations, and each man looks on himself as the equal of any Afghan, if not as the superior of all others. Yet when they hear of some atrocious deed they will exclaim—"An Afghan job that!" They are capable of enduring great privation, but when abundance comes their powers of eating astonish an European Still, sobriety and hardiness characterise the bulk of the people, though the higher classes are too often stained with deep and degrading debauchery.

The first impression made by the Afghans is favourable. The European, especially if he come from India, is charmed by their apparently frank, open-hearted, hospitable, and manly manners; but the charm is not of long duration, and he finds that under this frank demeanour there is craft as inveterate, if not as accomplished, as in any Hindu.

Such is the character of the Afghans as drawn by Ferrier and other recent writers, and undoubtedly founded on their experience, though perhaps the dark colour is laid on too universally. The impression is very different from that left by the accounts of Elphinstone and Burnes. Yet most of the individual features can be traced in Elphinstone, though drawn certainly under less temptation to look on the darker side, owing to the favourable circumstances of his intercourse with the Afghans, and touched with a more delicate and friendly hand, perhaps lightened by wider sympathies. Sir H. Edwardes, who had intimate dealings with the Afghans for many years, takes special exception to Elphinstone's high estimate of their character, and appeals to the experience of every officer who had served in the country. "Nothing," he sums up, "is finer than their physique, or worse than their morale."

Many things in Afghan character point to a nation in decadence—the frank manners and joyous temper, the hospitable traditions, the martial and independent spirit, the love of field sports, the nobility of aspect, suggest a

[1] Of one tribe, at least, of which this is told, the Afghan blood is doubtful.

time when these were more than superficial and deceptive indications of character, and were not marred by greed and treacherous cruelty.

POLITICAL INSTITUTIONS.—The political institutions of the Afghans present the rude and disjointed materials of a free constitution. The nation is theoretically divided into four great stocks, supposed to spring from four brothers. But these four divisions are practically obsolete, and only come up in genealogies. Each tribe has split into several branches, and in the more numerous and scattered tribes these branches have separated, and each has its own chief. They retain, however, the common name, and an idea of community in blood and interests.

The type of the Afghan institutions is perhaps best seen in some of the independent tribes near the British frontier. These cling most closely to the democratic traditions. Their rude state of society is held together by a code as rude, which is acknowledged, however, and understood by every one, and enforced by the community, every member of which considers its infringement as an act committed against his own privileges. The *Maliks* or chiefs are the representatives of the tribe, division, or family to which they each belong, but they possess no independent power of action, and before they can speak in council, they must have collected the wishes of the bodies which they represent.

The men of the section (*kandi*) of a village, having come to a decision, send their representative to a council of the whole village, and these again to that of the sept (*khail*), and the appointed chiefs of the septs finally assemble as the council of the *ûlûs* or tribe. These meetings, in all their stages, are apt to be stormy. If persuasion and argument fail to produce unanimity, no further steps can be taken, unless one party be much the weaker, when sometimes the stronger side will forcibly extort assent. When once a council has decided, implicit compliance is incumbent on the tribe under heavy penalties, and the maliks have the power of enforcing these.

Justice is administered in the towns, more or less defectively, according to Mahommedan law, by a kâzi and muftis. But the unwritten code by which Afghan communities in their typical state are guided, and the maxims of which penetrate the whole nation, is the *Pukhtûnwali*, or usage of the Pathans, a rude system of customary law, founded on principles such as one might suppose to have prevailed before the institution of civil government.[1]

A prominent law in this code is that called *Nanawatai*, or "entering in." By this law the Pathan is bound to grant any boon claimed by the person who passes his threshold and invokes its sanctions, even at the sacrifice of his own life and property. So also the Pathan is bound to feed and shelter any traveller claiming hospitality. *Retaliation* must be exacted by the Pathan for every injury or insult, and for the life of a kinsman. If immediate opportunity fail, a man will dodge his foe for years, with the cruel purpose ever uppermost, using every treacherous artifice to entrap him. To omit such obligations, above all the *vendetta*, exposes the Pathan to scorn. The injuries of one generation may be avenged in the next, or even by remoter posterity. The relatives of a murdered man may, however, before the tribal council, accept a blood-price.

Crimes punished by the Pathan code are such as murder without cause, refusal to go to battle, contravention of the decision of a tribal council, adultery.

The Afghans are Mahommedans of the Sunni or orthodox body, with the exception of a few tribes, perhaps not truly Pathan, who are Shiahs. They are much under the influence of their Mullahs, especially for evil; and have a stronger feeling against the Shiah heretic than against the unbeliever; their aversion to the Persians being aggravated thereby. But to those of another faith they are more tolerant than most Mahommedans, unless when creed becomes a war-cry. They are very superstitious in regard to charms, omens, astrology, and so forth; and greatly addicted to the worship of local saints, whose shrines (*ziyârat*) are found on every hill-top. The shrine, a domed tomb, or mayhap a heap of stones within a wall, sometimes marks the saint's grave, but is often a cenotaph. The saint may have been unknown in life for his virtues, but becomes after death an object of veneration, for reasons often hard to discern. In the immediate environs of Ghazni there are no less than 197 of these shrines.

A very marked feature in Afghan character is the passionate love of field sports, especially hawking. Deer-stalking in the open plains, the driving of game to well-known points by a host of beaters, and wild-fowl shooting with decoys, are others of their sports. They are capital horsemen, and unerring marksmen with the native rifle (*jezail*).

Among themselves the people are convivial and humorous. Festive gatherings are frequent, where they come together, not to buy or sell, or even to quarrel, but to make a noise and be happy. Tilting, shooting, racing, and wild music vary the amusements.

They have a wild dance called the *âtan*, in which the men work themselves into great excitement. Among some Kakar tribes it is said the atan is sometimes danced by both sexes together.

GOVERNMENT.—Afghanistan is now, and has been before, under one prince, but it is hardly a monarchy as we are used to understand the term. It is rather the government of a dictator for life over a military aristocracy, and within this a congeries of small democracies. Elphinstone compares it with Scotland in the middle ages; some things suggest a comparison with Poland, in spite of difference of physical geography; but in neither was there the democratic constitution of the Afghan *ulus*. The sirdars govern in their respective districts, each after his own fashion; jealous, ambitious, turbulent, the sovereign can restrain them only by their divisions. There is no unity nor permanence; everything depends on the pleasure of a number of chiefs bound by no law, always at variance, and always ready to revolt when they have the slightest interest in doing so—almost always ready to plunge into strife with a wild delight in it for its own sake. In war, as in peace, chiefs and soldiers are ready to pass from one service to another without scruple. It is a matter of speculation, and no disgrace.

The spirit of Afghan character and institutions was tersely expressed by an old man to Elphinstone, who had urged the advantages of quiet and security under a strong king: "We are content with discord, we are content with alarms, we are content with blood; but we will never be content with a master."

REVENUES.—The revenues of Dost Mahommed Khan were estimated in 1857 at 4,000,000 rupees, or about £400,000. This included Afghan Turkestan, but not Herat, which he did not hold. The Herat revenue was estimated some years before (probably too low) at £80,000. In the later years of Dost Mahommed the net revenue is stated to have amounted to £710,000, of which the army cost £430,000.[1] Information on this subject is very imperfect, and not always consistent. There seems to be a tax on the produce of the soil, both in kind and in money, and a special tax on garden ground. A house-tax of about 5 rupees is paid by all who are not Pathans. The latter pay a much lighter tax under another name; and

[1] Elphinstone.

[1] See *Edin. Review*, July 1873, p. 273.

the Hindus pay the separate poll-tax (*jazeya*). Taxes are paid on horses, &c., kept, and on the sale of animals in the public market.

The aggregate of taxation is not great, but the smallest exaction seems a tyrannical violence to an Afghan. Nor does payment guarantee the cultivator from further squeezing. In many parts of the country collections are only made spasmodically by military force. The people are let alone for years, till need and opportunity arise, when a force is marched in, and arrears extorted.

Customs dues at Kabul and Kandahar are only 2½ per cent. nominally, but this is increased a good deal by exactions. There is a considerable tax on horses exported for sale, and a toll on beasts of burden exporting merchandise, from 6 rupees on a loaded camel to 1 rupee on a donkey.

MILITARY FORCE.—According to the old system the Afghan forces were entirely composed of the *ulus*, or tribesmen of the chiefs, who were supposed to hold their lands on a condition of service, but who, as frequently as not, went over to the enemy in the day of need. As a counterpoise, the late Amir Dost Mahommed began to form a regular army. In 1858 this contained 16 infantry regiments of (nominally) 800 men, 3 of cavalry of 300 men, and about 80 field-pieces, besides a few heavy guns. The pay was bad, and extremely irregular, and punishments were severe. The men were fine, but recruited in the worst manner, viz., the arbitrary and forcible seizure of able-bodied men. There were also *Jezailchi* (riflemen), irregulars, some in the Amir's pay, others levies of the local chiefs; and a considerable number of irregular cavalry. We have failed to obtain recent data on this subject.

LANGUAGE AND LITERATURE.—Persian is the vernacular of a large part of the non-Afghan population, and is familiar to all educated Afghans. But the proper language of the Afghans is *Pushtû*, or *Pukhtû* (these are dialectic variations). Currency has been given to the notion that this language has a Semitic character, but this appears to be quite erroneous, and is entirely rejected by competent authorities, the majority of whom class Pushtu positively as an Aryan or Indo-Persian language. The Pushtu vocabulary preserves a number of ancient forms and connections with words that remain isolated in other Aryan languages. Interesting illustrations of this and other points connected with Pushtu will be found in a paper by Isidor Löwenthal in the *J. of the As. Soc. of Bengal*, vol. xxix.

Pushtu does not seem to be spoken in Herat, or (roughly speaking) west of the Helmand.

There is a respectable amount of Afghan literature. The oldest work in Pushtu as yet mentioned is a history of the conquest of Swat by Shaikh Mâli, a chief of the Yûsufzais, and leader in the conquest (A.D. 1413–24). In 1494 Kâjû Khan became chief of the same clan; during his rule Buner and Panjkora were completely conquered, and he wrote a history of the events. But these works have not been met with. In the reign of Akbar, Bayazîd Ansâri, called Pîr-i-Roshan, "The Saint of Light," the founder of an heretical sect, wrote in Pushtu; as did his chief antagonist, a famous Afghan saint called Akhund Darweza.

The literature is richest in poetry. Abdarrahmân (17th century) is the best known poet. Another very popular poet is Khushâl Khan, the warlike chief of the Khattaks in the time of Aurangzîb. Many other members of his family were poets also. Ahmed Shah, the founder of the monarchy, likewise wrote poetry. Ballads are numerous.

HISTORY.—The Afghan chroniclers call their people *Bani-Israil* (Arab. for Children of Israel), and claim descent from King Saul (whom they call by the Mahommedan corruption *Tâlût*) through a son whom they ascribe to him, called Jeremiah, who again had a son called Afghâna. The numerous stock of Afghana were removed by Nebuchadnezzar, and found their way to the mountains of Ghur and Feroza (east and north of Herat). Only nine years after Mahommed's announcement of his mission they heard of the new prophet, and sent to Medina a deputation headed by a wise and holy man called Kais, to make inquiry. The deputation became zealous converts, and on their return converted their countrymen. From Kais and his three sons the whole of the genuine Afghans claim descent.

This story is repeated in great and varying detail in sundry books by Afghans, the oldest of which appears to be of the 16th century; nor do we know that any trace of the legend is found of older date. In the version given by Major Raverty (Introd. to *Afghan Grammar*), Afghanah is settled by King Solomon himself *in the Sulimani mountains;* there is nothing about Nebuchadnezzar or Ghur. The historian Firishta says he had read that the Afghans were descended from Copts of the race of Pharaoh. And one of the Afghan histories, quoted by Mr Bellew, relates "a current tradition" that previous to the time of Kais, *Bilo* the father of the Biluchis, *Uzbak* (evidently the father of the Uzbegs), and *Afghana* were considered as brethren. As Mahommed Uzbeg Khan, the *eponymus* of the medley of Tartar tribes called Uzbegs, reigned in the 14th century A.D., this gives some possible light on the value of these so-called traditions.

We have analogous stories in the literature of almost all nations that derive their religion or their civilisation from a foreign source. To say nothing of the farce of the *Book of Mormon*, there is in our own age and in our own country a considerable number of persons who seriously hold and propagate the doctrine that the English people are descended from the tribes of Israel, and the literature of this whimsical theory would fill a much larger shelf than the Afghan histories. But the Hebrew ancestry of the Afghans is more worthy at least of consideration, for a respectable number of intelligent officers, well acquainted with the Afghans, have been strong in their belief of it; and though the customs alleged in proof will not bear the stress laid on them, undoubtedly a prevailing type of the Afghan physiognomy has a character strongly Jewish. This characteristic is certainly a remarkable one; but it is shared, to a considerable extent, by the Kashmîris (a circumstance which led Bernier to speculate on the Kashmiris representing the lost tribes of Israel), and, we believe, by the Tajik people of Badakhshan.

In the time of Darius Hystaspes (B.C. 500) we find the region now called Afghanistan embraced in the Achæmenian satrapies, and various parts of it occupied by *Sarangians* (in Seistan), *Arian* (in Herat), *Sattagydians* (supposed in highlands of upper Helmand and the plateau of Ghazni), *Dadicæ* (suggested to be Tajiks), *Aparytæ* (mountaineers, perhaps of Safed Koh, where lay the *Paryetæ* of Ptolemy), *Gandarii* (in Lower Kabul basin), and *Paktyes*, on or near the Indus. In the last name it has been plausibly suggested that we have the *Pukhtun*, as the eastern Afghans pronounce their name. Indeed, *Pusht*, *Pasht*, or *Pakht*, would seem to be the oldest name of the country of the Afghans in their traditions.

Alexander's march led him to *Artacoana* (Herat ?), the capital of *Aria*, and thence to the country of the *Zarangæ* (Seistan), to that of the *Euergetæ*, upon the *Etymander* (Helmand river), to *Arachosia*, thence to the *Indians* dwelling among snows in a barren country, probably the highlands between Ghazni and Kabul. Thence he marched to the foot of Caucasus, and spent the winter among the *Paropamisadæ*, founding a city, *Alexandria*, supposed to be Hupian, near Charikar. On his return from Bactria he prosecuted his march to India by the north side of the Kabul river.

The *Ariana* of Strabo corresponds generally with the existing dominions of Kabul, but overpasses their limits on the west and south.

About 310 B.C. Seleucus is said by Strabo to have given to the Indian Sandrocottus (Chandragupta), in consequence of a marriage

contract, some part of the country west of the Indus, occupied by an Indian population, and no doubt embracing a part of the Kabul basin. Some 60 years later occurred the establishment of an independent Greek dynasty in Bactria. Of the details of their history and extent of their dominion in different reigns we know almost nothing, and conjecture is often dependent on such vague data as are afforded by the collation of the localities in which the coins of independent princes have been found. But their power extended certainly over the Kabul basin, and probably, at times, over the whole of Afghanistan. The ancient architecture of Kashmir, the tope of Manikyala in the Panjab, and many sculptures found in the Peshawar valley, show unmistakable Greek influence. Demetrius (*circa* B.C. 190) is supposed to have reigned in Arachosia after being expelled from Bactria, much as, at a later date, Baber reigned in Kabul after his expulsion from Samarkand. Eucratides (181 B.C.) is alleged by Justin to have warred in India. With his coins, found abundantly in the Kabul basin, commences the use of an Arianian inscription, in addition to the Greek, supposed to imply the transfer of rule to the south of the mountains, over a people whom the Greek dynasty sought to conciliate. Under Heliocles (147 B.C. ?), the Parthians, who had already encroached on Ariana, pressed their conquests into India. Menander (126 B.C.) invaded India at least to the Jumna, and perhaps also to the Indus delta. The coinage of a succeeding king, Hermæus, indicates a barbaric irruption. There is a general correspondence between classical and Chinese accounts of the time when Bactria was overrun by Scythian invaders. The chief nation among these, called by the Chinese *Yuechi*, about 126 B.C. established themselves in Sogdiana and on the Oxus in five hordes. Near the Christian era the chief of one of these, which was called Kushan, subdued the rest, and extended his conquests over the countries south of Hindu Kush, including Sind as well as Afghanistan, thus establishing a great dominion, of which we hear from Greek writers as Indo-Scythia.

Buddhism had already acquired influence over the people of the Kabul basin, and some of the barbaric invaders adopted that system. Its traces are extensive, especially in the plains of Jalalabad and Peshawar, but also in the vicinity of Kabul.

Various barbaric dynasties succeeded each other, among which a notable monarch was Kanishka or Kanerkes, who reigned and conquered apparently about the time of Our Lord, and whose power extended over the upper Oxus basin, Kabul, Peshawar, Kashmir, and probably far into India. His name and legends still filled the land, or at least the Buddhist portion of it, 600 years later, when the Chinese pilgrim Hwen Thsang travelled in India; they had even reached the great Mahommedan philosopher, traveller, and geographer, Abu Rihân Al-Birûni, in the 11th century; and they are still celebrated in the Mongol versions of Buddhist ecclesiastical story.

In the time of Hwen Thsang (630-45 A.D.) there were both Indian and Turk princes in the Kabul valley, and in the succeeding centuries both these races seem to have predominated in succession. The first Mahommedan attempts at the conquest of Kabul were unsuccessful, though Seistan and Arachosia were permanently held from an early date. It was not till the end of the 10th century that a Hindu prince ceased to reign in Kabul, and it fell into the hands of the Turk Sabaktegin, who had established his capital at Ghazni. There, too, reigned his famous son Mahmûd, and a series of descendants, till the middle of the 12th century, rendering the city one of the most splendid in Asia. We then have a powerful dynasty, commonly believed to have been of Afghan race; and if so, the first. But the historians give them a legendary descent from Zohâk, which is no Afghan genealogy. The founder of the dynasty was Alâuddin, chief of Ghur, whose vengeance for the cruel death of his brother at the hands of Bahram the Ghaznevide was wreaked in devastating the great city. His nephew Shahâbuddîn Mahommed repeatedly invaded India, conquering as far as Benares. His empire in India indeed—ruled by his freedmen who after his death became independent—may be regarded as the origin of that great Mahommedan monarchy which endured nominally till 1857. For a brief period the Afghan countries were subject to the king of Kharizm, and it was here chiefly that occurred the gallant attempts of Jalaluddin of Kharizm to withstand the progress of Chinghiz Khan.

A passage in Firishta seems to imply that the Afghans in the Sulimani mountains were already known by that name in the first century of the Hegira, but it is uncertain how far this may be built on. The name *Afghans* is very distinctly mentioned in 'Utbi's *History of Sultan Mahmud*, written about A.D. 1030, coupled with that of the *Khiljis*. It also appears frequently in connection with the history of India in the 13th and 14th centuries. The successive dynasties of Dehli are generally called *Pathan*, but were really so only in part. Of the *Khiljis* (1288-1321) we have already spoken. The Tughlaks (1321-1421) were originally Tartars of the Karauna tribe. The Lodis (1450-1526) were pure Pathans. For a century and more after the Mongol invasion the whole of the Afghan countries were under Mongol rule; but in the middle of the 14th century a native dynasty sprang up in western Afghanistan, that of the *Kurts*, which extended its rule over Ghur, Herat, and Kandahar. The history of the Afghan countries under the Mongols is obscure; but that régime must have left its mark upon the country if we judge from the occurrence of frequent Mongol names of places, and even of Mongol expressions adopted into familiar language.

All these countries were included in Timur's conquests, and Kabul at least had remained in the possession of one of his descendants till 1501, only three years before it fell into the hands of another and more illustrious one, Sultan Baber. It was not till 1522 that Baber succeeded in permanently wresting Kandahar from the Arghuns, a family of Mongol descent, who had long held it. From the time of his conquest of Hindustan (victory at Panipat, April 21, 1526), Kabul and Kandahar may be regarded as part of the empire of Dehli under the (so-called) Moghul dynasty which Baber founded. Kabul so continued till the invasion of Nadir (1738). Kandahar often changed hands between the Moghuls and the rising Safavis (or Sofis) of Persia. Under the latter it had remained from 1642 till 1708, when in the reign of Husain, the last of them, the Ghilzais, provoked by the oppressive Persian governor Shahnawâz Khan (a Georgian prince of the Bagratid house) revolted under Mir Wais, and expelled the Persians. Mir Wais was acknowledged sovereign of Kandahar, and eventually defeated the Persian armies sent against him, but did not long survive (*d.* 1715).

Mahmud, the son of Mir Wais, a man of great courage and energy, carried out a project of his father's, the conquest of Persia itself. After a long siege, Shah Husain came forth from Ispahan with all his court, and surrendered the sword and diadem of the Sofis into the hands of the Ghilzai (Oct. 1722). Two years later Mahmud died mad, and a few years saw the end of Ghilzai rule in Persia.

Nadir Shah (1737–38) both recovered Kandahar and took Kabul. But he gained the goodwill of the Afghans, and enrolled many in his army. Among these was a noble young soldier, Ahmed Khan, of the Saddozai family of the Abdali clan, who after the assassination of Nadir (1747) was chosen by the Afghan chiefs at Kandahar to be their leader, and assumed kingly authority over the eastern part of Nadir's empire, with the style of *Dur-i-Durrân*, "Pearl of the Age," bestowing that of *Durrani* upon his clan, the Abdalis. With Ahmed Shah, Afghanistan, as such, first took a place among the kingdoms of the earth. During the twenty-six years of his reign he carried his warlike expeditions far and wide. Westward they extended nearly to the shores of the Caspian; eastward he repeatedly entered India as a conqueror. At his great battle of Panipat (Jan. 6, 1761), with vastly inferior numbers, he gave the Mahrattas, then at the zenith of power, a tremendous defeat, almost annihilating their vast army; but the success had for him no important result. Having long suffered from a terrible disease, he died in 1773, bequeathing to his son Timûr a dominion which embraced not only Afghanistan to its utmost limits, but the Panjab, Kashmir, and Turkestan to the Oxus, with Sind, Biluchistan, and Khorasan as tributary governments.

Timur transferred his residence from Kandahar to Kabul, and continued during a reign of twenty years to stave off the anarchy which followed close on his death. He left twenty-three sons, of whom the fifth, Zamân Mirza, by help of Payindah Khan, head of the Bârakzai family of the Abdalis, succeeded in grasping the royal power. For many years barbarous wars raged between the brothers, during which Zamân Shah, Shujâ-ul-Mulk, and Mahmûd, successively held the throne. The last owed success to Fatteh Khan, son of Payindah, a man of masterly ability in war and politics, the eldest of twenty-one brothers, a family of notable intelligence and force of character, and many of these he placed over the provinces. The malignity of Kamrân, the worthless son of Mahmud, succeeded

in making the king jealous of his minister; and with matchless treachery, ingratitude, and cruelty, the latter was first blinded, and afterwards murdered with prolonged torture, the brutal Kamran striking the first blow.

The Barakzai brothers united to avenge Fatteh Khan. The Saddozais were driven from Kabul, Ghazni, and Kandahar, and with difficulty reached Herat (1818). Herat remained thus till Kamran's death (1842), and after that was held by his able and wicked minister Yar Mahommed. The rest of the country was divided among the Barakzais—Dost Mahommed, the ablest, getting Kabul. Peshawar and the right bank of the Indus fell to the Sikhs after their victory at Naoshera in 1823. The last Afghan hold of the Panjab had been lost long before—Kashmir in 1819; Sind had cast off all allegiance since 1808; the Turkestan provinces had been practically independent since the death of Timur Shah.

In 1809, in consequence of the intrigues of Napoleon in Persia, the Hon. Mountstewart Elphinstone had been sent as envoy to Shah Shuja, then in power, and had been well received by him at Peshawar. This was the first time the Afghans made any acquaintance with Englishmen. Lieut. Alex. Burnes visited Kabul on his way to Bokhara in 1832. In 1837 the Persian siege of Herat and the proceedings of Russia created uneasiness, and Burnes was sent by the Governor-General as resident to the Amir's court at Kabul. But the terms which the Dost sought were not conceded by the government, and the rash resolution was taken of re-establishing Shah Shuja, long a refugee in British territory. Ranjit Singh, king of the Panjab, bound himself to co-operate, but eventually declined to let the expedition cross his territories. The "Army of the Indus," amounting to 21,000 men, therefore assembled in Upper Sind (March 1838), and advanced through the Bolan Pass under the command of Sir John Keane. There was hardship, but scarcely any opposition. Kohandil Khan of Kandahar fled to Persia. That city was occupied in April 1839, and Shah Shuja was crowned in his grandfather's mosque. Ghazni was reached 21st July; a gate of the city was blown open by the engineers (the match was fired by Lieut. afterwards Sir Henry Durand); and the place was taken by storm. Dost Mahommed, finding his troops deserting, passed the Hindu Kush, and Shah Shuja entered the capital (7th August). The war was thought at an end, and Sir John Keane (made a peer) returned to India with a considerable part of the force, leaving behind 8000 men, besides the Shah's force, with Sir W. Macnaghten as envoy, and Sir A. Burnes as his colleague.

During the two following years Shah Shuja and his allies remained in possession of Kabul and Kandahar. The British outposts extended to Saighân, in the Oxus basin, and to Mullah Khan, in the plain of Seistan. Dost Mahommed surrendered (Nov. 3, 1840), and was sent to India, where he was honourably treated. From the beginning, insurrection against the new government had been rife. The political authorities were over-confident, and neglected warnings. On the 2d November 1841 the revolt broke out violently at Kabul, with the massacre of Burnes and other officers. The position of the British camp, its communications with the citadel, and the location of the stores were the worst possible; and the general (Elphinstone) was shattered in constitution. Disaster after disaster occurred, not without misconduct. At a conference (23d December) with the Dost's son, Akbar Khan, who had taken the lead of the Afghans, Sir W. Macnaghten was murdered by that chief's own hand. On 6th January 1842, after a convention to evacuate the country had been signed, the British garrison, still numbering 4500 soldiers (of whom 690 were Europeans), with some 12,000 followers, marched out of the camp. The winter was severe, the troops demoralised, the march a mass of confusion and massacre; for there was hardly a pretence of keeping the terms. On the 13th the last survivors mustered at Gandamak only twenty muskets. Of those who left Kabul, Dr Brydone only reached Jalalabad, wounded and half dead. Ninety-five prisoners were afterwards recovered. The garrison of Ghazni had already been forced to surrender (10th December). But General Nott held Kandahar with a stern hand, and General Sale, who had reached Jalalabad from Kabul at the beginning of the outbreak, maintained that important point gallantly.

To avenge these disasters and recover the prisoners preparations were made in India on a fitting scale; but it was the 16th April 1842 before General Pollock could relieve Jalalabad, after forcing the Khybar Pass. After a long halt there, he advanced (20th August), and gaining rapid successes, occupied Kabul (15th September), where Nott, after retaking and dismantling Ghazni, joined him two days later. The prisoners were happily recovered from Bamian. The citadel and central bazaar of Kabul were destroyed, and the army finally evacuated Afghanistan December 1842.

Shah Shuja had been assassinated soon after the departure of the ill-fated garrison. Dost Mahommed, released, was able to resume his position at Kabul, which he retained till his death in 1863. Akbar Khan was made vazir, but died in 1848.

The most notable facts in later history must be briefly stated. In 1848, when the Sikh revolt broke out, Dost Mahommed, stimulated by popular outcry and by the Sikh offer to restore Peshawar, crossed the frontier and took Attok. A cavalry force of Afghans was sent to join Sher Singh against the British, and was present at the battle of Gujerat (21st Feb. 1849). The pursuit of the Afghans by Sir Walter Raleigh Gilbert, right up to the passes, was so hot that the Dost owed his escape to a fleet horse.

In 1850 the Afghans re-conquered Balkh.

In January 1855, friendly intercourse, which had been renewed between the Dost and the British government, led to the conclusion of a treaty at Peshawar.

In November 1855, after the death of his half-brother, Kohandil Khan of Kandahar, the Dost made himself master of that province. In 1856 came the new Persian advance to Herat, ending in its capture, and the English expedition to the Persian Gulf. In January 1857 the Dost had an interview at Peshawar with Sir J. Lawrence, at which the former was promised arms and a subsidy for protection against Persia. In consequence of this treaty a British mission under Major Lumsden proceeded to Kandahar. The Indian mutiny followed, and the Afghan excitement strongly tried the Dost's fidelity, but he maintained it. Lumsden's party held their ground, and returned in May 1858.

In 1863, Dost Mahommed, after a ten months' siege, captured Herat; but he died there thirteen days later (9th June), and was succeeded by his son Sher Ali Khan.

Since then the latter has passed through many vicissitudes in rivalry with his brothers and nephews, and at one time (1867) his fortunes were so low that he held only Balkh and Herat. By the autumn of 1868, however, he was again established on the throne of Kabul, and his competitors were beaten and dispersed. In April 1869 Sher Ali Khan was honourably and splendidly received at Amballa by the Earl of Mayo, who had shortly before replaced Sir J. Lawrence. Friendly relations were confirmed, though the Amir's expectations were not fulfilled. He received the balance of a donation of £120,000 which had been promised and partly paid by Sir John Lawrence. A considerable present of artillery and arms was made to

him; since then some small additional aid in money and arms has been sent, but no periodical subsidy.

Sher Ali Khan now reigns over all Afghanistan and Afghan Turkestan, whilst Badakhshan is tributary to him. In the latter part of 1872 a correspondence which had gone on between the Governments of Russia and England resulted in a declaration by the former that Afghanistan was beyond the field of Russian influence; whilst the Oxus, from its source in Lake Sirikol to the western limit of Balkh, was recognised as the frontier of Afghan dominion.

ANTIQUITIES.—We can afford space for only the briefest indication on this subject. The basin of the Kabul river especially abounds in remains of the period when Buddhism flourished, beginning with the Inscribed Rock of Shahbâzgarhi, or Kapur-di-giri, in the Peshawar plain, which bears one of the *repliche* of the famous edicts of Asoka (not later than B.C. 250). In the Koh-Daman, north of Kabul, are the sites of several ancient cities, the greatest of which, called Beghram, has furnished coins in scores of thousands, and has been supposed to represent Alexander's *Nicœa*. Nearer Kabul, and especially on the hills some miles south of the city, are numerous *topes*. In the valley of Jalalabad are many remains of the same character. In the Peshawar plain and on the adjoining heights are numerous ancient cities and walled villages, in many cases presenting ruins of much interest, besides the remains of topes, monasteries, cave temples, &c.; and frequently sculptures have been found on those sites, exhibiting evident traces of the influence of Greek art. The Mahâban mountain, near the Indus, which has been plausibly identified with the *Aornos* of the Greeks, and the hills more immediately compassing the Peshawar valley, abound in the ruins of very ancient fortresses. At Talash, on the Panjkora river, are extensive ruins of massive fortifications; and in Swat there are said to be remains of several ancient cities.

In the valley of the Tarnak are the ruins of a great city (Ulan Robat), supposed to be ancient *Arachosia*. About Girishk, on the Helmand, are extensive mounds and other traces of buildings; and the remains of several great cities exist in the plain of Seistan, as at Pulki, Peshawaran, and Lakh, relics of ancient *Drangiana*, as yet unexamined. An ancient stone vessel, preserved in a mosque at Kandahar, is almost certainly the same that was treasured at Peshawar in the 5th century as the begging-pot of Sakya-Muni. Of the city of Ghazni, the vast capital of Mahmud and his race, no substantial relics survive, except the tomb of Mahmud and two remarkable brick minarets.

To the vast and fruitful harvest of coins that has been gathered in Afghanistan and the adjoining regions, we can here but make an allusion.

(Elphinstone's *Caubool;* various papers in *J. As. Soc. Bengal;* Ferrier's *Journeys*, and *Hist. of the Afghans;* Bellew's *Journal*, *Report on the Yusufzais*, and *Notes on Flora of Afgh.;* James's *Report on Peshawur District;* Raverty's *Afghan Grammar; Punjab Trade Report;* Baber's *Memoirs;* Kaye's *History;* papers by Major Lumsden, and by Lieut.-Col. C. M. Macgregor, &c. The paragraph on the *Animal Kingdom* has been revised by Prof Henry Giglioli of Florence.) (H. Y.)

AFGHAN TURKESTAN is a convenient name applied of late years to those provinces in the basin of the Oxus which are subject to the Amir of Kabul. BADAKHSHAN and its dependencies, now tributary to the Amir, are sometimes included under the name, but will not be so included here. The whole of the Afghan dominions consist of AFGHANISTAN as defined under that heading, AFGHAN TURKESTAN, and BADAKHSHAN with its dependencies.

The territories included here will be, beginning from the east, the khanates or principalities of Kunduz, Khulm, Balkh with Akcha; and the western khanates of Sir-i-pul, Shibrghân, Andkhûi, and Maimana, sometimes classed together as the *Chihâr Vilâyat*, or "Four Domains;" and besides these, such part of the Hazara tribes as lie north of the Hindu Kush and its prolongation, defined in the article AFGHANISTAN. The tract thus includes the whole southern moiety of the Oxus basin, from the frontier of Badakhshan on the east to the upper Murghâb river on the west. The Oxus itself forms the northern boundary, from the confluence of the Kokcha or river of Badakhshan, in 69½° E. long., to Khoja Salih ferry, in 65° E. long. nearly. Here the boundary quits the river and skirts the Turkman desert to the point where the Murghâb issues upon it. Along the whole southern boundary we have a tract of lofty mountain country. Thus, in the east, above Kunduz, we have the Hindu Kush rising far into the region of perpetual snow, and with passes ranging from 12,000 to 13,000 feet and upwards. Above Khulm and Balkh is the prolongation of Hindu Kush, called Koh-i-baba, in which the elevation of the *cols* or passes seems to be nearly as high, though the general height of the crest is lower. The mountains then fork in three branches westward, viz., *Koh-i-Siâh*, "The Black Mountain," to the south of the Herat river; *Koh-i-Safed*, "The White Mountain," between the Herat river and the Murghab, and a third ridge north of the latter river. The second branch (Safed-Koh) has been assumed in the article AFGHANISTAN as the boundary of that region. We know almost nothing of these mountains, except from the journey of Ferrier, who crossed all three watersheds in four days of July 1845. He describes the middle range as very lofty, with a good deal of snow on the pass; the southern range not so high, the northern one not nearly so high.

RIVERS.—We shall first describe the rivers of this region in succession.

For the Oxus itself, see that article.

Beginning from the eastward, its first tributary within our limits is the river of Kunduz, known also as the river of Aksarai, the Surkhâb, and what not. As the principal source of this river we may regard the stream of Bamian, fed close under the Koh-i-Baba by a variety of torrents which join from the pass of Akrobat and other gorges of the Hazara country, adjoining that famous site (8496 feet above sea level). The names of some of these seem to preserve a tradition of the ancient population; such are the "Cutlers' Vale," "the Smiths' Vale," the "Valley of Eye-paint." At the eastern end of the valley the Bamian stream receives another of nearly equal bulk, descending from the pass of Hajjigak, the most important crossing of the mountains between Kabul and the Oxus, and from which the road descends upon Bamian, and thence by Saighân, Khurram, and Haibak, to Khulm, in the Oxus valley. On the volcanic rock which parts the streams stand extensive ruins, the name of which, Zohâk, connects them with the most ancient legends of Persian history.

From this the river turns nearly north, passing the country of the Sheikh 'Alis, one of the most famous Hazara clans, and closely skirting the great range of Hindu Kush. About 40 miles N.N.E. of Zohak it receives from the left two confluents, of size probably almost equal to its own—the rivers of Saighan and of Kâmard, both rising to the westward of Bamian, and crossing the highway from Bamian to Khulm. Hereabouts the river seems to take the name of Surkhab. The first considerable confluent on the right is the Andarâb river, draining the valley of that name, and joining at Doshi, about 85 miles in a direct line N.E. of Zohak. About Ghori, still a place of some note, the valley widens out greatly, and becomes in places swampy, with expanses of tall grass, a character which it thenceforth retains. The river is, or has been, bridged at Thomri, a few miles beyond Ghori, a work ascribed to Aurangzib. It then receives from the right the Baghlân river, coming from Nârîn and the hills of Khost. The only remaining confluent is the important one which joins immediately below the town of Kunduz, sometimes called the Khânâbâd river, sometimes by the names of its chief contributaries, the Farokhar and Bangi.

The Farokhar, or river of Talikân, is the most easterly, coming out of Badakhshan, the boundary of which runs along the watershed on its left bank. The Bangi flows through Khost from the highlands of Badakhshan, east of Andarab. A third tributary, the Shorâb, salt, as its name implies, drains the high range called Esk-mushk, above Narin.

The Surkhab or Kunduz river enters the Oxus at a point approximately (no traveller has visited the confluence) 32 miles N.W. of Kunduz, its whole length, exclusive of minor windings, being about 220 miles.

From Ghori downwards, the hills which bound the valley on either side appear to be of no great elevation, and to be tolerably clothed with grass, and occasionally with fir trees; the aspect of the country gradually approximating to that of Badakhshan, in contrast to the more sterile offshoots of Koh-i-Baba to the westward.

Kunduz itself lies very low, scarcely 500 feet above sea level, and the roads approaching the town have to pass over piles amid the swampy vegetation. The adjacent plain is in the main richly cultivated and thickly peopled, but it is interspersed with extensive tracts of jungly grass, and is extremely and proverbially unhealthy. The plains, which extend, though not unbroken, from Kunduz to the Oxus, are free from the bare and repulsive character of those further west, and are described as covered in part with rich cultivation, thick with groves and hamlets, and in part with splendid pasture.

Proceeding westward, the next tributary to the Oxus basin is the Khulm river. The traveller from Bamian northward first touches the Khulm river, on descending from the Kara-Kotal, at a spot called Doâb Shâhpasand, probably 5000 feet above the sea, where its two main sources join, and the main road to Turkestan keeps on or near the river till its exit on the Oxus plain. The character of the mass of mountains which extends from the Koh-i-Baba to Khulm is utter rocky aridity, but broken sometimes in the sudden trench-like valleys by an exuberant vigour of vegetation. Along a chain of these trench-like gorges, walled by stupendous cliffs seeming sometimes almost to close overhead, the traveller descends towards Khulm. At Haibak the valley opens out, but closes in again before Khulm is reached. Here he emerges from a narrow gorge upon the plain of the Oxus, some 20 miles from the great river, and leaves the mountains suddenly, as one leaves the gate of a fortress, still rising behind in a bold rampart to the height of 2500 feet. The river is believed to be spent in irrigation before reaching the Oxus.

As far north at least as Khurram, half-way from Bamian to Khulm, the offshoots of Koh-i-Baba, west of the Khulm defile, must reach a height of 11,000 or 12,000 feet; for here Ferrier found bitter cold and snow on the top on the 7th of July (latitude nearly 36°).

The next river westward is the Balkh river, sometimes called Dehâs. It rises not far from some of the tributaries of the Surkhab, nor from the sources of the Herat river, at a remarkable spot which, under the name of the *Band-i-Barbar*, or Barbar dam, is the subject of various legends, though we have no distinct account of it. The valley of Yekâlang, on the upper waters of this river, at a height of 7000 feet above the sea, was visited by A. Conolly, and is described by him as fertile, well-watered, and populous, about 15 miles in length by ¼ to ½ mile in width. Ferrier is the only traveller who has crossed the mature stream, and he merely mentions that he forded it, and that it was rather rapid. We thus know almost nothing of the river. In length it cannot come far short of the Surkhab. Beyond the lofty mountains recently spoken of, some of the hills towards the Balkh-ab have a thin clothing of wood, and the valleys opening on the river are wide and not unfertile. The main valley expands into level tracts of pasture, covered by long grass, and intersected by artificial water-courses; but (as with the Khulm river) the gorge from which the stream issues on the Oxus plain is narrow, and walled in by very high hills on either side. The ruins and gardens of ancient Balkh stand about 6 miles from the hills, but no part of the river appears to reach the site in its natural bed, nor does any part of its waters reach the Oxus in a running stream.

The plains that slope from the gardens of Balkh to the Oxus are naturally white hard steppes, destitute of spontaneous verdure save sparse brush of tamarisk and other meagre growths; but the soil responds richly to irrigation whenever this is bestowed.

The next stream that we meet with, and the last that can be considered even as an indirect tributary of the Oxus, is that which fertilises the small khanates of Shibrghan and Andkhui, on the verge of the Turkman desert; whilst the two confluents that contribute to form it have previously watered the territories of Siripul and Maimana. The river, or whatever survives of its water after irrigating Andkhui, is lost in the desert. The taste of the water is abominable, and, though the inhabitants are accustomed to it, strangers suffer from its use.

The last river that we have to notice is the Murghab, which rises between the two northern branches of the Koh-i-Baba or Paropamisus. Ferrier is the only traveller who has been on the upper waters of the Murghab. He takes no notice of the river itself, but describes a remarkable plain or basin, about 120 miles in circuit, entirely surrounded by mountains, well-watered, and rich in vegetation. The people are Mongol Hazaras, and, according to Ferrier, idolaters. Their country is a part of the old territory of Garjistân. At Shah Mashad, about half-way between this and the plains, the river was crossed by Major Eldred Pottinger, but we have no access to his report. Further down, as the river approaches the foot of Murghab Bâlâ, on the road from Maimana to Herat, it runs with great violence, and the valley narrows to a defile. At Panjdeh, 35 to 40 miles below Murghab, it begins to flow through a valley of clay soil, bounded by sandy heights, and gradually opening into the plain of Merv. Hereabouts, too, it quits the Afghan territory, but the boundary does not seem as yet to have been precisely fixed. About 100 miles from Panjdeh the river reaches Merv, where formerly there was a great dam, securing the fertility of that oasis, the nucleus of ancient *Margiana*. This was destroyed by the Amir Maasum (otherwise Shah Murad) of Bokhara, about 1785, when he carried off the whole population into slavery. Beyond Merv the river is lost in the desert.

PROVINCES AND PLACES OF NOTE.—We do not know the precise divisions maintained under the Afghans, but they coincide generally with the old principalities or khanates, the hereditary rulers of which, in several cases continue in authority under the Afghan governor of Turkestan. Bamian, Saighan, and the higher valleys belong, it is understood, to a special command over the Hazara tribes.

I. *Kunduz.*—Beginning again from the east, the first province is *Kunduz*, having on the east Badakhshan, on the west Khulm, on the north the Oxus, and on the south Hindu Kush. The districts of Kunduz are approximately as follows:—(1.) *Kunduz*, with the chief town of the province, a wretched place, as described by Wood, of some 500 or 600 mud huts, intermingled with straw sheds, Uzbek tents, gardens, and corn-fields, and overlooked by a mud fort on an extensive mound. (2.) *Hazrat Imâm*, on the irrigated and fertile Oxus plain. The town, known in the Middle Ages as *Arhang*, is described as about the same size as Kunduz, with a better fort, protected by a wet ditch. (3.) *Baghlân*, and (4.) *Ghori*, in the swampy valley of the Surkhab. (5.) *Doshi*, further up the same valley, at the confluence of the Andarab stream. (6.) *Killagai* and *Khinjân*, near the lower part of the Andarab stream. (7.) *Andarab*, at the foot of the Tul and Khâwak passes over Hindu Kush, often supposed to be the *Adrapsa* of Alexander's historians. This secluded town was a favourite minting place of the Samanid sovereigns of Persia and Turkestan, in the 10th century, probably owing to the vicinity of silver mines at Paryân. (8.) *Khost* lies between Andarab and Kunduz. The name often occurs in the history of Baber and his successors. (9.) *Narin* and *Ishkimish* lie to the east of Baghlan, at the sources of the Baghlan stream and of the Shorab branch of the Kunduz river. The second name appears to be the same as *Eshkmushk*, which Wood applies to a high mountain in this quarter. (10.) *Farhang* and *Châl* lie on the borders of Badakhshan, and are utterly unknown. (11.) *Tâlikân* also lies on the borders of Badakhshan, but is pretty well known, being on the main road between Kunduz and Faizabad, the capital of Badakhshan. It is now a poor place, but is ancient, and was once famous. A fortress here stood a long siege from Chinghiz Khan, and the place is mentioned by Marco Polo as *Taican*. During the rule of Murad Beg of Kunduz this was the seat of a government that included Badakhshan. (12.) *Khanabad*, on the river of that name, pleasantly elevated above the swampy level of Kunduz, is, or was, the usual summer residence of the chiefs of that territory.

II. *Khulm* was the next of the khanates, lying between Kunduz and Balkh. The districts, as far as we know them, are the following:—(1.) *Tâshkurghân*. The old town of Khulm stood in the Oxus plain, surrounded by watered orchards of famous productiveness; but it lay so exposed to the raids of the Kunduz Uzbeks that the chief, Killich Ali, in the beginning of this century, transferred

his residence to Tashkurghan, 4 miles further south, and just at the mouth of the defile—a cheerless group of villages, consisting of mud houses with domed roofs, connected by gardens and enclosed by a mud wall; it is supposed to contain at least 15,000 souls, and is a place of considerable trade. (2.) *Haibak*. The town presents rather an imposing aspect, clustering round a castle of some strength on an isolated eminence; the domed houses, however, are compared to large brown bee-hives. The Khulm river valley here opens out, and is very fertile; the banks are shaded by luxuriant fruit trees. The site is a very ancient one, and, under the name of *Samangân*, was famous in Persian legend. One traveller describes there a remarkable relic of antiquity called the *Takht* or Throne of Rustam. This, from the account, would seem to have been a Buddhist dagoba.[1] (3.) *Khurram Sarbâgh*, so called from two villages in the upper defiles of the Khulm river.

III. *Balkh*. *Balkh* proper is the populous and well-watered territory upon the eighteen canals which draw off the waters of the Balkh-ab, and on which there are said to be 360 villages.

No trace has been recovered of the ancient splendours of *Bactra*, nor do the best judges appear to accept Ferrier's belief that he saw cuneiform inscriptions upon bricks dug up there. A late Indian report by an intelligent Mahommedan speaks of a stone throne in the citadel, to which traditional antiquity is ascribed, but of this we know no more. The remains that exist are scattered over some 20 miles of circuit, but they consist mainly of mosques and tombs of sun-dried brick, and show nothing even of early Mahommedan date. The inner city, surrounded by a ruined wall of 4 or 5 miles in compass, is now entirely deserted; a scanty population still occupies a part of the outer city. In 1858 Mahommed Afzal Khan, ruling the districts of Turkestan on behalf of his father, Dost Mahommed, transferred the seat of the Afghan government and the bulk of the population to Takhtapul, a position which he fortified, some 8 miles east of the old city; and this remains the capital of the Afghan territories on the Oxus.

The only other place of note in the district is *Mazâr-i-Sharîf*, or the "Noble Shrine," on the road to Khulm, where a whimsical fiction has located the body of 'Ali, the son-in-law of Mahommed. It is the object of pilgrimages, and the scene of a great annual fair. Vámbéry speaks of the roses, matchless for colour and fragrance, that grow on the pretended tomb.

Of the districts lying on the Balkh river within the hills we know nothing.

Akcha, some 40 to 45 miles westward from Balkh, was an Uzbek khanate before the last Afghan conquest. It is small, but well-watered and populous. The town is fortified, and has a citadel. Accounts differ as to the population; one writer calls them Uzbeks, another Sarak Turkmans.

IV. The provinces known as the Four Domains are:—(1.) *Shibrghan*, some 20 miles west of Akcha. This was another small Uzbek khanate. The town, which contains about 12,000 Uzbeks and Parsiwans, has a citadel, but is not otherwise fortified. It is surrounded by good gardens, and excellent cultivation, but its water supply is dependent upon Siripul, and, in the frequent case of hostility between the two, is liable to be cut off. Ferrier speaks highly of the climate and the repute of the inhabitants for valour. Shibrghan (Sapurgan) and its fine melons are mentioned by Marco Polo. (2.) *Andkhui*, about 20 miles north-west of Shibrghan, forms an oasis in the desert, watered by the united streams from Siripul and from Maimana. It was once a flourishing city, and the oasis was reckoned to contain 50,000 inhabitants, but the place has scarcely recovered from the destruction it endured at the hands of Yar Mahommed of Herat in 1840. It was at Andkhui that Moorcroft died in 1825; but his grave is at Balkh. Trebeck, the last survivor of his party, died and was buried at Mazar. (3.) *Maimana*, 105 miles from Balkh, and some 50 south-west of Andkhui, contains some ten or twelve villages or townships, besides the capital, and a population estimated at 100,000 souls. It is a district of considerable productiveness, industry, and trade, and the Uzbek inhabitants have a high reputation as soldiers. The chief was formerly a notorious slave-dealer. (4.) *Siripul*. This khanate lying within the limits of the undulating country south-west of Balkh and east of Maimana, is of about the same calibre as the latter, but somewhat lower in estimated population. Two-thirds of the people are Uzbeks, the rest Hazaras. From the last a tribute of slaves is, or used to be, exacted; and Hazara widows, it is said, were claimed as government property, and sold by auction. The town of Siripul is an irregular mass of houses clustered on the slope of a hill crowned by a fort. Many tents gather round it also, and Ferrier estimates the population of town and tents as high as 18,000. The valley below is abundantly watered, and the breadth of orchards and tillage is considerable.

Population.—In the estimate of population cited under Afghanistan, that of Afghan Turkestan is reckoned at 642,000. This includes 55,000 for Badakhshan (no doubt too low an estimate); and the remainder, for the provinces included under our present article, excluding Hazaras, will be 587,000. Anything but a round number is entirely inappropriate to such an estimate; but we shall probably not be far wrong if we reckon the population at 600,000.

The Tajiks, or people of Iranian blood, are probably the representatives of the oldest surviving race of this region. They are found in some districts of Balkh and valleys of Kunduz. Khost, for instance, is said to be chiefly occupied by them. Uzbeks seem to be the most numerous race; and there are some other Turk tribes not classed as Uzbeks.[2] There seem to be a good many families claiming Arab descent; Afghans, especially about Balkh and Khulm; and in the towns some Hindus and Jews.

Products and Industry.—We have no means of giving any systematic account of the products of these provinces, either in natural history or industry. Rock-salt is worked at Chal, near the Badakhshan frontier, as well as beyond that frontier. Pistachio nuts are grown largely in the hill country of Kunduz, as well as the adjoining districts of Badakhshan, and the whole supply of India, Central Asia, and Russia is said to be derived from this region. Fruit is abundant and excellent, especially in Khulm and Balkh. Andkhui, before its decay, was famous for the black sheepskins and lambskins which we call *astrakhan;* and also for a breed of camels in great demand. Kunduz produces a breed of horses, highly valued in the Kabul market under the name of *Kataghan*. Maimana also is famous for horses, which are often exported to India; and is a mart for carpets and textures of wool and camels' hair, the work of Turkman and Jamshîdi women. Slave-dealing and man-stealing have long been the curse of this region, but late changes have tended to restrict these, and the Russian conquest of Khiva will probably have a most beneficial effect in this respect at least.

History.—Ancient Balkh, or *Bactra*, was probably one of the oldest capitals in Central Asia. There Persian tradition places the teaching of Zoroaster. Bactriana was a

[1] Burslem, *A Peep into Turkestan*, p. 125.

[2] The Uzbeks were, however, a confederation of many Turk and Tartar tribes, not one race.

province of the Achæmenian empire, and probably was occupied in great measure by a race of Iranian blood. About B.C. 250, Theodotus, governor of Bactria under the Seleucidæ, declared his independence, and commenced the history, so dark to us, of the Greco-Bactrian dynasties, whose dominions at one time or another—though probably never simultaneously—touched the Jaxartes and the Gulf of Cutch. Parthian rivalry first, and then a series of nomad movements from inner Asia, overwhelmed the isolated dominion of the Greeks (*circa* B.C. 126). Powers rose on the Oxus, known to the Chinese as Yuechi, Kweishwang, Yetha, Tukhâras, and what not; dimly to western Asia and Europe as Kushâns, Haiâthala, *Ephthalitæ* or White Huns, and *Tochari*. Buddhism, with its monasteries, colossi, and gilded pagodas, spread over the valley of the Oxus. We do not know what further traces of that time may yet be revealed; but we see some in the gigantic sculptures of Bamian. The old Arab historians of the Mahommedan conquest celebrate a heathen temple at Balkh, which they call *Naobihâr*, which Sir H. Rawlinson has pointed out to have been certainly a Buddhist monastery (*Nava-Vihâra*). The name Naobihar still attaches to a village on one of the Balkh canals, thus preserving, through so many centuries, the memory of the ancient Indian religion. The memoirs of the Chinese pilgrim Hwen Thsang, in the first part of the 7th century, give many particulars of the prevalence of his religion in the numerous principalities into which the empire of the Tukharas had broken up; and it is remarkable how many of these states and their names are identical with those which still exist. This is not confined to what were great cities like Balkh and Bamian; it applies to Khulm, Khost, Baghlan, Andarab, and many more.

As *Haiathalah*, or *Tokhâristân*, the country long continued to be known to Mahommedans; its political destiny generally followed that of Khorasan. It bore the brunt of all the fury of Chinghiz, and the region seems never to have effectually recovered from the devastations and massacres which he began, and which were repeated in degree in succeeding generations. For about a century these Oxus provinces were attached to the empire of the Dehli Moguls, and then fell into Uzbek hands. In the last century they formed a part of the dominion of Ahmed Khan Durrani (see AFGHANISTAN), and so remained under his son Timur. But during the fratricidal wars of Timur's sons they fell back under the independent rule of various Uzbek chiefs. Among these, the Kataghans of Kunduz were long predominant; and their chief, Murad Beg (1815 to about 1842), for some time ruled Kûlâb beyond the Oxus, and all south of it from near Balkh to Pamir.

In 1850 the Afghans recovered Balkh and Khulm; by 1855 they had also gained Akcha and the four western khanates; Kunduz in 1859. They were proceeding to extend their conquests to Badakhshan, when the Amir of that country agreed to pay homage and tribute.

We have noticed, in the conclusion of the article AFGHANISTAN, the correspondence which recently took place (1872–73) with Russia regarding the recognition of the Oxus as the boundary of Afghan Turkestan.

Antiquities.—These are known but very imperfectly. The best known, and probably the most remarkable, are the famous colossi at Bamian, with the adjoining innumerable caves. In the same locality are the ruins of the mediæval city destroyed by Chinghiz, the great fort called Sayadabad, and the ruins of Zohak. At Haibak are numerous caves like those of Bamian. Balkh seems to have little or nothing to show, though probably excavation would be rewarded. The little known or unknown valleys of Badakhshan probably contain remains of interest, but our only notices of them are so highly spiced with imagination as to be worthless. General Ferrier saw remarkable rock sculptures in a defile in the Hazara country, south of Siripul, and curious rock excavations a little further south.

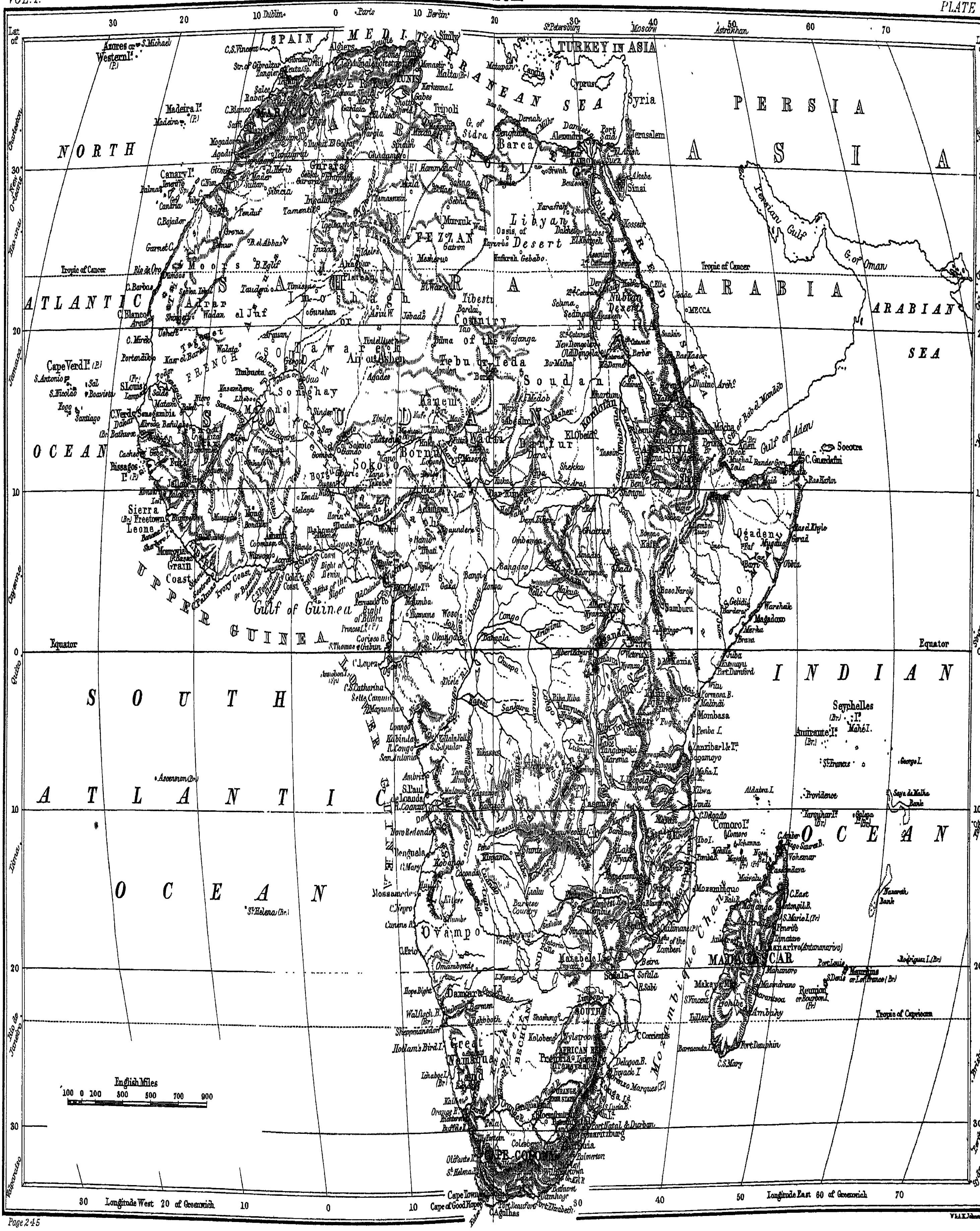
(Wood's *Journey*, 2d ed., 1873, with Introductory Essay; Ferrier's *Caravan Journeys*; Burnes's *Travels*; Indian official documents; Vámbéry's *Travels*; &c., &c.) (H. Y.)

AFIUM-KARA-HISSAR, a city of Asiatic Turkey, in the pashalic of Anatolia, nearly 200 miles E. of Smyrna, and 50 miles S.S.E. of Kutaiah. It stands partly on level ground, partly on a declivity, and above it rises a precipitous trachytic rock 400 feet in height, on the summit of which are the ruins of an ancient castle. From its situation on the route of the caravans between Smyrna and western Asia on the one hand, and Armenia, Georgia, &c., on the other, the city is a place of extensive trade, and its bazaars are well stocked with the merchandise both of Europe and the East. Opium in large quantities is produced in its vicinity, and forms the staple article of its commerce; and there are, besides, manufactures of black felts, carpets, arms, and saddlery. Afium contains several mosques (one of them a very handsome building), and it is the seat of an Armenian bishop. The population is estimated at about 60,000.

AFRAGOLA, a town of Italy, in the province of Napoli, 6 miles N.N.E. of Naples. It has extensive manufactures of straw bonnets. Population of commune (1865), 16,493.

AFRANIUS, LUCIUS, a Latin poet who lived about a century before Christ. He wrote comedies in imitation of Menander, and was commended by Cicero and Quintilian for his acute genius and fluent style. The fragments of his works which are extant have been collected by Bothe in his *Poetæ Scenici Latini*, and by Neukirch in his *De Fabula Togata Romanorum*.

AFRANIUS, LUCIUS, whose early history is unknown, was a devoted friend and adherent of Pompey, whom he served with distinction as one of his lieutenants in the Sertorian and Mithridatic wars. In the year 60 B.C., and chiefly by Pompey's support, he was raised to the consulship, but in performing the duties of that office he showed, like many other soldiers both before and since, an utter incapacity to manage civil affairs. In the following year, while governor of Cisalpine Gaul, he had the good fortune to obtain the honour of a triumph, and on the allotment of Spain to Pompey, 55 B.C., Afranius and Petreius were sent to take charge of the government of that country. On the rupture between Cæsar and Pompey, they were compelled, after a short campaign in which they were at first successful, to surrender to Cæsar at Ilerda, 49 B.C., and were dismissed on promising not to serve again in the war. Afranius, regardless of his promise, joined Pompey at Dyrrhachium, and at the battle of Pharsalia, 48 B.C., he had charge of Pompey's camp. On the complete defeat of Pompey, Afranius, despairing of pardon from Cæsar, repaired to Africa, and was present at the battle of Thapsus, 46 B.C., which ruined the hopes of the Pompeians in that part of the world. Escaping from the field with a strong body of cavalry, he was afterwards taken prisoner, along with Faustus Sulla, by the troops of Sittius, and handed over to Cæsar, whose veterans, disappointed at their not being led to immediate execution, rose in tumult and put them to death.


MEDITERRANEAN SEA
SPAIN
TURKEY IN ASIA
PERSIA
ASIA
ARABIA
ARABIAN SEA
NORTH ATLANTIC OCEAN
SAHARA
Libyan Desert
FEZZAN
Tripoli
Barca
Egypt
Nubian Desert
RED SEA
Soudan
Darfur
Kanem
Bornu
Sokoto
ABYSSINIA
Gulf of Aden
Socotra
Ogaden
Gulf of Guinea
UPPER GUINEA
LOWER GUINEA
Equator
Tropic of Cancer
Tropic of Capricorn
SOUTH ATLANTIC OCEAN
INDIAN OCEAN
Seychelles
Zanzibar
Mozambique Chan.
MADAGASCAR
Great Namaqua Land
Ovampo
CAPE COLONY
Cape Town
Cape of Good Hope
C. Agulhas
St. Helena (Br.)
Ascension (Br.)
English Miles
100 0 100 300 500 700 900
Longitude West 20 of Greenwich
Longitude East 60 of Greenwich

AFRICA

Ancient geography of Africa. Egypt.

THIS vast continent, thougn associated from the dawn of civilisation with traditions and mysteries of the most stimulating kind, has remained until recently one of the least known, and, both commercially and politically, one of the least important of the great divisions of the globe. The knowledge of Africa possessed by the ancients was very limited, owing principally to its physical construction. The great desert, which in a broad belt stretches quite across the continent, forbade every attempt to pass it until the introduction of the camel by the Arabs. The want of any known great river, except the Nile, that might conduct into the interior, contributed to confine the Greek and Roman colonists to the habitable belt along the northern coast. The Phœnicians are known to have formed establishments on the northern coast of Africa at a very early period of history, probably not less than 3000 years ago; and the conquest of Egypt by Cambyses dates as far back as the year B.C. 525. We may consider, therefore, the coasts of Egypt, of the Red Sea, and of the Mediterranean, to have been settled and well known to the ancient Asiatics, who were constantly passing the narrow isthmus which divided their country from Africa and led them immediately from parched deserts into a fertile valley, watered by a magnificent river. But whether they were much or little acquainted with the western coast, which bounds the Atlantic, and the eastern coast, washed by the Indian Ocean, is a question that has exercised the research and ingenuity of the ablest scholars and geographers, and has not yet been satisfactorily answered.

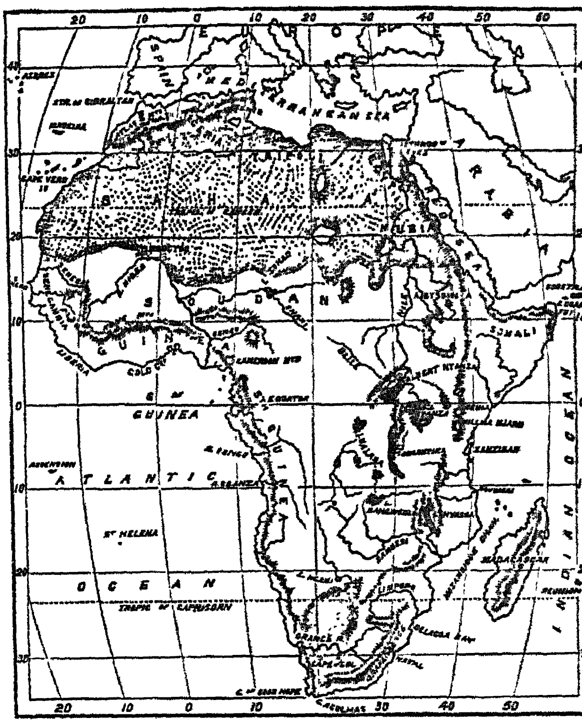
Western coast.

This question being one of curiosity rather than utility, we shall only state the case, and the results of the several inquiries, without entering into the merits of the arguments advanced by the different parties. We are told by Herodotus, that Necho, king of Egypt, sent out an expedition under the command of certain Phœnician seamen, for the purpose of circumnavigating Africa; and that, on their return, they asserted that they had accomplished this undertaking. Few of the ancient writers give credit to the story; but, among the moderns, the Abbé Paris and Montesquieu have contended that this voyage was actually performed. Isaac Vossius and D'Anville have strong doubts; and Dr Vincent and M. Gosselin maintain that such an expedition, at such a period, exceeds all the means and resources of navigation, then in its infancy. Last of all comes Major Rennel, who, in his elucidation of the geography of Herodotus, has done more than all the rest in clearing away the doubts of history; and *he* argues the possibility of such a voyage, from the construction of their ships, with flat bottoms and low masts, enabling them to keep close to the land, and to discover and enter into all the creeks and harbours which any part of the coast might present. At all events, one thing is evident: if such an expedition ever circumnavigated the African continent, the fruits of it have nearly, if not entirely, perished.

About half a century after this supposed expedition, the account of another voyage, down the western coast, is contained in the *Periplus* of Hanno, which has also called forth many learned and elaborate discussions among modern geographers, some of whom would carry Hanno to the Bight of Benin, others only to Sherbro Sound or the river Nun in lat. 28° N.

Eastern coast.

The extent to which ancient discovery proceeded along the eastern coast of Africa, has divided the opinion of the learned nearly as much as its progress on the western coast. Delisle, Huet, and Bochart, made the discovery of the coast to extend as far south as Mozambique and Madagascar. D'Anville could trace such discovery no farther than to Cape Delgado; and M. Gosselin contends that the ancients never proceeded down the coast beyond Brava. But Dr Vincent, who has entered more profoundly into the subject than any of his predecessors, and brought a great fund of learning to bear on the question, in his *Periplus of the Erythrean Sea*, has with great plausibility extended these boundaries to Mozambique and to the island of Madagascar.



Sketch Map of Africa.

Egypt, under the Ptolemies, the great patrons of science and promoters of discovery, possessing the advantage of the only great river which falls from the African continent into the Mediterranean, made no progress beyond its ancient boundaries; and though the Romans, who subsequently possessed Egypt, penetrated beyond the limits of their own dependencies, they extended their discoveries no further than Fezzan in one direction, and, at a later period, beyond Nubia as far as Abyssinia, and the regions of the Upper Nile. We know nothing of the progress made by the Carthaginians in the discovery of Interior Africa; but although it has been asserted that their merchants had reached the banks of the interior river, which we call the Kawara or Niger, they have left nothing on record that will warrant such a supposition. The story told by Herodotus, of some Nasamonians crossing the desert, and arriving at a large river, can only be applicable to some western arm of the Nile. The people from whom we derive the first information concerning the interior of Northern Africa are the Arabs, who, by means of the camel, were able to penetrate across the great desert to the very centre of the continent, and along the two coasts as far as the Senegal and the Gambia on the west, and to Sofala on the east. On this latter coast they not only explored to an extent far beyond any supposed limits of ancient discovery, but planted colonies at Sofala, Mombas, Melinda, and at various other places.

The Carthaginians.

The Arabs.

Portuguese.

The 15th century produced a new era in maritime discovery. The voyages of the Portuguese were the first to give anything like an accurate outline of the two coasts,

and to complete the circumnavigation of Africa. The discovery of America and the West India islands gave rise to that horrid traffic in African negroes, which has since been suppressed; but this traffic has been the means of acquiring a more extended and accurate knowledge of that part of the coast which lies between the rivers Senegal and the Cameroons, as well as of the manners and character of the people who inhabit this extended line of coast. With the English and French settlements in Africa began a systematic survey of the coast, and portions of the interior.

The English and French.

African association.

The uncertainty and confusion that prevailed in the geography of the interior of Africa induced a few learned and scientific individuals to form themselves into an association for promoting the exploration of Inner Africa. This society was formed in London in 1788, and under its auspices important additions were made to the geography of Africa by Houghton, Mungo Park, Hornemann, and Burckhardt. Repeated failures, however, at length discouraged the association from engaging other missionaries, and it subsequently merged in the Royal Geographical Society in 1831.

Discoveries in the 19th century

During the last sixty years more has been done to make us acquainted with the geography of Africa than during the whole of the 1700 previous years, since Ptolemy, taken together. With Mungo Park, strictly speaking, commences the era of unceasing endeavours to explore the interior.

Park.

Mungo Park proceeded in 1795 from the river Gambia on the west coast, to the Joliba (commonly called Niger), traced this river as far as the town of Silla, explored the intervening countries, determined the southern confines of the Sahara, and returned in 1797. In 1805 this adventurous traveller embarked on a second journey in the same regions, for the purpose of descending down the river Joliba to its mouth. This journey added little to the discoveries already made, and cost the traveller his life. He is ascertained to have passed Timbuktu, and to have reached Boussa, where he was killed by the natives. In 1798 Dr Lacerda, a scientific Portuguese traveller, who had already acquired fame through his journeys in Brazil, made the first great journey in South-Eastern Africa, inland from Mozambique, and reached the capital of the African king, known as the Cazembe, in whose country he died.

Lacerda.

Hornemann.

Hornemann, in 1796–98, penetrated from Cairo to Murzuk, and transmitted from that place valuable information respecting the countries to the south, especially Bornu. He then proceeded in that direction, but it is supposed that he soon afterwards perished, as no accounts of his further progress have ever reached Europe. The first actual crossing of the continent that has been recorded was accomplished between the years 1802 and 1806, by two *Pombeiros* or mercantile traders in the employment of the Portuguese, who passed from Angola eastward through the territories of the Muata Hianvo and the Cazembe, to the possessions on the Zambeze. In 1816 an expedition was sent out by the English Government, under the command of Captain Tuckey, to the river Congo, which was at that time believed to be the lower course of the Joliba. This was a disastrous undertaking, and the geographical additions were but slight, the river having been ascended a distance of only 280 miles.

Tuckey

Lyon and Ritchie.

In 1819 Lyon and Ritchie penetrated from Tripoli to Murzuk, and a little distance beyond that place.

Denham, Clapperton, and Oudney.

In 1822 Denham, Clapperton, and Oudney set forth from Tripoli in the same direction, crossed the Great Desert, and reached, on the 4th February 1823, the great lake Tsad or Chad. The surrounding countries were explored as far as Sakatu in the west, and Mandara in the south. This journey was altogether one of the most successful and important into the interior. Oudney died in Bornu, but Clapperton undertook a second journey from the coast of Guinea, crossed the Kawara, and arrived at Sakatu, at which place he also died. His servant, Richard Lander, returned to England, after having explored a part of the adjoining regions.

Laing.

Major Laing succeeded in reaching Timbuktu from Tripoli, but was murdered on his return in the desert.

Caillié.

In 1827 and 1828 Caillié set out from the Rio Nunez on the western coast, reached Timbuktu, and returned from that place through the Great Desert to Marocco. A second Portuguese journey was undertaken in 1830 from Mozambique to the Cazembe's dominions, and Major Monteiro, the leader of the expedition, more fortunate than his predecessor Dr Lacerda, was enabled to complete a map of the country traversed, and to bring back a complete account of this portion of the interior.

Landers.

The termination of the Joliba, Kawara, or Niger, remained in obscurity till 1830, when it was ascertained by Lander and his brother, who succeeded in tracing the river from Yaouri down to its mouth. They embarked on a second expedition, which sailed in 1832, for the purpose of ascending the Kawara as far as Timbuktu. But only Rabba was reached, and the general results of the expedition were most disastrous.

Niger expedition.

The great Niger expedition, similar to the foregoing, consisted of three steam-vessels, and was despatched by the Government in 1841, under Captain Trotter. It proved a failure, and resulted in a melancholy loss of life.

Duncan.

In the region between the Kawara and the coast, Mr Duncan, one of the survivors of the Niger expedition, made some additions to our geographical knowledge by his journey to Adafoodia, in 1845–46. This enterprising traveller met with an untimely death in a second attempt in the same region for the purpose of reaching Timbuktu.

East-African travellers.

The preceding journeys were confined chiefly to the northern and western portions of the continent. A much greater number of travellers explored the regions drained by the Nile, the salubrity of which, particularly of Abyssinia, is so infinitely greater than that of Western Africa, that among the many explorers of the former, a very small proportion have died as compared with the immense loss of life in Western Africa. Among the most distinguished of the earlier East African travellers are Bruce (1768–73), Browne (1793), who reached Darfur, Burckhardt (1814), Cailliaud (1819), and more recently Rüppel (1824–25), Russegger (1837), D'Abbadie (1838–44), Beke (1840–44), D'Arnaud and Werne on the White Nile (1840–42), and Brun Rollet (1845).

South-African travellers.

Though the Dutch settlement in South Africa was founded as early as 1650, not much information of the interior of that portion of the continent was gained till the end of the 18th century, when a series of journeys was commenced by Sparrmann, and followed up by Vaillant, Barrow, Trotter, Somerville, Lichtenstein, Burchell (1812), Campbell, Thomson, Smith, Alexander (1836–37), and Harris.

Mombas mission.

A station of the Church Missionary Society was established near Mombas, in about 4° S. lat. on the east coast of Africa, in 1845, and the zealous missionaries in charge of it began to make exploring journeys into the interior. Thus, early in 1849, the Rev. Mr Rebmann discovered the great snow-clad mountain of Kilima-njaro, rising on the edge of the inland plateau; and his companion, Dr Krapf, taking a more northerly route, came in sight of a second huge mountain named Kenia, also snow-clad, though directly beneath the equator. Frequent reports reached these missionaries of vast lakes in the interior beyond the mountains they had discovered, and their information awakened a great interest in this region at home.

Richardson.

About this time an embassy, for the purpose of concluding commercial treaties with the chiefs of Northern Africa, as far as Lake Chad, by which the legitimate trade of these countries should be extended and the system of slavery abolished, was originated by Mr James Richardson, who

left England for this purpose in 1849, accompanied by Drs Barth and Overweg. The expedition had already almost reached the scene of its labours when Richardson died;

Barth.

Overweg also fell a victim to his exertions, but Dr Barth continued his explorations till 1856. During this time he traversed in many directions almost the whole of the northern Soudan, completing a series of journeys which must always remain most conspicuous in North African travel, and upon which we are still dependent for the greater part of our knowledge of the central negro states.

Living-stone. (L. Ngami).

In the summer of 1849, Dr Livingstone, who, as an agent of the London Missionary Society, had laboured and travelled in the countries immediately north of the Cape Colony since 1840, began those remarkable journeys in the interior of Southern Africa, which have continued until the present time, and have given to him the first place among African discoverers. The finding of Lake Ngami, the central point of the continental drainage of South Africa, was the great discovery of the first year.

Graça.

Two journeys from the west coast now claim attention. In 1846 a Portuguese trader named Graça succeeded in again reaching the country of the South African potentate, named the Muata Yanvo, from Angola; he was followed by a Hungarian named Ladislaus Magyar, who explored the central country in various directions from 1847 to 1851.

Living-stone (the Zambeze).

Between 1851 and 1853 Livingstone made two journeys northward from his station in the land of the Bechuanas, and was the first European to embark upon the upper course of the Zambeze. From the Makololo country, in the central part of the river basin, he now led a party of natives westwards up-stream to the water-parting of the continent at the little Lake Dilolo, and thence to the western slope, reaching the Portuguese coast at Loanda in 1854.

Galton.

During 1851 Galton explored a part of the south-western country inhabited by the Damaras and Ovampo, from Walfisch Bay to a point in lat. 17° 58′ S., and long. 21° E., determining accurately a number of positions in this region. On the south-east, also, Gassiot made an interesting journey from Port Natal north-westward through the mountains to the river Limpopo.

Silva Porto.

Two most remarkable journeys across the whole continent now follow in order; the one, made by Silva Porto, a Portuguese trader, who leaving Benguela in 1853, took an eastward route, parallel to but considerably northward of the Zambeze, over perfectly unknown country. He then rounded the southern end of the Lake Nyassa (afterwards explored by Livingstone), and made his way across the east coast-land to the mouth of the Rovuma river, having spent a year and two months in his tedious march.

Living-stone (Victoria Falls).

The other was executed by Livingstone, who in returning (1855–56) by a somewhat more northerly route than that travelled over in going westward to Loanda, descended the Zambeze to its mouth at Quilimane, discovering the wonderful Victoria Falls of the river on his way.

Moffat.

In 1856 an important addition was made to the more exact geography of Africa, in a survey of the greater part of the course of the Orange river, by Mr Moffat, a son of the veteran South African missionary.

Hahn and Rath. Bastian. Du Chaillu

The following year was one of great activity in African exploration. Damara Land, in the south-west, was traversed by Messrs Hahn and Rath as far as the southern limit of the Portuguese territory at the Cunene river; Dr Bastian was exploring the interior of Congo and Angola, and Du Chaillu had begun his first journey in the forest country of the Fan tribes on the equatorial west coast.

Burton and Speke.

Under the auspices of the Royal Geographical Society, Captains Burton and Speke, already distinguished by their perilous journey to Harar, a trading centre in the Somali and Galla country of the east African promontory, set out from Zanzibar, to ascertain the truth about the great inland lakes which had been reported by the Mombas missionaries. Their most successful journey (1857–59) resulted in the discovery of Lake Tanganyika, in a deep basin, between 3° and 8° S. lat., and of the southern portion of a perhaps greater lake northward, supposed by Speke, its discoverer, to be the head reservoir of the Nile.

Living-stone and Kirk (the Shire).

In a new journey in the Zambeze region in 1859, Dr Livingstone, accompanied by Dr Kirk, traced the Shire river, a northern tributary of the Zambeze, to its outflow from the Nyassa, the most southerly of the great African chain of fresh lakes.

Explorers of the White Nile. Duveyrier

About this time also several travellers (Petherick (1858), Lejean, Miani, the Poncets, Antinori, Debono, Peney) were adding much to the existing knowledge of the Upper White Nile from the Egyptian side; and in the north the Algerian Sahara was being explored by the French scientific traveller Duveyrier.

Speke and Grant.

In 1860 Captain Speke, anxious to extend knowledge of the great inland reservoirs which had been discovered in his former journey, and to connect them with the known countries to northward, accompanied by Captain Grant, again left Zanzibar. Reaching a point on the north-western shores of the great lake which he had previously made known, and which he now named the Victoria Nyanza, the traveller thence traced the outflowing river to the White Nile at Gondokoro, thus completing a great link in the chain of African discoveries, which binds the country known from the east coast to that explored from the side of Egypt.

Living-stone (L Nyassa)

Meanwhile Dr Livingstone had endeavoured to find a way to his newly-discovered Lake Nyassa from the mouth of the Rovuma, a large river which flows to the Indian Ocean near Cape Delgado, and which was also reported to take its rise in this lake, but the river proved to be unnavigable beyond a point not far from the sea. He returned then (in 1861) to the Shire river; and, carrying a boat past its rapids, launched out to explore the whole length of Lake Nyassa.

Rohlfs (Marocco). Von Decken.

A series of important journeys by Gerhard Rohlfs had now (1861) begun in Marocco and in the Maroccan Sahara; and on the equatorial east coast region, Baron von der Decken had extended Rebmann's information in the region of the snowy mountain, Kilima-njaro.

Baines.

In the south the artist Baines had crossed the Kalahari Desert from Damara Land to the falls of the Zambeze. In 1862 Petherick made an important journey of exploration in the Nile region west of Gondokoro.

Baker (Albert Lake).

The year 1864 was marked by the discovery of a second great reservoir lake of the Nile, near the latitude of the Victoria Nyanza, by Baker, pushing southward from Gondokoro. This lake the discoverer named the Albert Nyanza. During this year also, Rohlfs extended his travels from Marocco to the oasis of Tuat, thence making his way to Ghadames and Tripoli; in Western Africa, the officers of the French marine stationed at the Gaboon explored the delta region of the great Ogowai river;

Du Chaillu. Von Decken.

and Du Chaillu, in a second journey (1864–65), entered the gorilla country of Ashango, south of this river; whilst, on the east coast, Baron von der Decken attempted the navigation of the Juba, but was destined to fall a martyr to the jealousies of the Galla and Somali tribes, whose territories the river divides.

Rohlfs (across N. Africa).

After a short stay at Tripoli, the traveller Rohlfs again turned southward, and in a journey which lasted from 1865 to 1867, crossed the whole northern continent—first reaching Lake Chad by almost the same route as that formerly taken by Barth, and thence striking south-westward by a new path to the Bight of Benin.

Walker.

In 1866 some progress was made in discovery in the west, by the navigation of the Ogowai river by Walker, for 200 miles from its mouth. Hahn and Rath also extended

their exploration of Damara Land. On the eastern side Messrs Wakefield and New, the successors of Krapf and Rebmann in the Mombas Mission, made numerous short journeys in the Galla country, and the former collected very valuable native information respecting the countries lying between this coast-land and the great lakes of the Nile basin. In this year also Dr Livingstone had again entered the Rovuma river, beginning that greatest of all his journeys from which he has not yet (1873) returned, and the outline of which we shall notice further on.

Wakefield and New.

Livingstone.

Still farther south, in 1866–67, the discovery of gold in the mountains between the Zambeze and Limpopo rivers, by the pioneer Mauch, gave great impetus to exploration in this part of the continent. The years 1867–68 brought the memorable Abyssinian campaign, and the accurate records kept of the line of march on the high land from Massowah to Magdala formed a most valuable contribution to African geography.

Mauch.

Abyssinian expedition.

Most important in the following years (1869-71) were the researches of the botanist, Dr Schweinfurth, in the region of the complicated network of tributaries received by the White Nile west of Gondokoro, during which he passed the water-parting of the Nile basin in this direction, and came into a new area of drainage, possibly belonging to the system of Lake Chad; and the outsetting of a great Egyptian military expedition (1869) by Sir Samuel Baker, for the purpose of exploration of the Upper Nile and of the extermination of slave traffic on the river, and to plant Egyptian military posts in the regions visited.

Schweinfurth.

Baker's Egyptian expedition.

The letters received from time to time in this country from Dr Livingstone enable us to trace roughly his movements from 1866 to the present time as follows:—Arriving from Bombay, on the East African coast, near the mouth of the Rovuma, he passed up the course of this river to the confluence of its main tributary branches, one coming from the north-west, the other from south-west. Following the latter arm, the traveller appears to have gone round the southern end of the Lake Nyassa, and, marching then in a north-westerly direction, he crossed the head waters of the Aruangoa tributary of the Zambeze, near the track of Lacerda, in the previous century; ascending a high land, he came upon a portion of the Chambeze river, belonging to a different basin, and continuing in a north-westerly direction, discovered Lake Liemba, a southern extension of Lake Tanganyika, in April 1867. Thence he turned to the Cazembe's town, and in journeys northward and southward from this point, made known the two great lakes, Moero (Sept. 1867), and Bangweolo or Bemba (July 1868), which form part of a new system, connected by the Chambeze (also named the Luapula and Lualaba) river in a basin south and west of that of the Tanganyika. In 1869 Livingstone had made his way to Ujiji, Burton's halting-place, on the eastern shore of the Tanganyika. Hence, crossing the lake, he penetrated the dense tropical forests and swamps of Manyuema country, in the heart of the southern portion of the continent, and during 1870–71 traced the vast river (Lualaba) flowing out of the Lake Moero, in its north and westerly course, to a second, and then a third great expansion—Lake Kamalondo the one, and the other a still unvisited body of water lying in about 3° S. lat., and 25° or 26° E. long; also learning, by native report, that the Lualaba (which is in all probability the upper course of the mighty Congo river) received a great tributary from south-westward. This south-western arm also expands into a vast lake, which Livingstone has named, in anticipation, Lake Lincoln.

Livingstone.

(Lake Liemba).

(Lakes Moero and Bangweolo).

(Manyuema).

(The Lualaba).

Though the untruth of a report of Livingstone's death, near the Nyassa, had been proved by an expedition sent out on his track by the Geographical Society of London in 1867, yet at the time of his Manyuema journey, the probable fate of the great traveller, from whom no news had come out of Africa for more than two years, became a matter of the greatest anxiety among all classes in Europe and America. This led to a special mission for Dr Livingstone's aid, generously fitted out at the cost of the proprietor of an American newspaper. Stanley, the leader of this expedition, made a bold march from Zanzibar to Ujiji, on Lake Tanganyika, and was fortunate in meeting the great traveller there, returning from Manyuema, broken down by the severity of the task which he had accomplished, and in need of everything. A boat voyage round the northern end of Tanganyika, undertaken in the latter part of 1871 by Livingstone and Stanley together, proved that this great lake has no apparent outlet in a northerly direction, and leaves the question of its drainage in considerable doubt.

Stanley.

Recruited in health, and supplied with stores and followers, Livingstone is believed to have started afresh from Unyanyembe, a point midway in the route from Zanzibar to Ujiji, where he parted with Stanley, in autumn of 1872, to carry out a projected journey, in which he will clear up all doubts respecting the ultimate direction of the great Lualaba river.

Of the expeditions which have been progressing in Africa contemporaneously with these later journeys of Dr Livingstone, that of Sir Samuel Baker is perhaps the most important, though its story has until now been one of almost continuous hardship and disaster. Up to the middle of the year 1870, at which time the expedition, consisting of upwards of 1500 men, with numerous vessels, had safely reached a point on the Nile in 9° 26′ N. lat., all appears to have gone well; but beyond this the passages of the river had become choked with overgrowth of vegetation, and each yard of advance had to be cut through this living barrier; disease broke out among the troops, and the expedition was reduced to the greatest straits. In the end, however, it appears to have been completely successful, and before Sir Samuel Baker's return to Egypt in 1873, the whole country, as far south as the equator, had been taken possession of in the name of Egypt, and several garrisons had been planted to maintain the hold.

Baker.

Knowledge of the rich country between the Transvaal Republic and the Zambeze has extended with wonderful rapidity, through the exertions of the pioneers Mauch, Mohr, Baines, Elton, and St Vincent Erskine, so that this region has now almost passed out of the category of lands in which geographical discoveries can be made. A point of great interest in the progress of the exploration of this country was the discovery by Mauch, in 1871, of the ruins of an ancient city or fortress, named Zimbaoe, certainly not of African construction, about 200 miles due west from Sofala, in lat. 20° 15′ S., long. 30° 45′ E., through which it has been sought to identify this region with the Ophir of Scripture. The finding, in 1869, of rich diamond fields in the upper valley of the Orange river, and in that of its tributary the Vaal, caused a rush of emigration to these districts, and tended still further to develop this portion of Africa.

Recent South African researches.

North African exploration is also vigorously progressing. In the west, during 1869, Winwood Reade made a journey from Sierra Leone to the head of the Niger, and from 1867 onwards M. Munzinger, consul at Massowa, has greatly extended our knowledge of Northern Abyssinia. A notable journey of exploration in the Sahara remains to be mentioned. In 1869 Dr Nachtigal was appointed to carry presents from the King of Prussia to the Sultan of Bornu, on Lake Chad, in acknowledgment of that potentate's aid to former travellers. Besides accomplishing this mission, this explorer has added very considerably to our knowledge of the Eastern Sahara by investigating the central mountainous country of Tibesti, hitherto only known by report; and in

Winwood Reade.

Munzinger.

Dr Nachtigal.

more recent journeys, still being continued, he has proved the existence of an outflowing river from Lake Chad, which has hitherto been believed to be a terminal lake, the freshness of its waters having on this account appeared an anomaly in physical geography.

With the double purpose of affording support to Dr Livingstone, and of adding to the geography of Equatorial Africa, two expeditions were fitted out by the Royal Geographical Society in 1872. One of these, led by Lieut. Cameron, was planned to follow the footsteps of Livingstone in his present journey from the eastern side, entering the country by the ordinary trade route from Zanzibar towards the Tanganyika. This expedition started from Zanzibar early in 1873, under the auspices of Sir Bartle Frere's mission, and has now made considerable progress towards the interior. The other, named the "Livingstone Congo Expedition," under Lieuts. Grandy, is to pass from the west coast to the interior, by following the river Congo, which is almost without doubt the lower course of the great Lualaba river, about to be further explored by Dr Livingstone coming to it from the eastern side. The latest accounts from this expedition are also in the highest degree favourable, and an advance of upwards of 150 miles has already been made from Loanda. A new expedition, under the leadership of the indefatigable traveller Rohlfs, is now in preparation, and is destined to explore the unknown portions of the Libyan desert.

Thus the exploration of the great continent is slowly advancing year by year, but with earnest and unceasing progress. As yet the only portions of Africa of which we possess any approach to an accurate topographical knowledge are, the Cape Colony and Natal under British rule in the south, the French colony of Algeria, the Portuguese possession of Angola, and Egypt and Tunis, dependent on the Turkish Empire, in the north.

Throughout the rest of the continent, a network of routes accomplished by travellers gives in most parts the great outline of its features; where these lines interlace more closely, as in the South African Republics, and in Abyssinia, the general aspect of the land is now so well known as to preclude the possibility of any important geographical discovery there; elsewhere, however, the gaps between the tracks are wider. In the vast inhospitable region of the Sahara there are great areas still unknown to civilised man, and the equatorial region of dense forests in Central Africa is still one of the greatest *terræ incognitæ* of the globe.

The origin and meaning of the name of this great continent has been a fertile subject for conjecture among philologists and antiquaries. By the Greeks it was called Libya, Λιβύη, and by the Romans Africa. Varro believed he had found the etymology of the former in *Libs*, the Greek name of the south wind; and Servius, the scholiast on Virgil, proposed to derive the other from the Latin word *aprica* (sunny), or the Greek word *a-phriké* (without cold). It is more probable that the name Libya was derived by the Greeks from the name of the people whom they found in possession of the country to the westward of Egypt, and who are believed to have been those that are called in the Hebrew Scriptures *Lehabim* or *Lubim*. With respect to the word *Africa*, Suidas tells us that it was the proper name of that great city which the Romans called *Carthago*, and the Greeks, *Karchedon*. It is certain, at least, that it was applied originally to the country in the immediate neighbourhood of Carthage, that part of the continent first known to the Romans, and that it was subsequently extended with their increasing knowledge, till it came at last to include the whole continent. Of the meaning of the name, the language of Carthage itself supplies a simple and natural explanation; the word *Afrygah*, signifying a separate establishment, or in other words a colony, as Carthage was of Tyre. So that the Phœnicians of old, at home, may have spoken of their Afrygah, just as we speak of our colonies. Be that as it may, the Arabs of the present day still give the name of Afrygah or Afrikiyah to the territory of Tunis. It may also be remarked, that the name seems not to have been used by the Romans till after the time of the first Punic war, when they became first acquainted with what they afterwards called *Africa Propria*.

Africa lies between the latitudes of 38° N. and 35° S., and is of all the continents the most truly tropical. It is, strictly speaking, an enormous peninsula attached to Asia by the isthmus of Suez. The most northern point is the Cape, situated a little to the west of Cabo Blanco, and opposite Sicily, which lies in lat. 37° 20′ 40″ N., long. 9° 41′ E. Its southernmost point is Cabo d'Agulhas, in 34° 49′ 15″ S.; the distance between these two points being 4330 geographical, or about 5000 English miles. The westernmost point is Cabo Verde, in long. 17° 33′ W., its easternmost Cape Jerdaffun, in long. 51° 21′ E., lat. 10° 25′ N., the distance between the two points being about the same as its length. The western coasts are washed by the Atlantic, the northern by the Mediterranean, and the eastern by the Indian Ocean. Position and extent

The form has been likened to a triangle, or to an oval, but such a comparison is scarcely warranted, it being of an irregular shape, the northern half rounding off, the southern one contracting and terminating in a point. Form.

The superficial extent of Africa has never been accurately determined, but may be taken at 9,858,000 geographical square miles, exclusive of the islands. It is larger than either Europe or Australia, but smaller than Asia and the New World. Superficial extent.

The coast line of Africa is very regular and unbroken, presenting few bays and peninsulas. The chief indentation is formed by the Gulf of Guinea, with its two secondary divisions, the Bight of Benin and the Bight of Biafra. On the northern coast, the Gulf of Sidra and the Gulf of Kabes must be mentioned, and on the eastern coast the Gulf of Arabia. Coast line and indentations.

The physical configuration may be considered under two heads, the great lower-lands and plains of Northern Africa, and the great table-lands, with their mountain ranges and groups, of Central and Southern Africa. The great northern lower-land comprises the Sahara, the Lake Chad region, and the valley of the Lower Nile. The Sahara is by no means a plain throughout, but for the greater part it rises into table-lands, interspersed with mountain groups of 6000 feet elevation, and probably more, and the term lower-lands can only be applied to it in a general way, to distinguish it from the more elevated region to the south. Physical configuration.

The Sahara has often been pictured as a monotonous and immense expanse of sand; but nothing could be more erroneous, as the greatest variety exists in the physical configuration of its surface, as well as in its geological features. Our knowledge is as yet too scanty to enable us to trace its features in every part. On the north, this great desert is fringed with extensive table-lands, which in some places rise abruptly from the Mediterranean, as the great plateau of Barbary, extending through Marocco, Algeria, and Tunis, and the table-land of Barca, elevated 1500 feet, and gradually descending towards the Delta of the Nile. This elevated ground is succeeded to the south by a depressed region, which extends from the Great Syrtis or Gulf of Sidra, in a general direction as far as Middle Egypt, and comprises the oases of Augila and Siwah. So greatly depressed is this region, that the level of the oasis of Siwah is 100 feet, and in one place (Bahrein) even 167 feet below the level of the sea. The western portions of this country, between the oases of Augila and Siwah, explored in The northern lower-land of Africa.

1869 by the traveller Rohlfs, were found to be everywhere from 100 to 150 feet beneath the level of the Mediterranean; and M. de Lesseps, in conducting a survey from the Egyptian side, found the eastern part to be much beneath the level of the Nile. Here then must be one of the greatest areas of depression in the land of the globe, comparable with that which surrounds the Caspian Sea. This depressed region is again followed by a table-land of considerable extent and width, extending from the Gulf of Kabes in a southerly direction, along the Tripoline shores, and probably traversing, in the same direction, the Libyan Desert, and reaching as far as the Nile, near the first cataract. Its north-western part, as far as Sokna, consists of the Hamadah, a stony, dreary, and extensive table-land, of from 1500 to 2000 feet high, "which seems to be like a broad belt intercepting the progress of commerce, civilisation, and conquest, from the shores of the Mediterranean to Central Africa." Near Sokna this plateau breaks up and forms what are called the Jebel-es-Soda, or Black Mountains, a most picturesque group of cliffs; and again, on the route from Murzuk to Egypt, it also breaks into huge cliffs, and bears the name of El-Harouj. The whole of the central portion of the Northern Sahara, as far south as the plateau of Air or Asben, is occupied by similar bare table-lands, with lower areas of sand dunes between. Numerous wadys, the only inhabited parts of the country, intersect the slopes of these plateaux. The country of Ahaggar, between 23° and 29° N. lat., and 5° E. long., appears to form the central elevation from which the greater of these dry water-courses radiate; from it a series of long wadys—one of them, the wady Rharis or Igharghar, being about 600 miles in length—run northward towards a depressed country which lies inland from the Gulf of Cabes, and contains several salt lagoons, covered with a few feet of water in winter, but dried up in summer, and lying considerably below the Mediterranean level. Other wadys radiate west and south-west from Ahaggar to the unknown region of the Sahara, which lies between this and the northern bend of the Niger. The most truly desert region of the Sahara is an irregular belt of shifting sand dunes, the "Erg" or "Areg," which stretches from the lagoons above referred to near the Mediterranean coast south-westward to near the river Senegal and the Atlantic, in an unbroken chain for upwards of 2000 miles, and having an average width of perhaps 200 miles. In this sand belt the wadys of the inward slope of the plateau of Barbary terminate, excepting the Wady Saura, which crosses the Erg to the important oasis of Tuat, near the centre of its southern border, and the Wady Draa, which turns to the Atlantic coast. From Wady Draa a great plain extends along the western shore as far as the river Senegal, and probably continues as such to the east towards Timbuktu, and thence to Lake Chad. Thus it appears that the western half of the Sahara is surrounded by a broad belt of plains and depressions, the central parts being formed by extensive table-lands, with occasional mountain knots, such as that which forms the fertile kingdom of Air and Asben, the culminating points of which are from 4000 to 5000 feet high.

The eastern portion of the Sahara appears to have nearly the same general elevation as the western half, and near its centre several fertile mountain regions, comparable with that of Asben, are known. Such is the mountainous country of Borgu, north-east of the kingdoms which surround Lake Chad, and Tibesti, north of it, in the centre of the Tibbu district, recently explored by Dr Nachtigal, who found rich vegetation and abundant animal life in the valleys of this mountain group.

The great South African plateau.

To the south and east of the region just described Africa may be considered as one connected mass of elevated land, comprising the most extensive table-lands, as well as high mountain groups and chains.

The great mass of the African plateau land is to southward of the 10th parallel of N. latitude, but it is prolonged on the eastern side almost to the north coast of the continent by the wedge-shaped table-land of Abyssinia, the highest surface in Africa, and by the mountains which extend from it between the lower course of the Nile and the Red Sea. The terminal point of the high land in this direction may be said to be Jebel Attaka, which rises immediately west of Suez to a height of 2640 feet. From this point to the southern extremity of the continent the eastern, and generally higher edge, of the great plateau runs in an almost unbroken line. Passing southwards along its margin, the most prominent heights before the table-land of Abyssinia is reached are Mounts Elba, 6900, and Soturba, 6000 feet in elevation, near the middle of the African coast of the Red Sea. There may, however, be greater heights in the little known region of Nubia, which lies between these mountains and the Nile.

Eastern edge of the plateau.

The eastern slope of the Abyssinian plateau begins immediately south of the port of Massowah, and is a uniform line of steep descent, unbroken by any river, falling abruptly from an average height of 7000 feet to the depressed plain which here skirts the coast of the Red Sea. This edge, which extends southward for at least 800 miles, forms the water-parting of the rivers which have furrowed deeply into the opposite slopes of the plateau, and appears to be higher than the general surface of the country; yet several lofty groups of mountains rising from the level of the high land attain a much greater elevation, and Mount Abba Jared, the highest known point, is estimated at 15,000 feet above the sea. Between the most southern part of Abyssinia which is known and the equator, where the edge of the plateau has again been partly explored, a long space of unknown country intervenes; but there is every reason to believe that the slope is continuous. Mount Kenia, 18,000 feet, and Kilimanjaro, 18,715 feet, the highest points in all Africa, mark the eastern edge under the equator; further south on the inland route from Zanzibar to the Tanganyika, the edge is known as the Rubeho Mountains, with a height of 5700 feet at the pass by which they are crossed on the caravan route. Still further, the edge is again known where it forms a rampart, called the Njesa, walling in the Nyassa Lake. From this point Mount Zomba, 7000 feet high, near Lake Shirwa, Mount Milanje, 8000 feet, and Mount Clarendon, 6000 feet, carry it south to where the Zambezo river makes the first break in its uniform line. The narrows and rapids of Lupata, below the town of Tete, mark the point at which the river breaks through the plateau land to the coast slope beneath it. Passing the river, the eastern edge is again followed in the Mashona and Matoppo Mountains (7200 feet) of Mosilikatse's kingdom, from which heights the chief tributaries of the Limpopo river flow. At the head-waters of that river the plateau edge forms the Hooge Veldt of the Transvaal Republic which joins with the Kathlamba or Drakenberg. The portion of the edge which bears this name is specially prominent: it runs southward in a huge wall of rocky crags which support the table-land behind for 500 miles, almost parallel with the coast, and at a distance of 150 miles from it, having Zulu Land, Natal, and Caffraria on the slopes of the spurs which it throws down to the coast. In the Transvaal Republic, where the Drakenberg joins the Hooge Veldt, the edge attains a height of 8725 feet in the summit named after the explorer Mauch, but it is highest where it forms the interior limit of Natal, and where Cathkin Peak rises to 10,357 feet above the sea.

As in Abyssinia, so here, this part of the eastern plateau

edge is the great water-parting of the continent, and the streams which form the Orange river flow down its inward slope. There is no break in the continuance of the edge where it passes round from the Drakenberg to form the inmost and highest of the alternate ridges and terraces of the Cape Colony. It is now named in successive parts from east to west the Storm Berge, the Zuur Berg, Schnee Berge, Nieuwe-veld, and Rogge-veld, the last-named portion of the edge turning northward with the bend of the western coast. Its greatest height within the Cape Colony is in Compass Berg, the summit of the Schnee Berge, 8500 feet above the sea.

Southern edge of the plateau.

The outer terraces of the Cape Colony, in which two chief ridges may be traced, lie closer together, and much nearer the coast; between these and the inmost or chief edge is the dry elevated region known as the Great Karroo. Their elevation is also very considerable, though they are broken through by lines of drainage sloping from the chief edge; the part of the middle ridge, which is named the Little Zwarte Berge, attains 7628 feet, and several points in both are upwards of 6000 feet above the sea. Table Mountain, a well-known and flat-topped mass of granite overhanging Cape Town, 3550 feet high, is the nucleus of the peninsula which extends south to form the Cape of Good Hope, but is altogether separated from the mountain ridges of the colony.

Western edge of the plateau.

The western edge of the great African plateau is generally lower than the eastern, since the whole slope of the continent is more or less from the great heights on its eastern side, towards the west, but it is also clearly traceable, and of great height throughout. Rounding the western side of the Cape Colony, the three ridges above noticed run together, and decrease somewhat in elevation as the mouth of the Orange river is approached. Their elevation at the point of union in Little Namaqua Land is still very considerable; and here Mount Welcome attains 5130 feet, and Vogelklip, to north of it, 4343 feet above the sea. Beyond the Orange river in Namaqua and Damara Lands, the western edge continues in one or more terraces parallel to the coast. Mount Omatako, in the latter country, rises to 8800 feet. Northward, through Benguela and Angola, a more broken series of ridges and terraces mark the descent from the interior plateau, and the great Congo river breaks through to the coast-land at the place where it forms the cataracts of the narrow gorge of Yellala. Sierra Complida is the name given by the Portuguese to that part of the western edge which runs between the Congo and the rapids of the lower Ogowai river on the equator. On the plateau edge at the southern side of this river, Du Chaillu has made known a mountain of 12,000 feet in elevation; and the furthest point which has been reached on the Ogowai was in the vicinity of high mountains. Passing the Ogowai, and following the coast of the Bight of Biafra, the edge is now known as the Sierra do Crystal. The Camaroon mountains, at the head of the gulf, form a high peninsula of volcanic mountains, rising to 13,700 feet; but are isolated from the plateau lands, and belong rather to the remarkable line of volcanic heights which shows itself in the islands of Fernando Po, Prince's Island, St Thomas, and Annobon, stretching away into the ocean in the direction of St Helena. From the Sierra do Crystal the plateau edge inclines towards the lower course of the river Niger to a point above its delta, and below the confluence of the Benue, and then turns abruptly to the east.

The heights which skirt the northern coast-land of the Gulf of Guinea, and which stretch as far as the head-waters of the Senegal and Gambia, and in the inner slope of which the Niger also has its sources, may be considered as an extension from the great plateau. But they are of smaller general elevation; and that best known part of the ridge, which has the name of the Kong Mountains, is apparently not higher than from 2000 to 3000 feet

Northern edge of the plateau.

The northern edge of the great African plateau is almost unknown; but there are evidences that it runs eastward between the 4th and 8th parallels of N. latitude, to a point at which it is well known, and where the Nile falls over its slope, forming the succession of rapids above Gondokoro. The character of the upper Benue river is that of a mountain-born river; and Mounts Alantika, 10,000 feet high, and Mindif, 6000 feet, which rise to southward of Lake Chad, seem to be the outliers of the plateau edge in which the Benue has its sources. Beyond the Nile the margin of the plateau curves northward, to form the inner slope of the Abyssinian table-land.

Heights in the interior of the plateau.

The general elevation of the surface of the great African plateau, the limits of which have now been traced, may be taken at from 3000 to 4000 feet above the sea; but its surface presents very great undulations, from the depressions which are occupied by some of the great lakes, to the high mountains which rise above its average level. The most prominent of these interior masses yet known are the Blue Mountains, discovered by Baker, rising from the western shore of the Albert Lake to a height of perhaps 10,000 feet, and which are believed to extend southward to unite with the Balegga Mountains, made known by Livingstone in his journey of 1871, north-west of Lake Tanganyika; these again are believed to join with the mountains which rise midway between the Victoria, the Albert Nyanza, and the Tanganyika, dividing the drainage to these vast lakes, and rising here in Mount M'fumbiro to upwards of 10,000 feet. Another great central line of heights which also had an important part in directing the water-shed of the interior of South Africa, runs from the north of the Nyassa Lake, where it is named the Lobisa plateau, through the Muchinga Mountains, which separate the drainage of the Lualaba and its lakes from that of the Zambeze basin, westward to the heights in the far interior of Angola, known as the Mossamba Mountains, and from which rivers flow in all directions.

Plateau of Barbary.

The plateau of Barbary, in the north of the continent, beyond the lower land of the Sahara, is a distinct and separate high land, stretching from Cape Bon, on the Mediterranean coast opposite Sicily, in a south-westerly direction to the Atlantic coast, through Tunis, Algeria, and Marocco. The eastern portion of it in Algeria and Tunis rises in a broad plateau from 2000 to 3000 feet in general height, with outer heights, enclosing an elevated steppe, at a distance of about 100 miles apart. On the west, where it enters Marocco, these outer ridges draw together and form the high ranges of the Atlas Mountains, rising to a much greater elevation, and attaining 11,400 feet in the summit named Mount Miltsin.

Greater geological features.

The African continent, as far as it has yet been explored, seems to be the portion of the globe least disturbed by volcanic action. The known active volcanoes in the continent are those of the Camaroon Mountains, on the coast of the Gulf of Guinea in the west, and the Artali volcano in the depressed region of the salt desert which lies between the Abyssinian plateau and the Red Sea. This latter volcano is probably a part of the system with which the volcanic island of Jebel Tur, in the Red Sea, near the same latitude, is connected. One other active volcano only is known by report,—the Njemsi volcano, in the country between Mount Kenia and the Victoria Lake. Shocks of earthquake appear to be almost unknown in any part of the continent. It has been pointed out by the late Sir Roderick Murchison that the older rocks which are known to circle round the continent, unquestionably included an interior marshy or lacustrine country, and that the present centre zone of waters, whether lakes, rivers, or marshes, extending from Lake Chad to Lake Ngami, are but the great modern residual phenomena of those

of a mesozoic age. The surface of the South African continent has not been diversified in recent times by the outpouring of lava streams, or broken up by the efforts of subterranean heat to escape. Nor has it been subjected to those great oscillations by which the surfaces of many other countries have been so placed under the waters of the ocean as to have been strewed over with erratic blocks and marine exuviæ. The interior of South Africa may therefore be viewed as a country of very ancient conservative terrestrial character. Knowledge of the special geology of Africa is yet confined to the few parts of the continent in which Europeans have permanently settled. In this respect the southern region of the Cape Colony and Natal have advanced furthest, and their geological features have been mapped out with some accuracy. Elsewhere in the continent, excepting in Algeria and Angola, light has only been thrown along the line followed by the few explorers who have given attention to this subject.

Minerals and metals.

Among the minerals of Africa, salt is widely distributed, though in some districts wholly wanting. Thus in the Abyssinian high land the salt, which is brought up in small blocks from the depressed salt plain on the Red Sea coast beneath, is so valued as to be used as a money currency; and in the native kingdoms of South Central Africa, the salt districts are royal possessions strictly guarded. Metals seem nowhere very abundant. Gold is perhaps the most generally distributed. The gold-fields of the Transvaal Republic and of the country which extends thence to the Zambeze, are numerous; but no yield has as yet been discovered of sufficient quantity to overcome the difficulties of working, and of transport to the distant sea-ports, to which no navigable rivers lead from this region. Copper is known to exist in large quantities in the mountains of native kingdoms of the centre of South Africa; and one of the objects of Dr Livingstone's present journey is to visit the famed copper country of Katanga south-west of the Tanganyika Lake. The diamond-fields in the districts of the Vaal and Orange rivers north of the Cape Colony are now steadily worked, and give good returns.

General nature of the surface of Africa.

Africa is the only one of the continents of the globe which lies equally to north and south of the equator, and the portions of it which extend beyond the tropics do not advance far into the temperate zones. From this it results that Africa, besides being the warmest of all the continents, has also the most equal distribution of the sun's heat during the seasons over the parts which lie north and south of the central line. Winds and rain, depending on the distribution of heat, are also correspondingly developed in these two great divisions of the continent, and the broad landscape zones, passing from humid forest to arid sandy desert, also agree exactly with one another north and south of Equatorial Africa.

Equatorial forests.

Between 10° N. and 10° S. of the equator, but especially in that portion of it the outskirts of which have only as yet been reached by travellers, Africa appears to be a land of dense tropical forest. Wherever it has been penetrated, travellers speak of an excessively rank vegetation; passage has to be forced through thick underwood and creeping plants, between giant trees, whose foliage shuts out the sun's rays; and the land teems with animal and insect life of every form and colour. Describing the forests of Manyuema country, west of the Tanganyika Lake, Livingstone says—"Into these [primæval forests] the sun, though vertical, cannot penetrate, excepting by sending down at midday thin pencils of rays into the gloom. The rain water stands for months in stagnant pools made by the feet of elephants. The climbing plants, from the size of a whipcord to that of a man-of-war's hawser, are so numerous, that the ancient path is the only passage. When one of the giant trees falls across the road, it forms a wall breast high to be climbed over, and the mass of tangled ropes brought down makes cutting a path round it a work of time which travellers never undertake." Here there is a double rainy season, and the rainfall is excessive. To north and south of this central belt, where the rainfall diminishes, and a dry and wet season divides the year, the forests gradually open into a park-like country, and then merge into pastoral grass-lands. In North Africa this pastoral belt is occupied by the native states of the Soudan, from Abyssinia westward, in the parallel of Lake Chad, to the Gambia on the Atlantic coast; and corresponding to this in the south, are the grass-lands stretching across the continent from the Zambeze to southern Angola and Benguela. The pastoral belts again gradually pass into the dry, almost rainless desert zones of the Sahara in the north, and the Kalahari desert in the south, which present many features of similarity.

Northern and southern pastoral belts.

Deserts.

The extremities of the continent, to which moisture is carried from the neighbouring oceans, again pass into a second belt of pastoral or agricultural land, in the northward slopes of the plateaus of Barbary, Marocco, Algeria, and Tunis, corresponding with the seaward terraces of cultivated land in the Cape Colony in the south.

Rivers.

Taking a broad view of the hydrography of Africa, there are two great areas of continental drainage, one in the north, the other in the south, from which no water escapes directly to the ocean. These correspond almost exactly with the two desert belts of the Sahara and the Kalahari above described. The whole of the remaining portions of the continent, its forests and pastoral districts, in which the greater rainfall gives greater power to the rivers, are drained by streams which find their way to the ocean on one side or other, generally forcing a passage through some natural or waterworn gorge in the higher circle of mountains which run round the outer edges of the great plateau.

By far the larger portion of the oceanic drainage of the continent is to the Atlantic and its branch the Mediterranean, to which the Nile, Niger, Ogowai, Congo, and Orange rivers flow. The great rivers which drain on the opposite side, to the Indian Ocean, are the Juba, Zambeze, and Limpopo; whilst the northern continental basin, by far more extensive than the southern, has only one great river, the Shari, which supplies Lake Chad.

It must be noticed that the capabilities of the African rivers, as highways of approach to the interior of the continent, are exceedingly small in comparison with those of the other great continents of the globe, most of them being either barred at their mouths, or by rapids at no great distance from the coast. It is owing to this physical cause mainly that the African continent has remained for so many centuries a sealed book to the civilised world. On the other hand, it must be observed, that when these outer barriers have been passed, the great interior of the land, in its most productive regions, possesses a network of vast rivers and lakes, unsurpassed in extent by those of any country of the world, by means of which the resources of Central Africa may in future be thoroughly developed.

Nile.

The Nile is the oldest of historical rivers, and afforded the only means of subsistence to the earliest civilised people on earth, and yet the origin of this river remained an enigma almost to the present day. Though it drains a larger area than any other river of Africa, upwards of 1,000,000 square miles, and in this respect is one of the largest rivers of the globe, the Nile, passing for a great portion of its lower course through the desert belt of North Africa, and receiving no tributaries there, loses much of its volume by evaporation, and is far surpassed in the quantity of water conveyed to the ocean by the Congo, in the moist equatorial zone. The great labours of Dr

Livingstone, in the lake region of Central Africa, have so narrowed the space within which the sources of the Nile can exist, that, though no traveller has yet reached the ultimate feeders of the great river, their position can now be predicated almost with certainty. The limit of the Nile basin on the south is formed by the high mountains which rise to westward of the Albert Lake, and which divide between this great reservoir and the Tanganyika, extending eastward to the plateau of Unyamuezi, on the northern side of which the Victoria Nyanza lies. The ultimate sources must then be the feeders of these great equatorial lakes, the Victoria and Albert. The river issuing from the former lake, at the Ripon Falls, 3300 feet above the sea, to join the northern end of the Albert Nyanza, may be considered as the first appearance of the Nile as a river. At the Ripon Falls the overflow is from 400 to 500 feet in breadth, and the descent of 12 feet is broken in three places by rocks. Further down, where the river turns westward to join the Albert Lake, it forms the Karuma and Murchison Falls, the latter being 120 feet in height. From the Albert Lake, the Nile, called the Kir in this part, begins its almost due northward course to the Mediterranean, and has no further lake expansion. Between the Albert and Gondokoro, in 5° N. lat., which lies at 2000 feet above the sea, the Nile descends at least 500 feet in a series of rapids and cataracts. Beyond Gondokoro, up to which point it is navigable, it enters the northern lower land of Africa, which is here a region of swamps and forests, and several tributaries join it from the west. The largest of these, named the Bahr-el-Ghazal, unites with the main stream below the 10th parallel; and, not much further on, a main tributary, the Sobat river, joins the Nile from the unknown region which lies to the south-east. Hence, onward, the Nile is known as the Bahr-el-Abiad or White River. The two remaining great tributary rivers descend from the high land of Abyssinia on the east. The first of these, the Bahr-el-Azrek or Blue River, its waters being pure in comparison with those of the Nile, has its source near Lake Dembea or Tzana, through which it flows, in the western side of the Abyssinian plateau, 6000 feet above the sea; forming a semicircular curve in the plateau, the Blue Nile runs north-westward to the confluence at Khartum, 1345 feet above the sea. Between this point and the union of the next tributary, the Nile forms the cataract which is known as the sixth from its mouth. In about 18° N. it is joined by the Atbara or Black River, the head stream of which is the Takkazze, flowing in a deep cut valley of the high land. This tributary is named from the dark mud which it carries from the high land, brought down to it by streams which swell into rushing torrents in the rainy season. It is to these rivers that the fertility of Lower Egypt is mainly due, for each year a vast quantity of Abyssinian mud is borne down to be spread over the delta. Hence the Nile pursues its way in a single line through the dry belt of desert to the Mediterranean without a single tributary, descending by five cataracts, at considerable distances apart. The delta of the Nile, in which the river divides into two main branches, from which a multitude of canals are drawn off, is a wide low plain, occupying an area of about 9000 square miles. The most remarkable circumstance connected with the delta is the annual rise and overflow of the river, which takes place with the greatest regularity in time and equality in amount, beginning at the end of June, and subsiding completely before the end of November, leaving over the whole delta a layer of rich fertilising slime.

Streams from the plateau of Barbary.

The Sheliff in Algeria, and the Muluya in Eastern Marocco, are the chief streams flowing to the Mediterranean from the high land of Barbary.

Passing round to the Atlantic system, the Sebu, the Ummer Rebia, and the Tensift, from the Atlas range, are permanent rivers flowing across the fertile plain of Western Marocco, which they serve to irrigate. Next is the Wady Draa, a water-course which has its rise on the inner slope of the high land in Marocco, and which bends round through the Maroccan Sahara to the Atlantic, near the 28th parallel. Its channel, of not less than 500 miles in length, forms a long oasis in the partly desert country through which it flows, and water remains in its bed nearly throughout the year.

A stretch of 1100 miles of waterless coast, where the desert belt touches on the Atlantic, intervenes between the Draa and the Senegal river, at the beginning of the pastoral belt in lat. 15° N.

The Senegal rises in the northern portion of the belt of mountains which skirt the Guinea coast, and has a north-westerly course to the sea. During the rainy season it is navigable for 500 miles, from its mouth to the cataract of Feloo, for vessels drawing 12 feet of water, but at other times it is not passable for more than a third part of this distance. The Gambia has its sources near those of the Senegal, and flows westward in a tortuous bed over the plain country, giving a navigable channel of 400 miles, up to the Falls of Barra Kunda. The Rio Grande, from the same heights, is also a considerable river. Senegal. Gambia.

The Niger is the third African river in point of area of drainage and volume; it is formed by the union of two great tributaries, the Quorra and Benue,—the former from the west, the latter from the country in the east of the river basin. The Quorra, called the Joliba in its upper course, has its springs in the inner slope of the mountains which give rise to the Senegal and Gambia, not far from the Atlantic coast. At first its course is north-eastward to as far as the city of Timbuctu, on the border of the desert zone; then it turns due east, and afterwards south-east to its confluence with the Benue, at a point 200 miles north from the coast of the Gulf of Guinea. The chief tributary of the Quorra is the Sokoto river, coming from the elevated country which forms the water-parting between the Niger basin and that of Lake Chad on the east, and its confluence is near the middle of the portion of the channel of the Quorra which bends to south-east. Niger.

At a distance of about 100 miles from its sources, the traveller Park, the first European who reached the Joliba, found it flowing in a wide fertile valley, and navigated by canoes which kept up a constant traffic. Above Timbuctu the commerce of the river is busily carried on in barges of 60 to 80 tons burden; further on, where the river touches upon the desert belt in the most northerly portion of its course, its fertile banks form the most marked contrast to the arid desert lands beyond. From the confluence of the Sokoto to the union with the Benue, the river course is only navigable after the rainy season, since at other times rocks and shoals interrupt the passage. The sources of the Benue are unknown as yet, but it is believed to have its rise in the northern edge of the great plateau of Southern Africa, almost due south of Lake Chad; its known course is westward, and at the furthest point to which it was easily navigated by the traveller Baikie, nearly 400 miles from its confluence with the Kawara or Quorra, it was still half a mile in width and about 10 feet in average depth, flowing through rich plains. From the confluence of the Quorra and Benue the Niger has a due south course to its delta, and the united river has an average width of about a mile. At a distance of 100 miles from the sea, minor branches which enclose the delta separate from the main stream on each side. The delta is much more extensive than that of the Nile, and measures about 14,000 square miles of low alluvial plain, covered with forest and jungle, and completely intersected by branches from the main river, the outmost of which reach the sea not less than 200 miles

apart. Unlike the Nile, the Niger possesses one main channel through the centre of the delta, called at its mouth the Nun river.

Gaboon Old Calabar river, the Camaroon river, and the Gaboon, are the best known of a number of wide inlets or estuaries of the sea, which occur on the west coast immediately north of the equator; but these are merely the receptacles of a number of minor streams, not the mouths of great rivers, as at one time supposed.

Ogowai. The Ogowai (pron. Ogowee) river, the delta of which forms Cape Lopez, immedaitely S. of the equator, is a great stream which is believed to drain a large area of the forest zone between the Niger and the Congo; as yet, its lower coast is only known to a distance of 200 miles from the sea. Above the delta the main stream of the river, named the Okanda, breaks through the edge of the plateau, and is joined by the Onango, a tributary from the coast range of the Sierra Complida. Below this confluence the river is a mile and a half in average width, its depth varying from 15 to 50 feet. The delta is formed by the two main branches into which the Ogowai divides at about 30 miles from the coast, and is a swampy flat, covered with mangroves.

Congo. The Congo or Zaire must be considered the second river of Africa in point of area of drainage, and it is the first in respect of the volume of water which it discharges to the ocean. There remains but little doubt that the head streams of this vast river are those which supply the great lacustrine system discovered by Dr Livingstone in his recent journeys south and west of Lake Tanganyika. Through these lakes the river, which rises in the upland north of Lake Nyassa, named in different parts of its course the Chambeze, Luapula, or Lualaba, flows in great bends to west and northward, to where it passes into the unknown country still to be explored in the heart of the continent. The Lualaba has a great tributary named the Lufira, from the south; and it is almost certain that the Kassabi river, which springs in the Mossamba Mountains, in the interior borders of Angola, is also one of the feeders of this great river. The Guango river, rising in the same mountains, nearer Angola, must also join the Congo lower down in its valley. At the furthest point on the Lualaba reached by Livingstone, in about lat. 6° S. and long. 25° E., the great river had a breadth of from 2000 to 6000 yards, and could not be forded at any season of the year. Every circumstance connected with this river—its direction, the time of its annual rising, and the volume of its water which could be discharged by the Congo mouth alone—point to its identity with this river. The explorer Tuckey, who, in 1816, followed up the Congo from its mouth on the west coast further than any one, found it, above the cataracts which it forms in breaking through the coast range, to have a width of from 2 to 4 English miles, and with a current of from 2 to 3 miles an hour; and his statement that at the lowest stage of its waters it discharges 2,000,000 of cubic feet of water per second, has been confirmed by more recent surveys. Forty miles out from its mouth its waters are only partially mingled with that of the sea, and some nine miles from the coast they are still perfectly fresh. The Congo is the only one of the large African rivers which has any approach to an estuary, contrasting in this respect with those which have delta mouths.

Coanza. The Coanza, the most important river of Angola, in respect of its affording a navigable channel for 140 miles from its mouth, rises in a broad valley formed by the Mossamba Mountains in the interior of Benguela, and curves north-westward to the ocean. Its upper course is rapid, and its navigation only begins after the last of its cataracts has been passed; the mouth is closed by a bar. The Cunene river has its rise in the opposite watershed of the mountains, its springs being close to those of the Coanza, and its course is south-westward, forming the southern limit of the territory of Mossamedes. It is the most southerly river of the central fertile zones of Africa on this side of the continent, and appears to be suitable for navigation throughout the greater part of its length—rising from 15 to 20 feet at times of flood, but having such a depth, at its lowest stage, as to be only passable by canoes.

From the Cunene, in lat. 17° S., to the Orange river in 29° S., the dry belt of the South African desert zone intervenes, and there are no permanent rivers on the land sloping to the sea. The coast lands from the edge of the plateau are, however, furrowed by numerous water-courses, which are filled only after the occasional rainfalls.

The Orange river also belongs for the greater part of its lower course to the water-courses of the arid belt, but it receives such a constant supply from its head streams, which descend from the high lands near the east coast of the continent, as to be able to maintain a perennial flow in its channel, which, however, is so shallow as to be of no value for navigation. Its main head streams are the Vaal and Nu Gariep or Orange, which rise on the opposite slopes of one of the summits of the Drakenberg range, called the Mont aux Sources. After encircling the Orange River Free State, these rivers unite near the centre of this part of the continent to form the Orange, which continues westward to the Atlantic, but without receiving any permanent tributary. The chief water channels which periodically carry supplies to it from the south are Brak and the Great Hartebeeste; from the Kalahari region in the north come the Molopo and Nosob channels. Midway between the union of the head streams and the ocean the river forms a great fall of 150 feet in height. Orange

The rivers which flow down from the terraces of the Cape Colony are numerous, but have little permanent depth of water, shrinking almost to dryness excepting after rains, when they become impetuous torrents; some have cut deep channels, much beneath the level of the country, and the banks of these cañons are choked with dense vegetation. Passing round to Natal and Zulu Land, the coast country is well watered by frequent streams which descend from the base of the cliff-wall of the Drakenberg; these have generally the character of mountain torrents, with rapid flow between high banks and changing volume, and are almost without exception closed at their mouths by sand bars, which in most instances shut in considerable lagoons. One of these, the lake of Santa Lucia, is more than 40 miles in length. Drainage to the Indian Ocean.

The first large river of the Indian Ocean system is the Limpopo or Crocodile river, so named from the great number of these animals found in its bed. Its basin lies centrally in the southern tropic, also in the desert belt, and on this account it barely maintains a shallow flow of water throughout the year. Its sources are in that part of the plateau edge in the Transvaal Republic which is known as the Hooge Veldt and Magalies Berg; from this it forms a wide semicircular sweep to north-east and south, reaching the ocean not far north of Delagoa Bay, in 25° S. Its chief tributary, the Olifant or Lepalule, has its rise in a part of the Hooge Veldt which is nearer the coast. Many of its minor tributaries in its lower course are periodical streams known as *sand rivers*, only filled after heavy rains. Limpopo

The Zambeze is the great river of the pastoral belt of South Africa, and the fourth in point of size in the continent, draining nearly 600,000 square miles. As far as its basin has yet been explored, the Zambeze has three head streams from the great water-parting ridge which extends from the Mossamba Mountains of inner Angola to the high lands north of Nyassa Lake, about the 12th parallel of S. latitude. There are the Lungebungo river from the Mossamba Mountains, the Leeba river from Lake Dilolo, on the water-parting which separates be- Zambeze.

tween the Zambeze and the Kassabi river, and the Leeambye or Jambaji, probably the main-source stream, coming from the unknown lands south-west of the Cazembe's territory. From the union of these streams the general course of the Zambeze is in two wide curves eastward, through the plateau and over its edge to the Indian Ocean, in about 19° S. lat. From the north its main tributaries are the Kafue and Loangwa or Aruangoa rivers, and the Shire river, flowing out of Lake Nyassa. Above this point, on its middle course, where it forms the great Victoria Falls, the Zambeze receives the Chobe from the north-west; and from southward numerous minor tributaries join its lower channel. The Zambeze forms a delta with many mouths, the outmost of which are nearly 100 miles apart, and their entrances are generally barred by sand banks; but if these be passed, the main river is continuously navigable for 320 miles to the town of Teté, and its tributary the Shire may also be followed up for nearly 150 miles, to where its cataracts stop navigation. At the Victoria Falls the great river contracts from its general width of nearly a mile, to 60 or 80 feet, and plunges over a height of 100 feet, into a remarkable zig-zag gorge rent in the hard basalt rocks.

The Rovuma, which has its chief tributaries from the plateau edge on the eastern side of Lake Nyassa, is the next great river of the drainage to the Indian Ocean. It has been navigated by Livingstone for 150 miles from the coast, and formed part of his route in entering the continent on the journey from which he has not yet returned, but its basin has not yet been explored.

Still farther north the mouths of a great river named the Rufiji are known, on the coast opposite the island of Monfia, south of Zanzibar; but no part of its course has yet been traced by any European.

The Kingani and the Wami are two streams from the plateau edge, in the country of Usagara, and reach the sea in the channel formed by Zanzibar island. The Pangani river, further north, rises in the snowy mountain Kilimanjaro. The Sabaki and Dana, which embouch on the opposite side of Formosa Bay, in 3° S., flow over the same coast plains, having their head springs in the spurs of Mount Kenia. The latter river might be navigated during the rainy season for 100 miles from the coast.

The Juba river is the most considerable on the eastern side north of the equator. It is believed to have its rise in the high lands immediately south of Abyssinia, and its general direction is south-eastward to the Indian Ocean; but nothing is known of its higher course except by report. The ill-fated expedition under Baron von der Decken explored this river for about 180 miles upwards from its mouth, but as yet no traffic is carried on by its means. The Webbe or Haines river flows down from the high lands in a direction nearly parallel to the Juba, a little farther north, but its outlet on the coast is completely barred by sand dunes of from 400 to 500 feet in height, behind which it forms a lagoon of varying extent. The desert zone is now again reached, and the water supply fails. No permanent rivers reach the Red Sea from the Abyssinian highlands or from the heights of Nubia which continue these northward; the largest water-course is that of the Barca, which is periodically filled by its tributaries in the northern part of the Abyssinian plateau.

Turning now to the great areas of continental drainage, it is observed that in North Africa there is a vast space of upwards of four millions of square miles, extending from the Nile valley westward to the Atlantic coast, and from the plateau of Barbary in the north to the extremities of the basin of Lake Chad in the south, from which no single river finds its way to the sea. The whole of this space, however, appears to be furrowed by water channels in the most varied directions. From the inner slopes of the plateau of Barbary numerous wadys take a direction towards the great sand-belt of the Erg, in which they terminate; a great series of channels appears to radiate from the higher portion of the Sahara, which lies immediately north of the tropic of Cancer and in about 5° E. of Greenwich; another cluster radiates from the Mountains of Tibesti, in the eastern Sahara.

Lake Chad, on the margin of the pastoral belt, is supplied by a large river named the Shari, coming from the moist forest country which lies nearer the equator; and the lake, which till recently was believed to have no outlet, overflows to north-eastward, fertilising a great wady, in which the waters become lost by evaporation as they are led towards the more arid country of the Sahara.

The southern area of continental drainage is of much smaller extent, and occupies the space of the desert zone which lies between the middle of the Zambeze basin and Damara Land. It centres in Lake Ngami, to which the Tioge river flows from the pastoral belt on the north-west. Several water-courses from the high Damara Land also take a direction toward this lake. The river Zuga carries off the overflow of Lake Ngami towards a series of salt lagoons which lie eastward near the edge of the plateau; but it becomes narrower and less in volume as it approaches these, and in some seasons scarcely reaches their bed.

Smaller spaces of continental drainage exist at various points near the eastern side of the continent. One of these occupies the depressed area between the base of the Abyssinian highland and the Red Sea, and is properly a continuation of the Sahara desert belt beyond the intervening plateau. In this space the Hawash river, descending from the plateau, terminates before reaching the sea. Another interior basin lies in the plateau between the edge on which mountains Kenia and Kilima-njaro rise and the country east of the Victoria Lake, and includes several salt lakes. It is probable that the great Tanganyika Lake is the centre of a third basin of no outflow on this side of the great plateau; and Lake Shirwa, south-east of the Nyassa, constitutes a fourth.

Lakes

The great lakes, which form such a prominent feature in African hydrography, are found chiefly in the southern and eastern regions of the continent, but they are distributed over all the systems of drainage. The Victoria and Albert Lakes of the Nile basin are great seas of fresh water; and if their extent should ultimately prove to be nearly that which is at present believed, they rival the great American lakes for the place of the greatest expanse of fresh water on the globe. The former, the Victoria Lake, is at an elevation of about 3300 feet above the sea; and its outline, as at present sketched on our maps, occupies an area of not less than 30,000 square miles. The Albert Lake, 2500 feet above the sea, is believed to have an extent not far short of this. Lake Baringo, north-east of the Victoria, is reported to be a great fresh lake, discharging towards the Nile by a river which is possibly the Sobat tributary. Lake Tzana or Dembea, 60 miles in length, at a level of 6000 feet above the sea, on the Abyssinian plateau, is the only remaining great lake of the Nile basin.

Nile Lakes.

Congo Lakes.

The great expansions of the Chambeze-Lualaba river, presumably belonging to the river Congo, are the only other considerable lakes of the Atlantic drainage. The highest of them, Lake Bangweolo or Bemba, is described as being 150 miles in length from east to west, and at an elevation of 4000 feet; Lake Moero, the next, extends through 60 miles; Lakes Kamalondo or Ulenge, and the yet unvisited lakes of the same drainage, are described as of vast extent, and lie at an elevation of about 2000 feet above the sea.

Zambeze Lake.

Belonging to the drainage system of the Indian Ocean are, Lake Nyassa, 1500 feet above the sea, and stretching meridionally over an area of nearly 9000 square miles in the basin of the Zambeze; and Lake Samburu, a reported lake of great extent, lying in the plateau edge north of Mount Kenia, and probably belonging to the basin of the Juba river. The great Lake Tanganyika, upwards of 10,000 square miles in area, and united by a broad channel with Lake Liemba in the south, occupies a deep longitudinal basin, girt with mountains; it is 2800 feet above the sea level. As yet no outlet has been discovered for this vast lake, and the question whether it has or has not an overflowing river, is still undecided; but its waters are not perfectly fresh, the drainage to it is small, and the probability is that the Tanganyika is a continental lake. Lake Shirwa, enclosed by mountains on the plateau edge south-east of Lake Nyassa, and 2000 feet above the sea, has brackish water, and no outlet.

Continental lakes.

Lake Chad, the greatest lake of the continental system of North Africa, is a shallow lagoon of very variable extent, with numerous islands: it lies at about 1100 feet above the sea; its waters are fresh and clear, and its overflow is carried off to north-eastward by the wady named Bahr-el-Ghazal.

Lake Ngami, the corresponding lake in the southern continental system, at an elevation of about 2900 feet, is also a shallow reedy lagoon, varying in extent according to the season. The Zuga river carries off its surplus water to eastward. Salt lakes are of frequent occurrence in the areas of continental drainage; perhaps the most remarkable of these is the Assal lake, which lies in a depression east of Abyssinia comparable with that of the Dead Sea, 600 feet beneath the level of the Red Sea; the Sebka-el-Faroon or Schott Kebir, south of Tunis, is a great salt lagoon, 100 miles in length, dried up in summer, when its bed is found to be thickly encrusted with salt, and in winter covered with water to a depth of two or three feet. It lies several feet beneath the level of the Mediterranean.

Salt lakes.

Climate.

Africa lies almost entirely in the torrid zone, and is the hottest continent of all. The greatest heat, however, is not found under the equator, since the whole of the central belt of the continent is protected by a dense covering of forest vegetation, supported by the heavy rainfall, and has in consequence a more equable climate, but in the dry, bare exposed desert belts, which lie on the margins of the tropics, the Sahara in the north and the Kalahari in the south, where the climate is extreme. The highest temperature is found throughout the Sahara, particularly in its eastern portions towards the Red Sea. In Upper Egypt and Nubia eggs may be baked in the hot sands; and the saying of the Arabs is, "in Nubia the soil is like fire and the wind like a flame." The regions along the Mediterranean and Atlantic coasts are rendered more temperate by the influence of the sea. To the south of the Great Desert the temperature decreases, chiefly on account of the increasing moisture and protection of the land surface from extreme heating by its tree growth, but also because of the greater elevation of the land as the great southern plateau is approached. Both on account of its elevation and its narrower form, which gives greater access to the equalising influence of the surrounding ocean, the southern half of the African continent has a less high temperature than the northern, though the same gradations of climate outward from the centre belt are clearly marked in each division. Regular snowfall does not occur even in the most southern or northern regions; and this phenomenon is only known in the most elevated points of the continent, as in the Atlas Mountains in the north, the summits of which retain patches of snow even in summer, in the Abyssinian peaks, in the highest points of the mountains of the Cape Colony, and most remarkably in the lofty summits of Mounts Kenia and Kilima-njaro, which rise on the plateau directly beneath the equator. The intensity of radiation and its influence upon the temperature are very great in Northern Africa; while in the day time the soil of the Sahara rapidly absorbs the solar rays, during the night it cools so rapidly that the formation of ice has often been known to occur.

The observed average temperatures of the extreme months of the year at various points of Africa, from N. to S., are given in the following table:—

	Jan.	July.		Jan.	July.
Las Palmas, Canary Islands, .	61·9	73·6	Kobbé, Darfur, .	67·1	87·8
Santa Cruz, Teneriffe, . . .	63·7	77·2	Ankobar, Abyssinia,	52·0	58·1
Funchal, Madeira,	63·5	72·5	Elmina, Gold Coast,	79·7	76·7
Casa Blanca, Marocco, . . .	57·4	77·9	Christiansborg, ,,	81·0	76·5
La Calle, Algeria,	54·6	78·4	Niger Mouth (5° 9 N.), . . .	86·0	80·2
Algiers, ,, (37° N.)	55·8	76·3	Gondokoro (5° N.),	89·3	78·5
Oran, ,,	56·2	76·9	Zanzibar, . . .	83·3	77·1
Constantine, ,,	44·6	81·0	Ascension I. (7° 30′ S.), . . .	77·0	75·0
L'Aghouat, ,,	54·2	98·9	St Helena, . .	73·6	65·8
Tunis, ...	57·2	77·2	Tete, on the Zambeze (16° S.), .	82·9	72·4
Alexandria, Egypt,	57·4	78·5	Port Louis, Mauritius, . . .	81·7	71·8
Cairo, ,, (30° N.)	55·8	86·0	St Denis, Bourbon,	79·7	71·8
Kenneh, ,,	62·4	94·3	Durban, Natal, .	74·2	62·4
Freetown, Sierra Leone, . . .	82·0	77·5	Pietermaritzburg (30° S.), . .	71·4	55·2
Kuka, Bornu (13° N.), . .	75·6	83·8	Cape Town (34° S.),	74·3	57·6
			Stellenbosch, . .	77·0	57·0
			Swellendam, . .	72·7	59·9

Winds.

Africa is not much under the influence of the regular winds, except the monsoons of the Indian Ocean, the great movement of the atmosphere depending chiefly on the oscillation of the continent beneath the sun during the seasons, as will be afterwards explained. The wind currents over the whole continent have a prevailing direction from the east. There are the trade winds, modified by interruptions of changing heat and elevation of the land surface. In the northern part of the Indian Ocean the year is divided between the south-west monsoon, blowing from March till September, away from Africa, towards the then heated continent of Asia; and the north-east monsoon, or rather the normal trade wind, blowing towards the African coasts, from October till February. It will be seen in the next paragraph, that the monsoons, although they extend only to about a third portion of the East African shores, have an extremely important bearing upon the physical economy of the whole African continent. From hurricanes Africa is nearly exempt, except in its south-eastern extremity, to which at times the Mauritius hurricanes extend. At rare intervals these have visited the east coast as far as Zanzibar. Northern Africa is much exposed to the hot winds and storms from the Sahara, which are called in Egypt Khamsin, in the Mediterranean Scirocco, Shume or Asshume in Marocco, and Harmattan on the west coasts of the Sahara and in the countries bordering on the Gulf of Guinea. These always blow directly across the coast from the interior, and seem to move round the compass during the year, beginning in Egypt in April, in Algeria in July, in Marocco in August, in Senegambia in November. Similar dry electrical winds are experienced in the Kalahari desert in the south. Whirlwinds, frequently carrying sand up into the atmosphere, are of frequent occurrence in these deserts, and are also known in the dry region of Unyamuezi, between Zanzibar and the Tanganyika, and in the Limpopo basin farther south. Extreme heat and dryness are the characteristics of these winds, which, raising the sand, filling the air with dust, and prodigiously favour-

ing the powers of evaporation, are often fatal to the vegetable and animal creation in the regions visited by them.

Rains within the tropics.

In Africa the dependence of the winds and rains upon the movement of the land beneath the sun is more clearly marked than in any other intertropical region of the globe. The high temperature caused by the vertical heat of the sun over a particular area induces an indraught of air to that place, an ascending current is produced which carries up with it the warm and moist air; condensed in the higher regions of the atmosphere, the moisture falls as rain, and the condensation makes way for a further indraught. It is thus that in Africa the winds and rains follow as a rule the pendulating movement of the continent beneath the sun, and the rainy season of any space begins almost immediately after the sun has reached its zenith. Between the tropics and the equator the sun comes twice to the zenith of each belt during the year, at the tropical lines the sun is only once in the zenith; thus it follows that a double rainy season is observed in all places lying in the central belt of the tropics, and a single rainy season in those which are nearer the skirts of the zone. These wet and dry seasons correspond to the cooler and hotter periods of the year, and take the place of the summer and winter of the temperate regions. Various circumstances tend to interfere with and modify the working of this general rule of the rotation of seasons. In Southern Africa that rainy season which follows the apparent movement of the sun northward, is greater than that which ensues after his passage south, since in the former case the winds are drawn inwards from the ocean and carry greater quantities of moisture, whereas in the latter the winds are drawn from the land north of the equator, and their moisture is already in great part spent.

On the coasts.

In the northern and eastern regions of Africa the winds and rains are governed as much by the heating and cooling of the Asiatic continent as by that of Africa itself, but in the central and western portions of the continent the rule is well exemplified. Thus in Damara Land, bordering on the southern tropic, there is one short rainy season from February till April, beginning only with the northing sun; at Loanda in Angola the greater rains last from February till May, the lesser rainy season, when the sun has passed this place going south, occurs in November only. At Annobon island, surrounded by wide sea, April and May are the rainy months of the northing sun, October and November of the southing. The Guinea coast, facing the sea to southward, has its greater rainy season from March to June, when the northing sun draws the ocean winds on to the coast; and its lesser rains occur in October and November, when the sun has passed southward from the land. Nearing the northern tropical line, the coast-land from Sierra Leone to the Senegal river has a simple wet and dry season during the year.

On the eastern coast-land the rains are more dependant on the direction of the monsoon winds; about the mouths of the Zambeze and on the Mozambique coast the rains begin in November, after the north-east monsoon wind has set in over the northern part of the Indian Ocean, bringing with it the vapours drawn from the sea to condense on the coast slopes. The rains continue here till March, when the south-west monsoon begins to blow away from the land towards the then heated surface of Asia. At Zanzibar there is a double rainy season, a stronger in the months of March, April, and May, with the northing sun, beginning immediately after the south-west monsoon has set in, and a weaker in September and October with the southing sun. Under the equator on the east coast the rains begin in April with the south-west monsoon, continuing till June, and during this period the sky is obscured by heavy clouds. The second rainy season here is only marked by a few showers in September and October. Whils the north-east monsoon is blowing the sky remains of a cloudless blue.

In the interior.

In the interior of the continent, between these tropical coasts, the rainy seasons appear rather to precede than follow the advancing sun. In the region of the central Zambeze the greater rains last through February, March, and April, the lesser occurring in October and November. The worst droughts are experienced in December and January. Nearer the centre of the continent the two rainy seasons become so lengthened as almost to merge into one period of rains, extending over about eight months of the year. In the newly-explored country south-west of the Tanganyika, Dr Livingstone found that the rains began in October, and that the last showers fell in May; but there is probably a drier period between these limits. At the Tanganyika Lake the rainy season begins in September, lasting till May, and the same rainy reason has been observed in the interior country of the west coast immediately north of the equator. Between these points, in Manuyema country, Dr Livingstone found that the rains continued till July, or almost through the year. Northward in the interior the rainy seasons are again clearly divided into a greater and lesser, and in the regions west of the Upper Nile between 5° and 10° N. lat., the stronger rains occur from August till October, the weaker come with the northing sun in April and May. The plateau of Abyssinia, rising high above the general level of the north of Africa, and intercepting and condensing the moist winds, has also a double rainy season,—a greater from June to September, when the sun is passing southward; a lesser in February and April, with the northing sun. The rainy seasons in Central Africa are ushered in and accompanied by violent thunderstorms and by occasional falls of hail. The quantity of the rainfall, which is excessive in the regions near the equator, diminishes rapidly to north and south of this belt as the dry regions on the borders of the tropics are approached.

The Sahara, and also the Kalahari of Southern Africa, are almost rainless regions, but wherever a sufficient elevation occurs to intercept a cooler stratum of the atmosphere, rain is not wanting, even in the midst of the Great Desert. A striking instance of this is related by Mr Richardson. That traveller relates that when on the borders of the mountain knot of "Aïr, in about latitude 19° N., on the 30th Sept. 1850, there was a cry in the encampment, 'The wady is coming.' Going out to look, I saw a broad white sheet of foam advancing from the south between the trees of the valley. In ten minutes after a river of water came pouring along, and spread all around us, converting the place of our encampment into an isle of the valley. The current in its deepest part was very powerful, capable of carrying away sheep and cattle, and of uprooting trees. This is one of the most interesting phenomena I have witnessed during my present tour in Africa. The scene, indeed, was perfectly African. Rain had been observed falling in the south; black clouds and darkness covered that zone of the heavens, and an hour afterwards came pouring down this river of water into the dry parched-up valley."

Dry regions.

The causes of want of rainfall in the vast region of the Sahara appear to be mainly these—that the winds advancing towards it come from a cooler and moister to a warmer and drier region, indeed to the hottest and driest of all, and so are constantly losing in moisture and gaining in temperature as they approach; the high plateau of Abyssinia forms an effective screen from the winds of the Indian Ocean, wringing out their moisture before the Sahara is reached, and on the Atlantic side the north-east trade wind constantly blows away from the land; a barrier of mountains also deprives the Sahara of rain from the south-west. Another cause of dryness is the low level of great areas of the Sahara. We have seen that wherever

there is a considerable elevation, even in its midst there is a periodical rainfall. The Kalahari region is almost rainless, on account of the great heat to which it is subjected; but specially because the winds coming towards it from the eastward, the prevailing winds, expend their moisture on the high slopes of the plateau which face the Indian Ocean. Heavy dews, consequent on the rapid changes of day and night temperature in these bare regions, partly compensate the deficiency of rain.

Extratropical rains. The portions of the continent which lie beyond the tropics north and south, the outer slopes of the plateau of Barbary and of the Cape Colony, have no marked rainy season, and the times of the occurrence of rain are altered, the summers of both being drier, the showers more frequent in winter. In Natal, and on the slopes of the plateau in its neighbourhood, rain may be expected in any month; but the greatest falls occur from October to March. The absolute quantity of rain which falls in Africa has as yet been measured at so few points, that no definite conclusions can be arrived at respecting it.

Plants. Although Africa belongs almost entirely to the torrid and warm zones, its vegetable productions are essentially different in different parts. Thus, in the extreme north, groves of oranges and olives, plains covered with wheat and barley, thick woods of evergreen oaks, cork-trees, and sea-pines, intermixed with cypresses, myrtles, arbutus, and fragrant tree-heaths, form the principal features of the landscape. On this northern coast the date-palm is first found; but its fruit does not arrive at perfection, and it is chiefly valued as an ornamental object in gardens. Various kinds of grain are cultivated. Beyond this region of the coast and the Atlas chain, with the borders of the Sahara, commences a new scene. It is in this region, extending to the borders of Soudan, that the date-tree forms the characteristic feature. Being peculiarly adapted to excessive dryness and high temperature, it flourishes where few other plants can maintain an existence. Were it not for the fruit of the invaluable date-tree, the inhabitants of the desert would almost entirely depend on the products of other regions for their subsistence. With the southern boundary of the Sahara, the date-tree disappears, the baobab or monkey bread-tree takes its place, and, under the influence of the tropical rains, a new, rich, and highly-developed flora presents itself. These trees, together with huge cotton-trees, oil-palms, sago-palms, and others of the same majestic tribe, determine the aspect of the landscape. The laburnum expands its branches of golden flower, and replaces the senna of the northern regions, and the swamps are often covered with immense quantities of the papyrus plant. Instead of waving fields of corn, the cassava, yam, pigeon-pea, and the ground-nut, form the farinaceous plants. The papaw, the tamarind, the Senegal custard-apple, and others, replace the vine and the fig. In Southern Africa, again, the tropical forms disappear, and in the inland desert-like plains, the fleshy, leafless, contorted, singular tribes of kapsias, of mesembryanthemums, euphorbias, crassulas, aloes, and other succulent plants, make their appearance. Endless species of heaths are there found in great beauty, and the hills and rocks are scattered over with a remarkable tribe of plants called *Cycadaceæ*. Plants of the protea tribe also add to the extraordinary variety in the vegetable physiognomy of that region.

Of the characteristic African plants, the date-tree is one of the most important, as it is likewise among the nearly one thousand different species of palms. It furnishes, as it were, the bread of the desert, beyond which it occurs only in Western Asia, wherever a similar dry and hot climate prevails. This tree requires a sandy soil, and springs must not be absent. The dates furnish food not only for man, but for the camel and the horse. For the latter purpose the stones are used in many parts, and are said to be more nourishing than the fruit itself. The Arabs make a great variety of dishes of which dates form the chief part. Of the sap of the tree palm-wine is prepared, and the young leaves are eaten like cabbage. Date-palm.

In Southern Africa are the extensive miniature woods of heaths, as characteristic as the groves of date-palms in the north. No less than five hundred species have already been discovered. These plants, of which some reach the height of 12 to 15 feet (*Erica urceolaris*), are covered throughout the greater part of the year with innumerable flowers of beautiful colours, the red being prevalent. Heaths.

The papyrus is an aquatic plant, having a stem from 3 to 6 feet high. It inhabits both stagnant waters and running streams, and is common in the countries of the Nile, particularly Egypt and Abyssinia. Its soft, smooth flower-stem afforded the most ancient material from which paper was prepared, and for this reason it is one of the noticeable African plants. It has, however, also been used for other purposes; its flowering stems and leaves are twisted into ropes; and the roots, which are sweet, are used as food.[1] Papyrus.

The following table, compiled from the "synonymic lists of species of mammals" given by Mr Andrew Murray,[2] affords a general view of the distribution of terrestrial mammals in the different parts of Africa,—the figures denoting the number of species found in each of the divisions, those in the last column being the number peculiar to Africa:— Animals.

ORDERS.	Distributed over Africa.	N. Africa, Marocco, Egypt, and the Sahara.	Abyssinia and the Upper Nile District.	Senegambia to Lake Chad District.	East Africa, Somali Land, Zanzibar, Mozambique, and Zambezia.	Madagascar.	S. Africa, Natal to Damara Land and C. Colony.	W. Africa, Benguela to Guinea.	Total Species in Africa.	Species peculiar to Africa.
Quadrumana,	..	2	10	8	10	32	8	41	97	94
Carnivora,	5	17	23	10	18	9	30	20	91	76
Ungulata,	3	9	19	14	20	1	32	12	84	74
Multungulata,	1	...	1	1	5	...	4	5	8	8
Edentata,	...	...	2	2	2	...	2	2	7	7
Insectivora,	1	22	16	8	26	11	29	10	104	92
Rodentia,	1	36	18	10	20	...	46	16	132	121
Marsupialia and Monotremata,	...	...	...	...	...	...	...	..	...	...
Total,	11	86	89	53	101	53	151	106	523	472

Quadrumana. The order Quadrumana is well represented, more particularly within the tropics, whence they decrease northwards and southwards. The most important members of this family are the anthropoid monkeys, the chimpanzee and gorilla, in Tropical and Western Africa. Baboons and mandrils, with few exceptions, are peculiar to Africa. Only a few species of the genus *Macacus*, which is East Indian, are found in Africa. The only short-tailed species (*Macacus Innuus*)

[1] See *Flora of Tropical Africa*, by Daniel Oliver, F.R.S., F.L.S. London, 1868.

[2] *The Geographical Distribution of Mammals*, by Andrew Murray, London, 1866.

is North African, and is also found wild on the opposite coast at the Rock of Gibraltar. In Madagascar the place of the true monkeys is supplied by the peculiar tribe of the true Lemurs or makis. Many species have close affinities with those of Asia; thus the orang-outang of Borneo is represented in Africa by the chimpanzee. The gibbons are entirely wanting

Carnivora. Of the larger Carnivora the bear is almost entirely wanting, and occurs only sparely in the Atlas Mountains in Barbary. The true martens are unknown, but otters occur. Of the *Canis* family the jackal is characteristic, and roams over the whole of Africa; it differs from the Asiatic species in its paler skin, which approaches the colour of the prevailing deserts. The wolf and fox do not extend beyond the northern margin of Africa. Hyænas are true African tenants; the striped hyæna extending from Asia over North Africa, the spotted hyæna over the remainder of the continent; in the southmost part of the continent the brown hyæna is also found, and with it the aardwolf, or earth wolf of the Cape colonists, allied to this genus. Africa is the chief home of the lion, which there remains undisturbed as king over the lower animal creation, though it has been driven inwards from the more settled portions of the coast-land; while in the extreme south-western parts of Asia, to which it is now confined, its power is divided with that of the tiger. The leopard, serval, caracal, chaus, and civet cat (the locality of the true civet being North Africa), are the other principal representatives of the cat tribe. The herpestes or ichneumons have the same distribution as the civets; the species which destroys the eggs of the crocodile is found in Egypt and the North of Africa.

Ungulata. (Hoofed Mammalia, Ruminantia, and Pachydermata). Of wild horses the asinine group is characteristic of Asia, and the hippotigrine of Africa. The quagga, exclusively African, inhabits the most southern parts of the continent, and is scarcely found north of the Orange river, but occurs in great herds, associated with the white-tailed gnu; the zebra (*Equus Burchellii*), or zebra of the plains, is widely distributed over Africa, from the limit of the quagga to Abyssinia and the west coast; the zebra of the mountains (*Equus zebra*), more completely striped than the rest, is only known in South Africa. The true onager or aboriginal wild ass is indigenous to North-East Africa and the island of Socotra. A species inhabiting the high land of Abyssinia is distinct from these. The horse, domesticated in other parts of Africa, excepting the region of forests, is not found in the eastern intertropical region; and, for some cause not yet clearly ascertained, it appears to be impossible to acclimatise it there. The single humped camel or dromedary is used over the whole of North Africa, as far south and west as the river Niger and Lake Chad. The Indian buffalo has spread by introduction to North Africa; the Cape buffalo, a species peculiar to Africa, reaches as far north as a line from Guinea to Abyssinia; the *Bos Brachycerus* is a species peculiar to West Africa, from Senegal to the Gaboon. Of sheep, the *Ovis Tragelaphus* is peculiar to North Africa; the Ibex goat extends into Abyssinia. The family of the antelopes is essentially African, five-sixths of the species composing it being natives of that country, and chiefly of the portion lying south of the Sahara, occurring in dense herds. Lastly, the giraffe, one of the most celebrated and characteristic of African quadrupeds, ranges from the limits of the Cape Colony as far as the Sahara and Nubia.

Edentata. Of Edentata the seven species known to occur in Africa are also peculiar to it. The aardwark (*Orycteropus capensis*) is essentially burrowing in its habits; and the burrows formed by these animals are the source of frequent danger to the waggons and horses of the Cape colonists.

Insectivora. A genus of moles is met with in South Africa, but is not found in the tropical regions. The Cape or gilded mole, *chryso-chlore*, is so called from its iridescent glossy fur; two or three species of hedgehog occur in the continent, and Madagascar has a peculiar family resembling these in appearance, but without the power of rolling up into a ball for defence. Bats are numerous in Africa, but few are peculiar to it.

Rodentia. Of Rodents the burrowing kinds prevail. The African species of porcupine are known in the northern and western coast-lands and in South-Eastern Africa. The hyrax extends over Eastern Africa and a portion of the west coast. Hares are only known in the countries north of the Sahara and in the Cape colony. Among squirrels, those with bristles or spines in their fur are peculiar to the southern regions of the continent.

Birds. The ornithology of Africa presents a close analogy in many of its species to those of Europe and South Asia. Thus, on its northern coasts, there is scarcely a single species to be found which does not also occur in the other countries bordering on the Mediterranean. The ornithology of the region of the Nile and the northern coasts is identified with that of Arabia, Persia, and Spain. The deserts are inhabited by species adapted to its solitudes; while Southern Africa presents different species.

The ostrich, the hugest of birds, which has been described as the feathered camel, or the giraffe among birds, is found in almost every part of Africa. But its chief home is the desert and the open plains; mountainous districts it avoids, unless pressed by hunger. The beautiful white feathers, so highly prized by the ladies of Europe, are found in the wings of the male bird. The chase is not without its difficulties, and it requires the greatest care to get within musket-shot of the bird, owing to its constant vigilance and the great distance to which it can see. The fleetest horse, too, will not overtake it unless stratagem be adopted to tire it out. If followed up too eagerly, the chase of the ostrich is not destitute of danger; for the huntsman has sometimes had his thigh-bone broken by a single stroke from the leg of a wounded bird.

The large messenger or secretary-bird, which preys upon serpents and other reptiles, is one of the most remarkable African birds. It is common near the Cape, and is not seldom domesticated. Of gallinaceous fowls, adapted to the poultry-yard, Africa possesses but a single genus, the guinea-hens, which, however, are found in no other part of the world. These birds, of which there are three or four distinct species, go in large flocks of 400 or 500, and are most frequently found among underwood in the vicinity of ponds and rivers. There are, besides, many species of partridges and quails in different parts of Africa. Water fowl of various species are also abundant on the lakes, and rivers, as are likewise various species of owls, falcons, and vultures, the latter of which are highly useful in consuming the offal and carrion, which might otherwise taint the air and produce disease.

Among the smaller birds of Africa are many species remarkable for the gaudiness and brilliancy of their plumage, or the singularity of their manners and economy. Of the former kind may be mentioned the sunbirds, the lamprotornis, the bee-eaters, the rollers, the plantain-eaters, the parrots, the halcyons, and numerous smaller birds that swarm in the forests. Of the latter kind it will be sufficient to mention the honey-cuckoo (*Cuculus indicator*).

Reptiles. Though Africa is not exempt from the scourge of venomous or dangerous reptiles, still it has comparatively fewer than other tropical countries, owing to the dryness of the climate. The reptiles harboured by the desert regions consist chiefly of harmless lizards and serpents of a small size, though often venomous. The frog and tortoise tribes are represented in but few species and numbers.

The most important among the reptiles is the crocodile, which inhabits nearly all the large rivers and lakes within the tropics, and is still abundant in the Nile below the first cataract.

The chameleon is common in Africa. Among the venomous species of snakes are the purple naja, the cerastes or horned viper, the ringed naja, and the darting viper.

Fishes. Edible fish are found almost everywhere in great variety and quantity. The fresh waters of Egypt produce the gigantic bishir, the coffres, and numerous species of the pimelodes. Many varieties of fish exist in the great interior lakes; five large species found in the Tanganyika are described by Burton. The greater number of the fish of the Red Sea resemble the saxatiles of the warm seas of Asia. On the west coasts are found the fish belonging to equatorial latitudes, while the shores of the Mediterranean produce those of France and Spain. The seas of the southern extremity possess the species common to the latitudes of the antarctic, south of the three great capes. The fish of the east coast are the same as those of the Indian Sea.

Insects. Of the insect tribes Africa also contains many thousand different kinds. The locust has been, from time immemorial, the proverbial scourge of the whole continent; scorpions, scarcely less to be dreaded than noxious serpents, are everywhere abundant; and the zebub, or fly, one of the instruments employed by the Almighty to punish the Egyptians of old, is still the plague of the low and cultivated districts. In the interior of Africa a venomous fly occurs in certain regions of the south and east, which is fatal to nearly all domestic animals. It is called tsetse (*Glossina morsitans*), and its size is almost that of the common blue fly which settles on meat; but the wings are larger. On the absence of this insect greatly depended the success of recent explorers in that quarter, as, where it appeared, their cattle infallibly fell victims to its bite. There are large tribes which cannot keep either cattle or sheep, because the tsetse abounds in their country. Its bite is not, however, dangerous to man; wild animals likewise are undisturbed by it. The termites or white ants are likewise a scourge to the country where they occur in great numbers. This destructive creature devours everything in the shape of wood, leather, cloth, &c., that falls in its way; and they march together in such swarms, that the devastation they commit is almost incredible.

Zoophytes. Of the class of zoophytes, the brilliant polypi of every variety, and madrepores, abound on the coasts of Africa. The shores of the Mediterranean produce the finest coral, and those of the Red Sea bristle with extensive reefs of the same mollusca.

From the shores of the Mediterranean to about the latitude of 20° N., the population of Africa consists largely of tribes not originally native to the soil, but of Arabs and Turks, planted by conquest, with a considerable number of Jews, the children of dispersion; and the more recently introduced French. The Berbers of the Atlas region, the Tuaricks and Tibbus of the Sahara, and the Copts of Egypt, may be viewed as the descendants of the primitive stock, while those to whom the general name of Moors is applied, are perhaps of mixed descent, native and foreign. From the latitude stated to the Cape Colony, tribes commonly classed together under the title of the Ethiopic or Negro family are found, though many depart very widely from the peculiar physiognomy of the Negro, which is most apparent in the natives of the Guinea coast. In the Cape Colony, and on its borders, the Hottentots form a distinct variety in the population of Africa, most closely resembling the Mongolian races of Asia.

The Copts, or as they are correctly pronounced, either Ckoobt or Ckibt, are considered to be the descendants of the ancient Egyptians. They do not now compose more than one sixteenth part of the population of Egypt, their number not exceeding 145,000, about 10,000 of whom reside at Cairo. Conversions to the Mohammedan faith, and intermarriages with the Moslems, have occasioned this decrease in their numbers; to which may be added the persecutions which they endured from their Arabic invaders and subsequent rulers. They were forced to adopt distinctions of dress, and they still wear a turban of a black or blue, or a grayish or light brown colour, in contradistinction to the red or white turban. In some parts of Upper Egypt there are villages exclusively inhabited by the Copts. Their complexion is somewhat darker than that of the Arabs, their foreheads flat, and their hair of a soft and woolly character; their noses short, but not flat; mouths wide, and lips thick; the eyes large, and bent upwards in an angle like those of the Mongols; their cheek-bones high, and their beards thin. They are not an unmixed race, their ancestors in the earlier ages of Christianity having intermarried with Greeks, Nubians, and Abyssinians. With the exception of a small proportion, the Copts are Christians of the sect called Jacobites, Eutychians, Monophysites, and Monothelites, whose creed was condemned by the Council of Chalcedon, A.D. 451. They are extremely bigoted, and bear a bitter hatred to all other Christians; they are of a sullen temper, extremely avaricious, great dissemblers, ignorant, and faithless. They frequently indulge in excessive drinking; but in their meals, their mode of eating, and the manner in which they pass their hours of leisure, which is chiefly in smoking their pipes and drinking coffee, they resemble the other inhabitants of the country. Most of the Copts in Cairo are employed as secretaries and accountants, or tradesmen; they are chiefly engaged in the government offices; and as merchants, goldsmiths, silversmiths, jewellers, architects, builders, and carpenters, they are generally considered more skilful than the Moslems. The Coptic language is now understood by few persons, and the Arabic being employed in its stead, it may be considered as a dead language.

Nubians. The countries above Egypt are inhabited by two tribes of people resembling each other in physical characters, but of distinct language and origin. One is, perhaps, the aboriginal or native, the other a foreign tribe. Dr Prichard terms them Eastern Nubians, or Nubians of the Red Sea, and Nubians of the Nile, or Berberines. All these tribes are people of a red-brown complexion, their colour in some instances approaching to black, but still different from the ebony hue of the Eastern negroes. Their hair is often frizzled and thick, and is described as even woolly; yet it is not precisely similar to the hair of the negroes of Guinea. The Eastern Nubians are tribes of roving people who inhabit the country between the Nile and the Red Sea; the northern division of this race are the Ababdeh, who reach northward in the eastern desert as far as Kosseir, and, towards the parallel of Deir, border on the Bishari. The Bishari reach thence towards the confines of Abyssinia. The latter are extremely savage and inhospitable; they are said to drink the warm blood of living animals; they are for the most part nomadic, and live on flesh and milk. They are described as a handsome people, with beautiful features, fine expressive eyes, of slender and elegant forms; their complexion is said to be a dark brown, or a dark chocolate colour. The Barábra or Berberines are a people well known in Egypt, whither they resort as labourers from the higher country of the Nile. They inhabit the valley of that name from the southern limit of Egypt to Sennaar. They are a people distinct from the Arabs and all the surrounding nations. They live on the banks of the Nile; and wherever there is any soil, they plant date-trees, set up wheels for irrigation, and sow durra and some

leguminous plants. At Cairo, whither many of this race resort, they are esteemed for their honesty. They profess Islam. The Barábra are divided into three sections by their dialects, which are those of the Nuba, the Kenous, and the Dongolawi. According to Dr Prichard, it is probable that the Berberines may be an offset from the original stock which first peopled Egypt and Nubia.

Tibbus. The country of the Nubians is limited on the west by that of the Tibbus, who are spread over the eastern portions of the Sahara, as far as Fezzan and Lake Chad. Dr Latham considers it probable that their language belongs to the Nubian class. They inhabit the locality of the ancient Libyans or *Libyes.* Their colour is not uniform. In some it is quite black, but many have copper-coloured faces. They are slim and well made, have high cheekbones, the nose sometimes flat like that of the negro, and sometimes aquiline. Their mouth is in general large, but their teeth fine. Their lips are frequently formed like those of Europeans; their eyes are expressive, and their hair, though curled, not woolly. The females are especially distinguished by a light and elegant form, and in their walk and erect manner of carrying themselves are very striking. Their feet and ankles are delicately formed, and not loaded with a mass of brass or iron, as is the practice in other countries of Northern Africa, but have merely a light anklet of polished silver or copper, sufficient to show their jetty skin to more advantage; and they also wear neat red slippers. The Tibbus are chiefly a pastoral people. They keep horses, cattle, sheep, and goats, but camels constitute their principal riches. The villages of the Tibbus are very regularly built in a square, with a space left on the north and south faces of the quadrangle for the use of the cattle. The huts are entirely of mats, which exclude the sun, yet admit both the light and the air. The interior of these habitations is singularly neat: clean wooden bowls for the preservation of milk, each with a cover of basket-work, are hung against their walls. They are greatly exposed to predatory incursions into their country by the enemies who surround them. The Tibbus of Tibesti are described by Dr Nachtigal as of medium stature, well made, of elegant though muscular frame; in colour they vary between a clear bronze and black: the greater number are dark bronze-coloured, yet without the slightest trace of what is generally recognised as the negro physiognomy. They carry on a considerable traffic in slaves between Sudan, Fezzan, and Tripoli.

Berber group. "All that is not Arabic in the kingdom of Marocco," says Dr Latham, "all that is not Arabic in the French provinces of Algeria, and all that is not Arabic in Tunis, Tripoli, and Fezzan, is Berber. The language, also, of the ancient Cyrenaica, indeed the whole country bordering the Mediterranean, between Tripoli and Egypt, is Berber. The extinct language of the Canary Isles was Berber; and, finally, the language of the Sahara is Berber. The Berber languages, in their present geographical localities, are essentially inland languages. As a general rule, the Arabic is the language for the whole of the sea-coast from the Delta of the Nile to the Straits of Gibraltar, and from the Straits of Gibraltar to the mouth of the Senegal." The Berber nation is one of great antiquity, and from the times of the earliest history has been spread over the same extent of country as at present; the ancient Numidian and Mauritanian names of Sallust, and other writers, have a meaning in the modern Berber. It has affinities with the Semitic languages. In the northern parts of Atlas these people are called Berbers; in the southern tracts they are the Shuluh or Shelhas. In the hilly country belonging to Tunis, the Kabyles; in Mount Auress, the Showiah; and in the Desert, the Tuarick,—all belong to the same group. The mountains of Atlas are said to be inhabited by more than twenty different tribes, carrying on perpetual warfare against each other. They are very poor, and make plundering excursions in quest of the means of supporting life. They are described as an athletic, strong-featured people, accustomed to hardships and fatigue. Their only covering is a woollen garment without sleeves, fastened round the waist by a belt.

The Shuluh, who are the mountaineers of the Northern Atlas, live in villages of houses made of stone and mud, with slate roofs, occasionally in tents, and even in caves. They are chiefly huntsmen, but cultivate the ground and rear bees. They are described as lively, intelligent, well-formed, athletic men, not tall, without marked features, and with light complexions. The Kabyles, or Kabaily, of the Algerian and Tunisian territories, are the most industrious inhabitants of the Barbary States, and, besides tillage, work the mines contained in their mountains, and obtain lead, iron, and copper. They live in huts made of the branches of trees and covered with clay, which resemble the *magalia* of the old Numidians, spread in little groups over the sides of the mountains, and preserve the grain, the legumes, and other fruits, which are the produce of their husbandry, in *mattoures,* or conical excavations in the ground. They are of middle stature; their complexion is brown, and sometimes nearly black.

The Tuarick are a people spread in various tribes through the greater portion of the Sahara. The expedition under Richardson, Barth, and Overweg, who traversed and explored a great portion of the Tuarick territories, has greatly added to our knowledge of these people. The following are the names and localities of the principal tribes:—

1. Tanelkum, located in Fezzan.

2. Azghers, { Ouraghen, family of Shafou, / Emanghasatan, „ of Hateetah, / Amana, „ of Jabour, } located at Ghat.

3. Aheethanaran, the tribe of Janet.

4. Hagar (Ahagar), pure Hagars and Maghatah. They occupy the tract between Ghat, Tuat, and Timbuktu.

5. Sagamaram, located on the route from Aisou to Tuat.

6. Kailouees, including the Kailouees proper, the Kaltadak, and the Kalfadaï.

7. Kilgris, including the Kilgris proper, the Iteesan, and the Ashraf. These and the tribes under the preceding head inhabit the kingdom of Ahir.

8. Oulimad, tribes surrounding Timbuktu in great numbers. This, probably identical with the Sorghou, is the largest and most powerful tribe, while the Tanelkums are the smallest and weakest.

The various tribes are very different in their characters, but they are all fine men, tall, straight, and handsome. They exact a tribute from all the caravans traversing their country, which chiefly furnishes them with the means of subsistence. They are most abstemious, their food consisting principally of coarse brown bread, dates, olives, and water. Even on the heated desert, where the thermometer generally is from 90° to 120°, they are clothed from head to foot, and cover the face up to the eyes with a black or coloured handkerchief.

Moors. The Moors who inhabit large portions of the empire of Marocco, and are spread all along the Mediterranean coast, are a mixed race, grafted upon the ancient Mauritanian stock; whence their name. After the conquest of Africa by the Arabs they became mixed with Arabs; and having conquered Spain in their turn, they intermarried with the natives of that country, whence, after a possession of seven centuries, they were driven back to Mauritania. They are a handsome race, having much more resemblance to Europeans and western Asiatics than to Arabs or Berbers, although their language is Arabic, that is, the Mogrebin dialect, which differs considerably from the Arabic in

Arabia, and even in Egypt. They are an intellectual people, and not altogether unlettered; but they are cruel, revengeful, and blood-thirsty, exhibiting but very few traces of that nobility of mind and delicacy of feeling and taste which graced their ancestors in Spain. The history of the throne of Marocco, of the dynastic revolutions at Algiers, Tunis, and Tripoli, is written with blood; and among the pirates who infested the Mediterranean they were the worst. Their religion is the Mohammedan. They are temperate in their diet and simple in their dress, except the richer classes in the principal towns, where the ladies literally cover themselves with silk, gold, and jewels, while the men indulge to excess their love of fine horses and splendid arms. They generally lead a settled life as merchants, mechanics, or agriculturists, but there are also many wandering tribes. They exhibit considerable skill and taste in dyeing, and in the manufacture of swords, saddlery, leathernware, gold and silver ornaments. At the Great Exhibition in London in 1851, the Moorish department contained several articles which were greatly admired. The Moors along the coast of Marocco still carry on piracy by means of armed boats.

At two different periods, separated from each other by perhaps a thousand years, Africa was invaded by Arabic tribes, which took a lasting possession of the districts they conquered, and whose descendants form no inconsiderable portion of the population of North and Central Africa, while their language has superseded all others as that of civilisation and religion. Of the first invasion more has been said under the head "Abyssinians." The second was that effected by the first successors of Mahomet, who conquered Egypt, and subsequently the whole north of Africa as far as the shores of the Atlantic, in the course of the first century of the Hegira, or the seventh of the Christian era. As regards language, Egypt is now an entirely Arabic country, although in many other respects the Fellahs are totally different from the peasants in Arabia. But there are also several tribes of true Arabic descent scattered about from the high lands of Abyssinia down over Nubia and Egypt, and westward over the central provinces of Kordofan, Darfur, Waday, and Bornu. Others wander in the Libyan deserts and the Great Sahara, as well as in the states of Tripoli, Tunis, and Algiers, leading a similar life with the Kabyles, but constituting a totally distinct race. Others, again, dwell in the empire of Marocco, among whom those along the shores of the Atlantic are notorious for their predatory habits and ferocious character. In many places Arabic adventurers have succeeded in subduing native tribes of every nationality, over which they rule as sovereign lords; and on the coast of Zanzibar resides an Arabic royal dynasty. Many of the smaller islands to the north of Madagascar are inhabited by Arabs, and traces of them have been discovered in Madagascar itself. The African Arabs are not all alike in features and colour of skin, the differences being attributable to some of them having intermarried with natives, while others preserved the purity of their blood.

Jews. The early settlements of the Jews in Egypt are facts universally known. Under the Ptolemies, large numbers of them settled at Alexandria and in Cyrenaica, and after the destruction of Jerusalem they rapidly spread over the whole of the Roman possessions in Africa; many also took refuge in Abyssinia. King Philip II. having driven them out of Spain, many thousands of families took refuge on the opposite coast of Africa. They are now numerous in all the larger towns in the north, where they carry on the occupation of merchants, brokers, &c., the trade with Europe being mostly in their hands. They live in a state of great degradation, except in Algiers, where the French restored them to freedom and independence. They have acquired much wealth, and although compelled to hide their riches from the cupidity of their rulers, they lose no opportunity of showing them whenever they can do so without risk of being plundered, fear and vanity being characteristic features of their character. The Jewesses in Marocco and Algiers are of remarkable beauty.

Turks. Ever since the conquest of Egypt by Sultan Selim, and the establishment of Turkish pashalics in Tripoli, Tunis, and Algiers, Turks have settled in the north of Africa; and as they were the rulers of the country, whose numbers were always on the increase on account of the incessant arrivals of Turkish soldiers and officials, the Turkish became, and still is, the language of the different governments. Properly speaking, however, they are not settled, but only encamped in Africa, and hardly deserve a place among the African nations.

Abyssinians. Not all the inhabitants of the country called Abyssinia are Abyssinians; nor are the real Abyssinians all of the same origin, being a mixed race, to the formation of which several distinct nations have contributed. The primitive stock is of Ethiopian origin, but, as their language clearly shows, was at an early period mixed with a tribe of the Himyarites from the opposite coast of Arabia, who, in their turn, were ethnologically much more closely connected with the Hebrews than with the Joctanides, or the Arabs properly speaking. In the age of the Egyptian Ptolemies, and after the destruction of Jerusalem, Jews settled in Abyssinia in such numbers, that not only their religion spread among the inhabitants, but the Hebrew language became mixed with the Abyssinian as it then was. Hence the surprising analogy between the principal Abyssinian languages, viz., the Gheez in Tigré, and the Amharic in Amhara, with the Hebrew. The uninterrupted intercourse with Arabia, and the immigration of several Arabic tribes, also contributed towards the apparently Semitic aspect of the present Abyssinian language. A large portion of Abyssinia having been occupied by Galla and other tribes, we shall here only dwell on the original Abyssinians. They inhabit a large tract, extending from the upper course of the Blue River, north as far as the Red Sea, and some isolated districts in the south and south-east. To the west of them are the Agau Abyssinians, a different tribe, whose idiom, however, is the common language of the lower classes in Tigré and Amhara also. Abyssinia was once a large and powerful kingdom, but the Galla having conquered the whole south of it, it gradually declined until the king or emperor became a mere shadow, in whose name several vassal princes exercise an unlimited power each in his own territory. Owing to their jealousy and mutual fears, war seldom ceases among the inhabitants. The Christian religion was introduced into Abyssinia in the first centuries after Christ; but whatever its condition might have been in former times, it now presents a degraded mixture of Christian dogmas and rites, Jewish observances, and heathenish superstition. Yet of Judaism, which was once so powerful, but feeble traces are extant, while the Mohammedan religion is visibly on the increase. European missionaries have been, and still are very active among them, but their efforts have been crowned only with partial success. The Abyssinians, the Gallas being excluded from that denomination, are a fine strong race, of a copper hue, more or less dark, and altogether different from the Negroes, with whom, however, they have frequently been confounded, because they were called a black people. Their noses are nearly straight, their eyes beautifully clear, yet languishing, and their hair is black and crisp, but not woolly. They are on the whole a barbarous people, addicted to the grossest sensual pleasures; and their priests, among whom marriage is customary, are little better than the common herd of the people. They live in huts, a large assemblage of which forms a so-called

town; and although they possess some solid constructions of stone, such as churches and bridges, it appears that these were built by the Portuguese, the ruins at Axum and other places belonging to a much earlier period, when the country undoubtedly enjoyed a higher civilisation than at present. Owing to the influence exercised upon them during the last thirty years by European missionaries and travellers, their conduct towards strangers is less rude than it used to be at the time of Bruce. It is a remarkable fact that, notwithstanding the low state of their religion, the Christians in Abyssinia are not allowed to keep slaves, although they may purchase them for the purpose of selling them again.

Ethiopic

This extensive race comprehends by far the greater number of African nations, extending over the whole of Middle and South Africa, except its southernmost projection towards the Cape of Good Hope. A line drawn from the mouth of the Senegal in the west to Cape Jerdaffun in the east, forms its northern limits almost with geometrical accuracy, few Ethiopic tribes being found to the north of it. All the members of this race, however, are not Negroes. The latter are only one of its numerous offshoots; but between the receding forehead, the projecting cheek-bones, the thick lips of the Negro of Guinea, and the more straight configuration of the head of a Galla in Abyssinia, there are still many striking analogies; and modern philology having traced still greater analogies, denoting a common origin, among the only apparently disconnected languages of so many thousands of tribes, whose colour presents all the hues between the deepest black and the yellow brown, it is no longer doubtful that the Negro, the Galla, the Somali, and the Kaffre, all belong to the same ethnological stock.

The principal Negro nations, as we know them, are the *Mandingoes*, who are numerous, powerful, and not uncivilised, in Senegambia, and farther inland, around the head waters of the Quorra, where they have established a great number of kingdoms and smaller sovereignties. The inland trade is chiefly in their hands. They are black, with a mixture of yellow, and their hair is completely woolly. The *Wolofs* or *Yolofs*, whose language is totally different from those of their neighbours, are the handsomest and blackest of all Negroes, although they live at a greater distance from the equator than most of the other black tribes, their principal dwelling-places being between the Senegal and the Gambia, along the coast of the Atlantic. They are a mild and social people. The *Foulahs* or *Fellatahs* occupy the central parts of Soudan, situated in the crescent formed by the course of the Quorra, and also large tracts to the south-east, as far as the equator west to the Senegal, and east till beyond Lake Chad. Their colour, as a rule, is black, intermixed, however, with a striking copper hue, some of them being hardly more dark than gipsies. They are one of the most remarkable nations in Africa, very industrious, live in commodious and clean habitations, and are mostly Mohammedans. A distinction was formerly made between the Foulahs of Senegambia and the Fellatahs of Central Africa, but it has since been ascertained that they belong to the same stock, and speak the same language. The hair of the Foulahs is much less woolly than that of other Negroes. Of the principal nations in Guinea, among whom the true Negro type is particularly distinct, especially around the Bight of Benin, are the Feloops, near the Casamança, very black, yet handsome; and the Ashanti, of the Amina race, who surpass all their neighbours in civilisation, and the cast of whose features differs so much from the Negro type that they are said to be more like Indians than Africans; although this is perhaps only true of the higher orders. They are still in possession of a powerful kingdom. The country behind the Slave Coast is occupied by tribes akin to the Dahomeh on the coast. In South Guinea we meet three principal races, namely, the Congo, the Abunda, and the Benguela Negroes, who are divided into a variety of smaller tribes, with whom we are much less acquainted than with the northern Negroes, although the Portuguese have occupied this coast for upwards of three centuries. The *Wamasai* and *Wakwavi*, possibly of Abyssinian stock, are a remarkable race of wild nomad hunters, who occupy the high plateau which rises between the coast-land and the Victoria Nyanza, extending from the equator southward to the route which leads from Zanzibar to the Tanganyika Lake. They are the terror of the more settled inhabitants of the surrounding countries, and occasionally make raids down even to the coast-land behind Mombas. The next great branch of the Ethiopic race comprehends the Galla, who occupy an immense tract in Eastern Africa, from Abyssinia as far as the fourth degree of S. latitude, on the coast inward from Mombas. Our knowledge of them is chiefly confined to those Gallas who conquered Abyssinia. With regard to their physical conformation, they stand between the Negro of Guinea and the Arab and Berber. Their countenances are rounder than those of the Arabs, their noses are almost straight, and their hair, though strongly frizzled, is not so woolly as that of the Negro, nor are their lips quite so thick. Their eyes are small (in which they again differ from the Abyssinians), deeply set, but very lively. They are a strong, large, almost bulky people, whose colour varies between black and brownish, some of their women being remarkably fair, considering the race they belong to. An interesting tribe of them has lately been brought to the knowledge of Europeans, the Somali, originally Arabs, who have advanced from the southern shores of the Gulf of Aden since the 15th century, and now occupy the greater portion of the East African promontory wedging into the Galla region, and almost dividing that country into two distinct portions. For the most part they pursue a wandering and pastoral life.

Wamasai and Wakwavi.

Galla.

Somali.

Negroid tribes.

In the central regions of the continent the negroid tribes, which are classed under the general name of Wanyamwezi, occupying the plateau south of the Victoria and east of the Tanganyika Lakes, have been made known by Burton and subsequent travellers; round the west and north of the Victoria are several distinct kingdoms, the chief being those of Karague and Uganda, traversed by Speke and Grant; in the region west of the Upper Nile the countries of the Jur, Dor, and Bongo tribes have been explored by Dr Schweinfurth, and he has passed beyond the watershed of the Nile into a new basin, where he found the Niamniam and Monbuttu tribes. Dr Livingstone, in his latest journey, has entered the country of the Manyuema tribes, west of Tanganyika, in the heart of the continent; these he describes as a fine, tall handsome race, superior alike to the slaves seen at Zanzibar and the typical negro of the west coast; exceedingly numerous, and living in a primitive condition, utterly ignorant of the outer world. The Balunda race of Negroes occupy a great area of South Central Africa, and have two ancient and powerful kingdoms of Muropua and Lunda, the former ruled over by the hereditary "Muata" or chief Hianvo, who has his capital near the Cassabi tributary of the Congo, and the latter by the Hianvo's vassal, the Cazembe, whose palace is near the Luapula river, south-west of Lake Tanganyika. Kibakoe or Quiboque and Lobal, south-west of the kingdom of Hianvo, are the chief states on the borders of Angola and Benguela; towards the Nyassa lake, south-east from the Cazembe's dominions, the Maravi tribe is perhaps the most powerful, and beyond the Nyassa that of the Wahiao is the chief. The Makololo tribe, occupying the central portion of the Zambeze basin, is of southern origin, and forms an intermediate stage between the Negro and Kaffre.

Kaffres.

The Kaffres, who, together with the tribes most akin to them, occupy the greater portion of South Africa, especially the eastern portions, have some analogy with Europeans in

their features; but they are woolly haired, and while some are almost black, others are comparatively fair, although some of their tribes might have been mixed with the Eastern Negroes. They have been very wrongly classed with the Negroes. They are a strong, muscular, active people, addicted to plunder and warfare. The Eastern Kaffres, among whom the Amakosah and Amazulah are best known to us, on account of their frequent invasions of the Cape Colony, are much more savage than the western and northern, or the Bechuana and Sichuana tribes. All Kaffres are pastoral, keeping large herds of cattle; but the last-named tribes inhabit large towns, well-built houses, cultivate the ground carefully, and exhibit every appearance of being capable of entire civilisation. The word Kaffre, or Kafir, as it ought to be written, is Arabic, and was first applied by the Europeans to the inhabitants of the coast of Mozambique, because they were so called by the Mohammedans, in whose eyes they were *Kafirs*, that is infidels.

Hottentots. We conclude this sketch with the Hottentot race, which is entirely different from all the other races of Africa. Where they originally came from, and how they happened to be hemmed in and confined entirely to this remote corner of the earth, is a problem not likely to be ever satisfactorily solved. The only people to whom the Hottentot has been thought to bear a resemblance, are the Chinese or Malays, or their original stock the Mongols. Like these people they have the broad forehead, the high cheek-bones, the oblique eye, the thin beard, and the dull yellow tint of complexion, resembling the colour of a dried tobacco leaf; but there is a difference with regard to the hair, which grows in small tufts, harsh, and rather wiry, covering the scalp somewhat like the hard pellets of a shoe-brush. The women, too, have a peculiarity in their physical conformation, which, though occasionally to be met with in other nations, is not universal, as among the Hottentots. Their constitutional "bustles" sometimes grow to three times the size of those artificial stuffings with which our fashionable ladies have disfigured themselves. Even the females of the diminutive Bosjesmen Hottentots, who frequently perish of hunger in the barren mountains, and are reduced to skeletons, have the same protuberances as the Hottentots of the plains. It is not known even whence the name of Hottentot proceeds, as it is none of their own. It has been conjectured that *hot* and *tot* frequently occurring in their singular language, in which the monosyllables are enunciated with a palatic clacking with the tongue, like that of a hen, may have given rise to the name, and that the early Dutch settlers named them *hot-en-tot*. They call themselves *quiquæ*, pronounced with a clack. They are a lively, cheerful, good-humoured people, and by no means wanting in intellect; but they have met with nothing but harsh treatment since their first connection with Europeans. Neither Bartholomew Diaz, who first discovered, nor Vasco de Gama, who first doubled, the Cape of Good Hope, nor any of the subsequent Portuguese navigators, down to 1509, had much communication with the natives of this southern angle of Africa; but in the year above mentioned, Francisco d'Almeyda, viceroy of India, having landed on his return at Saldanha (now Table) Bay, was killed, with about twenty of his people, in a scuffle with the natives. To avenge his death, a Portuguese captain, about three years afterwards, is said to have landed a piece of ordnance loaded with grape shot, as a pretended present to the Hottentots. Two ropes were attached to this fatal engine; the Hottentots poured down in swarms. Men, women, and children flocked round the deadly machine, as the Trojans did round the wooden horse, "*funemque manu contingere gaudent.*" The brutal Portuguese fired off the piece, and viewed with savage delight the mangled carcasses of the deluded people. The Dutch effected their ruin by gratifying their propensity for brandy and tobacco, at the expense of their herds of cattle, on which they subsisted. Under the British sway they have received protection, and shown themselves not unworthy of it. They now possess property, and enjoy it in security. One of the most beautiful villages, and the neatest and best-cultivated gardens, belong to a large community of Hottentots, under the instruction and guidance of a few Moravian missionaries.

These forlorn people are of Hottentot origin. Of them also several tribes have been discovered much farther north, and intelligence has lately reached Europe, that between the Portuguese possessions, in the very centre of South Africa, there is a nation of dwarfish appearance who possess large herds, and who seem to belong to the original Bushmen stock. Bushmen.

The island of Madagascar is inhabited by a race of Malay origin, exhibiting traces of Negro and Arabic mixture.

The area and population of Africa and its divisions are thus estimated:—[1] Population.

Divisions.	Area in English square miles.	Population.	Average Density. No. to a sq. mile.
North Africa,	4,003,600	20,420,000	5
Marocco,	259,600	2,750,000	10
Algeria,	258,300	2,921,146	11
Tunis,	45,700	2,000,000	43
Tripoli, with Barca and Fezzan,	344,400	750,000	2
Egyptian territory,	659,100	8,000,000	12
Sahara,	2,436,500	4,000,000	1·6
The Mohammedan States of Central Soudan,	631,000	38,800,000	61
Western Soudan, from the Senegal to the Lower Niger, including Upper Guinea, and	818,600	38,500,000	47
French Senegambia,	96,530	209,162	2
Liberia,	9,580	718,000	72
Dahomeh,	3,880	180,000	47
British possessions,	17,100	577,313	34
Portuguese possessions,	35,880	8,500	0·2
East Africa,	1,595,000	29,700,000	18
Abyssinia,	158,400	3,000,000	19
South Africa,	1,966,000	16,000,000	8
Portuguese territory, East coast,	382,000	300,000	0·8
Portuguese territory, West coast,	312,500	9,000,000	29
Cape Colony,	221,310	682,600	3
Natal,	17,800	269,362	15
Orange R. Free State,	42,500	37,000	0·8
Transvaal Republic,	114,360	120,000	1
Equatorial Regions,	1,522,200	43,000,000	29
Islands in the Atlantic Ocean,	2,720	99,145	37
C. Verd Islands,	1,650	67,347	42
St Thomas and Principe,	454	19,295	42
Fernando Po & Annobon,	488	5,590	11
Ascension,	38	400	10
St Helena,	47	6,860	145
Tristan da Cunha,	45	53	1
Islands in the Indian Ocean,	233,870	6,000,000	25
Socotra,	1,700	3,000	2
Abd-el-Kuri,	64	100	2
Zanzibar,	616	380,000	616
Madagascar,	228,575	5,000,000	22
Comoro Islands (with Mayotta),	1,062	64,600	64
The Arco Islands, &c.,	150	...	...
Réunion,	970	209,737	216
Mauritius and its dependencies,	708	322,924	456
Desert of Kalahari and the Great Inland Lakes,	783,600	—	...
Africa,	11,556,600	192,520,000	16

[1] Compiled from the Tables in Behm and Wagner's *Bevölkerung der Erde*. Gotha, 1872.

In the central forest regions of Africa, wherever communications with the coast-land have been opened up, hunting the elephant for its tusks to barter with the traders appears to be the characteristic occupation, if any, beyond that of mere attention to the daily wants of life, is engaged in; and here the population may be considered as a settled one, living in villages in the more open spaces of the woods. A rudely agricultural state seems to mark the outer belt of negro land on each side of the equatorial zone, where the population is also more or less stationary. The arid regions of the Sahara and the Kalahari beyond have, on the other hand, a thinly scattered nomadic population, though here also the fertile wadys form lines of more permanent habitation, and contain permanent towns and villages. Excepting in the immediate neighbourhood of the Mediterranean in Abyssinia, on a narrow margin of the coasts of the Atlantic and the Indian Ocean, and in those parts which have been colonised by Europeans, or which came directly under their influence, society has remained in a barbarian state, and there remain great areas the inhabitants of which have as yet no knowledge of the outer world.

Agriculture is conducted with little art. The natural fertility of the soil in the well-watered districts supersedes the need of skill, while the production of the simplest manufactures is alone requisite, where the range of personal wants embraces few objects, and those of the humblest class.

Wars, cruel and incessant, waged not for the sake of territory, but for the capture of slaves, form one of the most marked and deplorable features in the social condition of the African races. This practice, though not of foreign introduction, has been largely promoted by the cupidity of the Europeans and Transatlantic nations; and, unhappily, the efforts of private philanthropy, and the political arrangements of various governments, have not yet availed to terminate the hideous traffic in mankind, or abate the suffering entailed upon its victims.

Religion. In *Religion*, Christianity is professed in Abyssinia, and in Egypt by the Copts, but its doctrines and precepts are little understood and obeyed. Mohammedanism prevails in all Northern Africa, excepting Abyssinia, as far as a line passing through the Soudan, from the Gambia on the west to the confluence of the Quorra and Benue, and thence eastward, generally following the 10th parallel of N. lat. to the Nile below the junction of the Ghazal; thence south-east, leaving the coast-land in the Mohammedan region, to Cape Delgado. In Marocco, Algeria, and Egypt, there is an admixture of Jews. Heathen Negroes and Caffre tribes extend southward over the continent from the line described above to the colonies in the southern extremity of the continent; and over this vast area the native mind is surrendered to superstitions of infinite number and character. In the Cape Colony Protestantism again prevails, but with a strong intermixture of heathenism. The labours of Christian missionaries have, however, done much, especially in South Africa, towards turning the benighted Africans from idols to the living God.

Political divisions. In describing the political divisions of Africa, we shall proceed from north to south.

Barbary. The country included under the general name of Barbary extends from the borders of Egypt on the east to the Atlantic on the west, and is bounded by the Mediterranean on the north, and by the Sahara on the south. It comprises the states of Marocco, Algeria, Tunis, and Tripoli.

Marocco. Marocco, the most westerly state of Barbary, is thus named by the Europeans, but by the Arabs themselves Mogr'-eb-el-Aksa, or "the extreme west." The eastern boundary was determined in the treaty with the French of 18th March 1845, by a line which, in the south, commences east of the oasis Figueg, intersecting the desert of Angad, and reaching the Mediterranean at a point about 30 miles west of the French port Nemours. In the south Marocco embraces the oasis of Tuat and the Wady Draa. The power of the government of Marocco, which is despotic and cruel, as well as the population of the country, appear to have diminished greatly. Two-thirds of the country are independent of the Sultan's authority, and are held by mountain chiefs who defy his power. The trade of the coast is maintained by European merchants. See MAROCCO.

Algeria. Algeria extends from Marocco in the west, to Tunis in the east, and closely answers in its limits to the ancient kingdom of Numidia. The southern boundaries are not very definite, falling, as they do, within the boundless plains of the desert. See ALGIERS.

Tunis. Tunis is the smallest of the Barbary states. The configuration of the surface is similar to that of Algeria, in three divisions, the "Tell," or fertile coast slopes, the steppes on the high lands, and the low-lying Sahara beyond. The highest peaks range between 4000 and 5000 feet. The southern plains comprise the land of dates (Belad-el-Jerid), and several extensive salt lakes. Tunis possesses but few rivers and streams, and springs are plentiful only in the mountainous regions.

The climate is, upon the whole, salubrious, and is not of the same excessive character as that of Algeria; regular sea-breezes exercise an ameliorating influence both in summer and winter; frost is almost unknown, and snow never falls. During summer occasional winds from the south render the atmosphere exceedingly dry and hot.

The natural productions of the country are somewhat similar to those of the other Barbary states, but dates of the finest quality are more largely produced. The horses and dromedaries are of excellent breed, and the former are eagerly sought for the French army in Algeria. Bees are reared in great quantity, and coral fisheries are carried on. Of minerals lead, salt, and saltpetre are the most noticeable.

The population consists chiefly of Mohammedan Moors and Arabs; the number of Jews is estimated at 45,000, and of Roman Catholics 25,000. The former have attained a higher degree of industry and civilisation than their brethren elsewhere; those of the latter who inhabit the central mountainous regions are nearly independent.

The government is vested in a hereditary bey, and has been conducted in peace and security for a number of years. From the year 1575 onwards, Tunis has been under the rule of Turkey; but by a firman of October 1871 the Sultan renounced the ancient tribute. The bey, who is styled "Possessor of the kingdom of Tunis," is confirmed in his position at Constantinople, and may neither enter into a war, nor conclude a treaty of peace, nor cede any part of his territory without the sanction of the Sultan. The Tunisian coinage bears the name of the Sultan, and the troops (3900 infantry and artillery, and 100 cavalry, form the regular army) are at the disposal of the Sublime Porte in time of war. In the interior of the country the bey has absolute power. The slave trade was abolished in 1842.

The commerce of Tunis is considerable, but agriculture is in a backward state. The exports consist chiefly of wool, olive-oil, wax, honey, hides, dates, grain, coral, &c.

The principal town is Tunis, situated on a shallow lake on the north coast. It is the most important commercial place on the southern shores of the Mediterranean after Alexandria, and has a population of about 125,000. The site of the ancient Carthage is 13 miles from Tunis in the direction of Cape Bon.

Tripoli. Tripoli, a regency of the Turkish empire, extends from Tunis along the shores of the Mediterranean to the table-land of Barca, which forms a separate province. Politically, it includes the pashalic of Fezzan, a country which, in a physical point of view, belongs to the Sahara.

Tripoli is the least favoured by nature of the Barbary

states, possessing a great extent of sterile surface. Mr Richardson graphically describes the physiognomy of the country between the towns of Tripoli and Murzuk in eight zones:—1. The plain along the sea-shore, with the date-palm plantations and the sandhills; 2. The Gharian mountains, with their olive and fig plantations, more favoured with rains than the other regions; 3. The limestone hills and broad valleys between the town of Kalubah and Ghareeah, gradually assuming the aridity of the Sahara as yo proceed southward; 4. The Hamadah, an immense desert plateau, separating Tripoli from Fezzan; 5. The sandy valleys and limestone rocks between El-Hessi and Es-Shaty, where herbage and trees are found; 6. The sand between Shiaty and El-Wady, piled in masses or heaps, and extending in undulating plains; 7. The sandy valleys of El-Wady, covered with forests of date-palms; 8. The plateau of Murzuk, consisting of shallow valleys, ridges of low sandstone hills, and naked plains. These zones extend parallel with the Mediterranean shores through the greater portion of the ountry. A summit of the Jebel-es-Soda, or Black Mountains, midway between Tripoli and Murzuk, almost 2800 feet high, is supposed to be the culminating point of the regency. Rivers exist only periodically, and springs are exceedingly scarce.

The climate is somewhat more subject to extremes than that of Tunis, especially in the interior, where burning heat is followed by excessive cold. As far south as Sokna snow occasionally falls. The climate of Murzuk is very unhealthy, and frequently fatal to Europeans.

The natural products are very much like those of Tunis. Oxen and horses are small, but of good quality; the mules are of excellent breed. Locusts and scorpions are among the most noxious animals. Salt and sulphur are the chief minerals.

The population is very thin. Arabs are the prominent race, besides which are Turks, Berbers, Jews, Tibbus, and Negroes. The country is governed by a pasha, subject to the Ottoman empire. The military force by which the Turks hold possession of this vast but thinly-peopled territory amounts to 4500 men.

The commerce is not inconsiderable, and the inhabitants of Tripoli trade with almost every part of the Sahara, as well as the Soudan. At Murzuk there is a large annual market, which lasts from October to January. The exports of Tripoli are wheat, wax, ivory, ostrich feathers, madder, esparto grass, cattle, salt, and dates.

Tripoli is the capital of the regency, and the largest town; it lies on the Mediterranean, surrounded by a fertile plain; the number of inhabitants is about 30,000. Murzuk, the capital of Fezzan, has a mixed population of about 11,000 souls. The town of Ghadamis has about 7000 inhabitants.

In 1869 the maritime plateau of Barca and the depressed region inland from it, which contains the oases of Aujila and Jalo, was formed into a separate government, dependent directly upon Constantinople. This country is the seat of the ancient Greek *Pentapolis* of Bernice, Arsinœ, Barca, Apollonia, and Cyrene. Bengazi, the only place of importance, occupies the site of the first of these on the Mediterranean, and has from 6000 to 7000 inhabitants.

Egypt. Egypt occupies the north-eastern corner of Africa, and is remarkable for its ancient and sacred associations, and its wonderful monuments of human art.

Egypt is a vast desert, the fertile portions susceptible of cultivation being confined to the Delta of the Nile and its narrow valley, a region celebrated in the most ancient historic documents for its singular fertility, and still pouring an annual surplus of grain into the markets of Europe. By the annual inundation of the Nile this region is laid under water, and upon its retirement the grain crops are sown in the layer of mud left behind it. Barren ranges of hills and elevated tracts occupy the land on both sides of the Nile, which is the only river of the country. The amount of its rise is a matter of extreme solicitude to the people, for should it pass its customary bounds a few feet, cattle are drowned, houses are swept away, and immense injury ensues; a falling short of the ordinary height, on the other hand, causes dearth and famine, according to its extent. The water of the Nile is renowned for its agreeable taste and wholesome quality. In connection with the Nile is the Birket-el-Kerun, a salt lake.

The climate is very hot and dry. Rain falls but seldom along the coasts, but the dews are very copious. The hot and oppressive winds, called khamsin and simooms, are a frequent scourge to the country; but the climate is, upon the whole, more salubrious than that of many other tropical countries.

The natural products are not of great variety. The wild plants are but few and scanty, while those cultivated include all the more important kinds adapted to tropical countries; rice, wheat, sugar, cotton, indigo, are cultivated for export; dates, figs, pomegranates, lemons, and olives, are likewise grown. The doum-palm, which appears in Upper Egypt, is characteristic, as also the papyrus. The fauna is characterised by an immense number of waterfowl, flamingoes, pelicans, &c. The hippopotamus and crocodile, the two primeval inhabitants of the Nile, seem to be banished from the Delta, the latter being still seen in Upper Egypt. The cattle are of excellent breed. Large beasts of prey are wanting; but the ichneumon of the ancients still exists. Bees, silkworms, and corals are noticeable. Minerals are scarce, natron, salt, and sulphur being the principal.

The native Egyptians of Arab descent compose the great bulk of the people, the peasant and labouring class, and are termed Fellahs. Next in number, though comparatively few (145,000), are the Copts, descended from the old inhabitants of the country, the ancient Egyptians, but far from being an unmixed race. The Arabic Bedouin tribes, Negroes, European Christians (Greeks, Italians, French, Austrian, English), the Jews, and the dominant Turks, compose the remainder of the population.

Egypt is formally a Turkish pashalic, but the hereditary pasha, by whom the government is conducted, and whose authority is absolute, is practically an independent prince. The government of Nubia and Kordofan is also conducted by the Pasha of Egypt, and recently the whole of the Nile valley, as far south as the equator, has been annexed by the Egyptian government. An army of about 14,000 men is maintained.

The agriculture of Egypt has always been considerable, there being three harvests in the year. The industry is limited: one peculiar branch is the artificial hatching of eggs in ovens heated to the requisite temperature, a process which has been handed down from antiquity, and is now chiefly carried on by the Copts. Floating bee-hives are also peculiar to the Nile. The commerce is extensive and important: the exports to Europe consist chiefly of cotton, flax, indigo, gum-arabic, ostrich feathers, ivory, senna, and gold. The country forms part of the great highway of traffic between Europe and Southern Asia. Railways, from the ports of Alexandria and Damietta in the Mediterranean, and from Suez on the Red Sea, unite at Cairo; and a railway now extends thence up the bank of the Nile to near the first cataract of the river at Assouan, in lat. 24° N.

Suez canal. The Suez canal, uniting the Red Sea and the Mediterranean, was begun in April 1859, and was opened for traffic ten years later, in November 1869. The cutting runs from the artificial harbour of Port Said on the Mediterranean, through the shallow lagoon of Menzaleh, and

through two smaller lakes with low sandhills between; nearer Suez a depressed area, in which several salt lakes formerly existed, has been filled up by water let in by the canal, and now forms a wide expanse of water. In length the canal is nearly 100 miles, and has a depth throughout of 26 feet, with a general width of 200 to 300 feet at the top of the banks and 72 feet at the bottom. Vessels are able to steam or be towed through the canal in sixteen hours from sea to sea. Extensive harbours and docks have been constructed both on the Mediterranean side and at Suez. The number of vessels which entered Port Said in 1871 was 1215, of 928,000 tons, exclusive of 87 war-ships.

Egypt proper is divided into three sub-pashalics—Bahari or Lower Egypt, Vostani or Middle Egypt, and Said or Upper Egypt. Cairo, on the east bank of the Nile, is the capital of Egypt, and is the largest town of Africa, containing 354,000 inhabitants: it has 400 mosques, and upwards of 130 minarets, some of them of rich and graceful architecture, presenting at a distance an appearance singularly imposing. Alexandria, on the coast, is the emporium of the commerce with Europe, and has 220,000 inhabitants, among whom are 54,000 Europeans. Damietta has a population of 37,100; Rosetta of 18,300. Suez, on the northern extremity of the Red Sea, is a small, ill-built town, but has assumed importance as a good port since the establishment of the overland route to India and the completion of the maritime canal. It has now nearly 14,000 inhabitants, of whom about 2500 are Europeans. Port Said has 8800 inhabitants, of whom one-half are foreigners.

Nubia. Nubia extends along the Red Sea, from Egypt to Abyssinia, comprising the middle course of the Nile.

The natural features of the country are varied; the northern portion consisting of a burning sterile wilderness, while the southern, lying within the range of the tropical rains, and watered by the Abyssinian affluents of the Nile, exhibits vegetation in its tropical glory, forests of arborescent grasses, timber-trees, and parasitical plants largely clothing the country. This latter territory, which may be called Upper Nubia, includes the region of ancient Meroe, situated in the peninsula formed by the Nile proper, the Blue River, and the Atbara, and comprises, further south, the recently extinguished modern kingdom of Sennaar.

Nubia forms the link between the plain of Egypt and the high table-lands of Abyssinia; its general physical character is that of a slightly ascending region. The lowest parts in Upper Nubia scarcely exceed an altitude of 1300 feet; Khartum, at the confluence of the Blue and White Rivers, being 1345 feet above the level of the sea. A chain of mountains and elevated land rises abruptly along the shores of the Red Sea, gradually sloping down to the valley of the Nile; the intermediate region being intersected by smaller ranges, groups of hills, and numerous wadys filled with sand. The spurs of the Abyssinian table-land, extending within the southern confines of Nubia, reach a height of 3000 feet. Besides the Nile, the country is watered by two other large rivers, its tributaries, the Bhar-el-Azrek or Blue River, and the Atbara or Takkazze, both being much alike in magnitude, and having their head-streams in the Abyssinian table-land.

The climate of Nubia is tropical throughout, and the heat in the deserts of its central portions is not exceeded by that of any other part of the globe. The southern half of the country is within the influence of the tropical rains, the northern partakes the character of the almost rainless Sahara; and while the latter is generally very salubrious, the former is a land of dangerous fevers, particularly in the plains subject to inundations. Such is the Kolla, a marshy and swampy region of great extent, situated along the foot of the Abyssinian Mountains, between the Blue River and the Takkazze.

The northern region is poor in natural productions, but in the south the vegetation is most luxuriant; palms form a prominent feature, and the monkey bread-tree attains its most colossal dimensions. The date-tree, dourra, cotton, and indigo are cultivated. The date-palm does not extend beyond the south of Abou-Egli, in lat. 18° 36′.

The elephant occasionally wanders as far as Sennaar; the rhinoceros, lion, giraffe, and buffalo are more common. The waters are inhabited by crocodiles more ferocious than those of Egypt, and by huge hippopotami. The young hippopotamus brought to the Zoological Gardens of London in 1850, was captured in Nubia, in an island of the Nile, about 1800 miles above Cairo: no living specimen had been seen in Europe since the period when they were exhibited by the third Gordian in the Colosseum at Rome. Monkeys and antelopes are found in great numbers. The camel does not extend beyond the twelfth degree of latitude to the south. Ostriches roam over the deserts; and among the reptiles, besides the crocodile, are large serpents of the python species, and tortoises. Of the numerous insects the most remarkable is the scarabæus of the ancient Egyptians, still found in Sennaar. Of minerals Nubia possesses gold, silver, copper, iron, salt.

In the inhabitants two principal varieties are recognised, the pure original population, and their descendants, mixed with other nations. The Berberines inhabit the northern part, and the Bisharis the desert regions; the latter are the genuine Nubians, finely moulded and dark complexioned, supposed by some to agree more closely with the ancient Egyptians than the Copts, usually deemed their representatives. In the south-eastern part the true Negro element appears.

Nubia, now a province under the pashalic of Egypt, consisted formerly of a number of small and independent kingdoms. The Turkish conquest lasted from 1813 to 1822; in the latter years it was invaded and mercilessly ravaged by the army of Mahomet Ali, under his second son Ismayl, whose dreadful atrocities entailed a fearful fate upon himself, having been surprised when attending a nocturnal banquet, at some distance from his camp, and burned to death.

The country is favourable for agriculture, which, however, is only carried on to a limited extent, by the women. Cattle are abundant, and the camels of the Bisharin and Ababde are famous for their enduring powers. Salt is largely exported from the shores of the Red Sea to India, and ivory, with other products of tropical Africa, forms a principal article of trade.

Khartum, the capital of Nubia, the headquarters of the Egyptian government, and the chief seat of commerce, contains a population variously estimated at from 20,000 to 50,000. It is a modern town, having been founded in 1821, and lies in a dry, flat, and unhealthy country, near the confluence of the two main branches of the Nile. It is in telegraphic communication with Cairo.

Kordofan. Kordofan, on the western side of Nubia, lies between the parallels of 12° and 16°, and between the meridians 29° and 32°, containing about 30,000 square miles. It is a flat country, interspersed with a few hills, presenting in the dry season a desert with little appearance of vegetation, and in the rainy season a prairie, covered with luxuriant grass and other plants. The general elevation of the country is 2000 feet, and some of the hills attain a height of 3000. The altitude of El Obeid is 2150 feet. There are no permanent rivers in the country, and the natural products are similar to those of the adjoining regions of Nubia.

The population consists of Negroes. This country was, simultaneously with Nubia, made tributary to Egypt. The

commerce consists of gum-arabic, ivory, and gold, and is not inconsiderable. El Obeid, the chief town, is composed of several villages of mud-built houses, thatched with straw, containing about 12,000 inhabitants.

Abyssinia. The boundaries of Abyssinia are somewhat uncertain; but confining it to the provinces actually under the government of Christian or Mohammedan princes, it may be described as extending from about 9° to 16° N. lat., and from 35° to 40° E. long. See ABYSSINIA.

Saharan countries. The Saharan countries extend from the Atlantic in the west, to the Nilotic countries in the east, from the Barbary States in the north, to the basins of the Rivers Senegal and Kawara, and Lake Chad in the south. The area of this large space amounts to at least 2,000,000 square miles, or upwards of one-half of that of the whole of Europe. It is very scantily populated, but from our present defective knowledge of that region, the number of its inhabitants can be but roughly estimated.

The physical configuration of the Sahara has already been indicated. Notwithstanding the proverbial heat, which is almost insupportable by day, there is often great cold at night, owing to the excessive radiation, promoted by the clearness of the sky. Rain is nearly, though not entirely absent, in this desolate region. It appears that when nature has poured her bounty over the adjoining regions in the south, and has little more left to bestow, she sends a few smart showers of rain to the desert, parched by the long prevalence of the perpendicular rays of the sun. The prevailing winds blow during three months from the west, and nine months from the east. When the wind increases into a storm, it frequently raises the loose sand in such quantities that a layer of nearly equal portions of sand and air, and rising about 20 feet above the surface of the ground, divides the purer atmosphere from the solid earth. This sand, when agitated by whirlwinds, sometimes overwhelms caravans with destruction, and, even when not fatal, involves them in the greatest confusion and danger.

The natural products correspond with the physical features of the country. Vegetation and animal life exist only sparingly in the oases or valleys where springs occur, and where the soil is not utterly unfit to nourish certain plants. Amongst the few trees the most important is the date-palm, which is peculiarly suited to the dryness of the climate. This useful tree flourishes best in the eastern part of the desert, inhabited by the Tibbus. The doum-palm is likewise a native of the same part, and seems entirely absent in the western Sahara; its northernmost limit is on the southern borders of Fezzan and Tegerry, in lat. 24° N. Acacias are found in the extreme west towards Senegambia, furnishing the so-called gum-arabic. In many parts of the desert a thorny evergreen plant occurs, about 18 inches high. It is eagerly eaten by the camels, and is almost the only plant which supplies them with food while thus traversing the desert. The cultivation of grains to a small extent is limited to the western oases of Tuat and others, a little barley, rice, and beans, being there grown. In the kingdom of Air there are some fields of maize and other grains; but upon the whole, the population depend for these products on Soudan and other regions. There are but a few specimens of wild animals in these wildernesses; lions and panthers are found only on its borders. Gazelles and antelopes are abundant, hares and foxes but scarce. Ostriches are very numerous, and vultures and ravens are also met with. In approaching Soudan, animal and vegetable life becomes more varied and abundant. Of reptiles, only the smaller kinds are found, mostly harmless lizards and a few species of snakes. Of domestic animals, the most important is the camel, but horses and goats are not wanting, and in the country of the Tuaricks an excellent breed of sheep is found, while in that of the Tibbus a large and fine variety of the ass is valuable to the inhabitants. Of minerals, salt is the chief production, which occurs chiefly near Bilma.

The habitable portions of the Sahara are possessed by three different nations. In the extreme western portion are Moors and Arabs. They live in tents, which they remove from one place to another; and their residences consist of similar encampments, formed of from twenty to a hundred of such tents, where they are governed by a sheik of their own body; each encampment constituting, as it were, a particular tribe. They are a daring set of people, and not restrained by any scruple in plundering, ill-treating, and even killing persons who are not of their own faith; but to such as are, they are hospitable and benevolent. The boldest of these children of the desert are the Tuaricks, who occupy the middle of the wilderness, where it is widest. The form of their bodies, and their language, prove that they belong to the aboriginal inhabitants of Northern Africa, who are known by the name of Berbers. They are a fine race of men, tall, straight, and handsome, with an air of independence which is very imposing. They live chiefly upon the tribute they exact from all caravans traversing their country. They render themselves formidable to all their neighbours, with whom they are nearly always in a state of enmity, making predatory incursions into the neighbouring countries. The third division of Saharan people are the Tibbus, who inhabit the eastern portion, comprising one of the best parts of the desert. In some of their features they resemble the Negroes. They are an agricultural and pastoral nation, live mostly in fixed abodes, and are in this respect greatly different from their western neighbours. Their country is as yet little explored by Europeans. The Tibbus are in part Pagans, while the other inhabitants of the Sahara are Mohammedans.

The commerce of the Sahara consists chiefly of gold, ostrich feathers, slaves, ivory, iron, and salt, exchanged for manufactured goods, and transported across the desert by great caravans, which follow lines uniting the greater cities and oases of the southern and northern borders.

Western Africa. Western Africa comprehends the west coast of Africa, from the borders of the Sahara, in about lat. 17° N. to Nourse River, in about the same latitude south, with a considerable space of inland territory, varying in its extent from the shores, and, in fact, completely undefined in its interior limits.

Senegambia. Senegambia, the country of the Senegal and Gambia, extends from the Sahara in the north to lat. 10° in the south, and may be considered as extending inland to the sources of the waters which flow through it to the Atlantic.

The western portion is very flat, and its contiguity to the great desert is frequently evidenced by dry hot winds, an atmosphere loaded with fine sand, and clouds of locusts. The eastern portion is occupied with hills and elevated land. Under the 10th parallel the hills approach quite close to the coast. The country possesses a great number of rivers, among which the Senegal, Gambia, and Rio Grande are the most important. Senegambia ranges, in point of heat, with the Sahara and Nubia. The atmosphere is most oppressive in the rainy season, which lasts from June to November, when an enormous amount of rain drenches the country. The prevailing winds in that period are south-west, whereas in the dry season they are from the east. The climate is, upon the whole, most unhealthy, and too generally proves fatal to Europeans.

The vegetation is most luxuriant and vigorous. The baobab (monkey bread-tree), the most enormous tree on the face of the globe, is eminently characteristic of Senegambia. It attains to no great height, but the circumference of the trunk is frequently 60 to 75 feet, and has been found to measure 112 feet; its fruit, the monkey bread, is a princi-

pal article of food with the natives. Bombaceæ (cotton-trees) are likewise numerous, and they are among the loftiest in the world. Acacias, which furnish the gum-arabic, are most abundant, while the shores are lined with mangrove trees. The flora and fauna are similar to those of Nubia. Gold and iron are the chief metals.

The inhabitants consist of various Negro nations, the chief of which are the Wolof.

The gum trade is the most important traffic on the Senegal; bees-wax, ivory, bark, and hides, forming the chief exports from the Gambia.

Of European settlements are: The French possessions on the Senegal; the capital of which is St Louis, built about the year 1626, on an island at the mouth of the river. The total population of the settlement amounts to about 210,000.

The British settlement on the Gambia has about 7000 inhabitants. Bathurst is the chief town.

The Portuguese settlement consists of small factories south of the Gambia, at the Bissagos Islands, Bissao, Cacheo, and some other points.

The Guinea Coast. The west coast of Africa, from Senegambia to the Nourse River, is commonly comprised by the general denomination Guinea Coast, a term of Portuguese origin.

The coast is generally so very low, as to be visible to navigators only within a very short distance, the trees being their only sailing marks. North of the equator, in the Bight of Benin, the coast forms an exception, being high and bold, with the Cameroon Mountains behind; as also at Sierra Leone, which has received its name (Lion Mountain) in consequence. The coast presents a dead level often for thirty to fifty miles inland. It has numerous rivers, some of which extend to the furthest recesses of Inner Africa.

The climate, notoriously fatal to European life, is rendered pestilential by the muddy creeks and inlets, the putrid swamps, and the mangrove jungles that cover the banks of the rivers. There are two seasons in the year, the rainy and the dry season. The former commences in the southern portion in March, but at Sierra Leone and other northern parts, a month later.

Vegetation is exceedingly luxuriant and varied. One of the most important trees is the *Elais guineensis*, a species of palm, from the covering of whose seed or nut is extracted the palm-oil, so well known to English commerce and manufacture; several thousand tons are annually brought into the ports of Liverpool, London, and Bristol. The palm-oil tree is indigenous and abundant from the river Gambia to the Congo; but the oil is manufactured in large quantities chiefly in the country of the Gold and Slave Coasts. The former comprises nearly all the more remarkable of African animals: particularly abundant are elephants, hippopotami, monkeys, lions, leopards, crocodiles, serpents, parrots. The domestic animals are mostly of an inferior quality. The principal minerals are gold and iron. The population consists, besides a few European colonists, of a vast variety of Negro nations, similar in their physical qualities and prevailing customs, but differing considerably in their dispositions and morals.

The chief articles of commerce are palm-oil, ivory, gold, wax, various kinds of timber, spices, gums, and rice.

The divisions of Northern or Upper Guinea are mostly founded on the productions characteristic of the different parts, and are still popularly retained.

Sierra Leone. The British colony of Sierra Leone extends from Rokelle river in the north, to Kater river in the south, and about twenty miles inland. The chief portion of the settlement is a rugged peninsula of mountains with a barren soil, but surrounded by a belt of rich coast-land, with a moist and pestilential climate. The colony was founded in 1787, and has been maintained with a view to the suppression of the West African slave trade. The population, consisting chiefly of liberated slaves, amounted, in 1869, to 55,374, of which number 129 were white men. Freetown, the capital is, after St Louis, the most considerable European town on the western coast of Africa.

Grain Coast. The Malaghetta or Grain Coast extends from Sierra Leone to Cape Palmas. Malaghetta is a species of pepper yielded by a parasitical plant of this region. It is sometimes styled the Windy or Windward Coast, from the frequency of short but furious tornadoes throughout the year. Liberia. The republic of Liberia, a settlement of the American Colonisation Society, founded in 1822, for the purpose of removing free people of colour from the United States, occupies a considerable extent of the coast, and has for its capital Monrovia, a town named after the president, Mr Monro.

Ivory Coast. The Ivory Coast extends from Cape Palmas 3° W. long., and obtained its name from the quantity of the article supplied by its numerous elephants. The French settlements of Grand Bassam, Assinie, and Dabou were abandoned in 1871.

Gold Coast. The Gold Coast stretches from west of Cape Three Points to the river Volta, and has long been frequented for gold-dust and other products. By a treaty of February 1871, the whole of the Dutch possessions on the Gold Coast were made over to Britain, and the Danish settlements of Christiansburg and Friedensburg were ceded to the English in 1849; so that the British coast now extends from the mouth of the Tenda river, in long 2° 40′ W., to that of the Ewe, in long. 1° 10′ E. of Greenwich. The protected territory extends inland from this coast strip to an average distance of 50 miles. Cape Coast Castle and Fort James, founded by the British, and Elmina (population about 10,000) the most important of the former Dutch stations, with Accra, are the chief settlements.

Slave Coast. The Slave Coast extends from the river Volta to the Calabar river, and is, as its name implies, the chief scene of the most disgraceful traffic that blots the history of mankind. Eko or Lagos, one of the chief towns of the coast, was destroyed by the British in 1852, and was proclaimed a British possession in 1861. Palma and Badagry are also British settlements.

The kingdoms of Ashantee, Dahomey, Yoruba, and others, occupy the interior country of the Guinea coast. Ashantee, the most powerful Negro state of Upper Guinea, is an exceedingly fertile and productive country. Its inhabitants, though skilled in some manufactures and of a higher intelligence than is usually found in this region, are of an exceedingly sanguinary disposition, and have frequently been involved in war with the British. The capital city, Kumassi, is believed to have a population of about 100,000.

The coast from the Old Calabar river to the Portuguese possessions is inhabited by various tribes. Duke Town, on the former river, is a town of 4000 inhabitants, with considerable trade in palm-oil, ivory, and timber.

On the Gaboon river, close to the equator, are a French settlement (in 1871 the French retained only a coaling station), and American missionary stations. At the equator Southern or Lower Guinea begins, where the only European settlements are those of the Portuguese.

Loango is reckoned from the equator to the Zaïre or Congo river. Its chief town is Boally, called Loango by the Europeans.

Congo. Congo extends south of the Zaïre, comprising a very fertile region, with veins of copper and iron. Banza Congo or St Salvador is the capital.

Angola and Benguela. Angola comprises the districts of Angola proper, Benguela, and Mossamedes. In these regions the Portuguese settlements extend farther inland than the two preceding

districts, namely, about 200 miles. The capital, St Paulo de Loando, contains 12,300 inhabitants, and has a fine harbour. St Felipe de Benguela is situated in a picturesque but very marshy and most unhealthy spot.

South Africa.

The coast from Benguela to the Cape Colony may, in a general arrangement like this, be included either within West Africa or South Africa. The whole coast is little visited or known, being of a most barren and desolate description, and possessing few harbours. Ichabo island and Angra Peguena Bay are visited for their guano deposits, and are claimed as British possessions.

Under South Africa the Cape Colony only is generally comprised. It takes its name from the Cape of Good Hope, and extends from thence to the Orange river in the north, and to the Kai river in the east. A large proportion of the territory included within these limits, especially in the north, is either unoccupied, or, excepting missionary stations, entirely in the hands of the aborigines.

Apart from the shores, the country consists of high lands, forming parallel mountainous ridges, with elevated plains or terraces of varying extent between. The loftiest range, styled in different parts of its course Sneuw-bergen, Winter-bergen, Nieuveld-bergen, and Roggenveld-bergen, names originated by the Dutch, is the third and last encountered on proceeding into the interior from the south coast. This and the other chains are deeply cut by the transverse valleys called kloofs, which serve as passes across them, and appear as if produced by some sudden convulsion of nature, subsequently widened by the action of the atmosphere and running water.

The high plains or terraces are remarkable for their extraordinary change of aspect in the succession of the seasons. During the summer heats they are perfect deserts, answering to the term applied to them, karroos, signifying, in the Hottentot language, "dry" or "arid." But the sandy soil being pervaded with the roots and fibres of various plants, is spontaneously clothed with the richest verdure after the rains, and becomes transformed for a time into a vast garden of gorgeous flowers, yielding the most fragrant odours. Adapted thus to the support of graminivorous animals, the karroos are the resort of antelopes, zebras, quaggas, and gnus in countless herds, and of the carnivorous beasts that prey upon them, the lion, hyæna, leopard, and panther. These quadrupeds, however, with the elephant, rhinoceros, hippopotamus, giraffe, buffalo, and ostrich, have been largely banished from their old haunts by the advancing footsteps of civilised man, and are only found in the more secluded parts of the interior. The country has a singular and superb flora, but it comprises few native plants useful to man: many such have been now introduced. Heaths of varied species and great beauty abound; and geraniums are treated as common weeds. Many highly productive districts occur; corn, wines, and fruit being the chief objects of cultivation in the neighbourhood of the Cape, while the more inland settlements are grazing farms. Some fine natural forests clothe the sides of the mountains; but in general the colony is deficient in timber trees, as well as in navigable streams, perennial springs, and regular rain. A great deposit of rich copper ore occurs near the mouth of the Orange; and salt is obtained for consumption and sale from salt lakes.

The climate is exceedingly fine and salubrious. There are two seasons, characterised by the prevalence of certain winds. During the summer, which lasts from September to April, the winds blow from south-east, cold and dry; during the winter, namely from May to September, north-west winds prevail. In the most elevated regions the winters are occasionally severe, and snow and ice occur.

The chief native tribes within the British territory are the Hottentots, Bechuanas, and Kaffres. No manufacture is conducted at the Cape except the making of wine, of which from 10,000 to 40,000 gallons are annually exported to England. Various articles of provision are supplied to ships sailing between Europe and the East Indies.

Cape Town is the capital of the colony, and contains 28,460 inhabitants, of whom 15,120 are Europeans. Its commerce is considerable, and the port is frequented by 500 to 600 vessels every year.

The Orange river sovereignty, added to the British territories in 1848, but subsequently given up and constituted a free republic, extends north of the Orange river as far as the Ky Gariep or Vaal river. In consequence of the discovery of rich diamond fields on the lower Vaal river and in the neighbouring territory of the Griqua chief Waterboer, who also petitioned to have his lands subjected to British rule, a wide country surrounding the diamond-fields was incorporated with the Cape Colony in October 1871, under the name of Griqua Land West, divided into the districts of Pneil, Griqua Town, and Klipdrift. The population of this new territory was estimated at 50,000 in 1872, concentrated in camps round the chief diamond-fields. In 1869, Bassuto Land, a mountainous territory at the head waters of the Nu Gariep branch of the Orange river, and on the inward slope of the Drakenberg range, was incorporated as a British possession.

Griqua Land West.

Bassuto Land.

Natal.

Natal or Victoria, a district on the east coast, and separated from the Cape Colony by Kaffraria, is a recently formed British settlement, which was created into a colony in 1856. It is highly favoured in those respects in which the Cape is most deficient, having abundance of wood and water, with coal and various metallic ores, a fine alluvial soil, and a climate adapted to the cultivation of the products for which the home demand is large and constant—cotton, silk, and indigo. Pietermaritzburg, the capital of the settlement, lies 50 miles from the coast. Port Natal, now D'Urban, seated on a fine lake-like bay, is the only harbour.

The Transvaal Republic is an inland state, between the Vaal on the south and the Limpopo river on the north, having the Drakenberg edge on the east, and the Bechuana tribes, which occupy the region bordering on the Kalahira desert, on the west, founded by the Dutch *boers* emigrating from the Cape Colony. Its surface is an elevated plateau, thinly wooded in some parts, but generally affording excellent pasture. The chief town is Potchefstroom, on a tributary of the Vaal; but the seat of government is at Pretoria, in the region of the head streams of the Limpopo.

Sofala.

East Africa extends from Natal northwards to the Red Sea, comprising Sofala, Mozambique, Zanzibar, and the Somali country. But little is known of that region beyond the shores. The Sofala Coast, extending from Delagoa Bay to the Zambeze river, is flat, sandy, and marshy, gradually ascending towards the interior. It abounds with rivers, which are the source of yearly inundations. The soil is very fertile, and produces chiefly rice. In the interior, gold and other metals, as well as precious stones, are found. The Portuguese have settlements at Sofala, in an unhealthy spot, abounding with salt marshes; it consists of only huts, a church, and a fort in ruins. Inhambane, near the tropic of Capricorn, has an excellent harbour.

Mozambique.

Mozambique extends from the Zambeze to Cape Delgado, and is similar, in its natural features, to the Sofala Coast. The greatest river is the Zambeze. The principal settlement of the Portuguese is at Quillimane, which is situated in a very unhealthy position on the northern arm of the delta of the Zambeze, surrounded with mangrove trees.

Zanzibar.

The Zanzibar or Sawahili Coast extends from Cape Delgado to the river Jub, near the equator. The coast is generally low, and has but few bays or harbours: its northern portion is rendered dangerous by a line of coral reefs extending along it. The region possesses a great number of

rivers, but none of them attain a first-rate magnitude. The principal are the Rovuma, the Lufiji, Ruvu, Pangani, and Dana; the two latter rising in the snowy mountains of Kilima-njaro and Kenia. The climate is similar to that of other tropical coasts of Africa, hot and unhealthy in general: in some portions, however, the elevated ground, and with it a more temperate and healthy climate, approaches the shores to within a short distance. The vegetation is luxuriant, and cocoa-nut, palms, maize, rice, and olives are the chief articles of cultivation. The fauna comprises all the more characteristic African species.

The chief inhabitants are the Sawahili, of mixed Arab and Negro descent, but the coasts are under the Arab dominion of the Imaum of Muscat, by whose efforts commerce with the nations of the interior has greatly increased.

The island of Zanzibar (Unguja of the Sawahili) is the residence of a Sultan, tributary to the Imaum of Muscat, and the seat of extensive commerce. Mombas, on a small island close to the main shore, possesses the finest harbour on that coast, and has recently become famous as the seat of an important missionary station.

Somali country. The Somali country comprises the eastern horn of Africa, from the equator northward to the Bay of Tadjurra, near the entrance into the Red Sea. The coast is generally bold and rocky, in some places covered with sand; and the extensive region it encloses presents a slightly ascending plain, traversed by large valleys of great fertility, among which the Wady Nogal is prominent. This country is not so well watered as the region to the south, and some of its rivers are periodical.

The Somali country is famous for its aromatic productions and gums of various kinds; and it is supposed that the spices and incense consumed in such large quantities by the ancient peoples of Egypt, Greece, Syria, and Rome, were derived from this part of Africa, and not from Arabia.

Zeïla and Berbera, on the northern coast, are the chief trading ports: the permanent population of the former is about 3000, while the latter may be said to exist only during the winter, when no less than 20,000 strangers, at an average, arrive to pitch their tents, and thus create a great market-place. Harrar, in the Galla country, is the chief place in the interior, with 8000 inhabitants, who are Mohammedans. One-third of the population is Somali, one-third Arab.

Central Africa. Central Africa comprises the regions which extend from the southern borders of the Sahara in the north to Cape Colony in the south, and from Senegambia in the west to the territory of the Egyptian pashalic on the east. It comprehends the central basins of the great lakes from Lake Chad to the Nyassa, and the greater part of the basins of the Niger, Congo, Nile, and Zambeze. Even the Sahara may well be included in this general denomination. So little is yet known of this vast region that the general features of some portions only can be indicated. The greater portion seems to be densely peopled with numerous tribes, and to possess inexhaustible natural resources. The portion north of the equator, under the name Soudan or Nigritia, comprises a great number of states, among which the principal are Bambarra, Timbuktu, and Houssa, in the west; Bornu, Baghermi, and Waday, around Lake Chad; Darfur in the east; and Adamaua in the south. The inhabitants are of Negro race, with many Arabs, Moors, and Berbers.

Bambarra. Bambarra occupies part of the basin of the Joliba, or upper source of the Quorra. The dominant inhabitants are the Mandingoes and Foulahs, who have embraced Islamism, and are much more advanced in civilisation than the other Negro tribes. The country comprises extensive and excellent pastures, with abundance of domestic animals, as horned cattle, sheep, goats, and horses of a fine breed. Among the vegetable products the most remarkable is the butter-tree, which furnishes an important article of agricultural industry and trade.

Sego, the capital, is situated on the Joliba, and contains 30,000 inhabitants. It was here that Mungo Park first caught sight of the long-sought river.

Timbuktu. Timbuktu, or Jennie, comprises the basin of the Joliba below Bambarra, and lies partly within the Great Sahara. Timbuktu, a few miles from the banks of the Joliba, and situated amid sands and deserts, is a celebrated centre of the North African caravan trade. It contains from 12,000 to 15,000 inhabitants.

Houssa. Houssa is an extensive country extending to the Sahara in the north, to the Joliba or Kawara on the west, to Bornu on the east, and to about 10° N. lat. on the south. The dominant race are the Foulahs, but the mass of the population are Negroes. It is a very fertile and beautiful country, but the climate is insalubrious, and in many parts fatal to Europeans. The inhabitants are engaged in pastoral, as well as in agricultural and commercial pursuits.

The capital, Sakatu, is one of the largest cities in Negroland; it is situated in a fertile but marshy plain. Kano, another large town, containing 30,000 to 40,000 inhabitants, is the great emporium of trade in Houssa; there the English merchandise coming from the north through the Sahara, meets with American goods coming from the Bight of Benin. The manufactures of Kano consist chiefly of cloth, for the dyeing of which that town is famed all over Central Africa.

Bornu. Bornu is one of the most powerful states of Negroland; extending on the west to the 10th degree of long., on the east to Lake Chad and the kingdom of Baghermi, and on the south as far as Mandara and Adamaua, in about 11° N. lat. Kanem, on the northern side of Lake Chad, has recently been conquered and brought under Bornuese sovereignty.

The general character of Bornu is that of a plain, subject to inundations, particularly near Lake Chad. It is very fertile, and cotton and indigo attain a high degree of excellence. The original Bornuese are an agricultural people.

Kuka, the capital and residence of the Sheik of Bornu, had in 1866 about 60,000 inhabitants.

Baghermi. Baghermi, another powerful kingdom, is situated east of Bornu. The boundaries, according to Dr Barth, who first visited this country and penetrated as far as Maseña, the capital, are on the west the river Loggemé, a tributary of the Shary or Asu, by which it is divided from Bornu and Adamaua; on the north its limits are in about $12\frac{1}{2}$° N. lat., and on the east $19\frac{1}{2}$° E. long., both lines dividing it from Waday; the southern boundary is in about $8\frac{1}{2}$° N. lat. Baghermi is an extensive plain or valley formed by the river Shary or Asu and its tributaries. The inhabitants are very warlike, and frequently engage in slave marauding expeditions into the neighbouring states to the south.

Maseña, the capital, lies in 11° 40′ N. lat., and 17° 20′ E. long.

Waday. Waday, or Dar Saley, lies east of Baghermi, and reaches as far as Darfur. It comprises an extensive region, stretching as far as the basin of the Nile. Lake Fittri, situated in the western portion, forms a basin, unconnected with that of Lake Chad, and by which the country as far as Darfur is drained. It has never been explored by Europeans. The population comprises a great variety of tribes and different languages.

Wara, the capital, is placed by Dr Barth in 14° N. lat., and 22° E. long.

Darfur. Darfur, east of Waday, extends as far as Kordofan. The country rises towards the west into a range of hills called Jebel Marrah. It is drained into the Nile. A great portion of the country is Saharan in its character, while other parts are fertile and diversified. Browne, in 1703, estimated the whole population at 200,000. It has an extensive trade with Egypt.

Cobbeah, the capital, is a merchant town, and contains about 6000 inhabitants.

Adamaua. Fumbina or Adamaua is an extensive country south of Houssa and Bornu, under Foulah dominion. It consists of a large, fertile, and highly-cultivated valley, formed by the River Benue. Near Yola, the capital, the Benue receives the Faro, a large tributary coming from the south-west. This country was first visited by Dr Barth in 1851.

Yola, the capital, lies in 8° 50′ N. lat., and 13° 30′ E. longitude.

South of the belt of Negro states of the Soudan lies the great unknown region of Central Africa. On the east the unexplored area is bounded by the numerous states of the lake region made known by Burton, Speke, and Livingstone. Of these the chief are Unyamwesi, occupying the plateau south of the Victoria Lake, and east of Lake Tanganyika, with the capital town of Kaseh or Tabora, frequented by Arab traders from Zanzibar; Karague on the western side of the Victoria Nyanza; and Uganda, stretching round its north-western shores. In the interior, beyond Lake Tanganyika, Livingstone has recently made known the peoples of Manyuema land, where "there is no political cohesion; not one king or kingdom. Each man is independent of every other." To the south of the unknown region are the powerful Negro kingdoms of the Muata Yanvo and of the Cazembe, occupying the whole of the interior between 6° and 12° S. lat. Kabebe, the capital of the former state, is believed to be in about lat. 8° S., long. 23° 30′ E. of Greenwich; and Lunda, the chief town of the latter potentate, is in the Luapula valley, south-west of the Tanganyika Lake, and was visited by Livingstone in 1867–68. The Makololo kingdom, occupying the central basin of the Zambeze river, with the chief town of Linyanti, west of the Victoria Falls; and that of Mosilikatse in the south-east, between the Zambeze and the Limpopo rivers, are the great remaining divisions of Central Africa. Besides these, however, innumerable petty kingdoms, chiefships, and tribes subdivide the vast populations of Negroland.

Islands. To Africa belong a considerable number of islands. The Madeiras, belonging to Portugal, lie off the north-west coast of Africa, at a distance of about 360 miles. Madeira, the chief island, is about 100 miles in circuit, and has long been famed for its picturesque beauty, rich fruits, and fine climate, which renders it a favourite resort of invalids. Wine is the staple produce. Funchal, the chief town, with 18,000 inhabitants, is a regular station for the West India mail steam-packets from Southampton, and the Brazilian sailing-packets from Falmouth.

The Canaries, belonging to Spain, the supposed Fortunate Islands of the ancients, are situated about 300 miles south of Madeira. They are 13 in number, all of volcanic origin, Teneriffe being the largest. The latter is remarkable for its peak, which rises as a vast pyramidal mass to the height of 12,173 feet.

The Cape Verde Islands, subject to Portugal, are a numerous group about 80 miles from Cape Verde. They obtained their name from the profusion of sea-weed found by the discoverers in the neighbouring ocean, giving it the appearance of a green meadow. They are also of volcanic origin.

Fernando Po, a very mountainous forest-covered island, is in the Bight of Biafra. The British settlement of Clarence Town was established in 1827, but afterwards abandoned. The island now belongs to Spain.

St Thomas, immediately under the equator, is a Portuguese settlement; as is also Prince's Island, in 2° N. lat.

Annobon in 2° S. lat., belongs to the Spaniards.

Ascension, a small, arid, volcanic islet, was made a British port on the arrival of Napoleon Bonaparte at St Helena, and since retained as a station, at which ships may touch for stores. Green Hill, the summit of the island, rises to the height of 2840 feet.

St Helena is a huge dark mass of rock, rising abruptly from the ocean to the height of 2692 feet. James' Town is the only town and port.

Madagascar, the largest island of Africa, and one of the largest in the world, is separated from the Mozambique coast by a channel of that name, about 250 miles wide. The area exceeds that of France. Madagascar

The high interior of the island is generally very fertile, with magnificent forests and fine pastures watered by numerous rivers, but a belt of hot swamp land with a deadly climate surrounds the coast.

The inhabitants are diverse races of Negro, Arab, and Malay origin. The Ovahs, a people of the central provinces, are now dominant. The principal town, Antananarivo, has about 80,000 inhabitants.

The French possess the islands of Sante Marie and Nossibe on the coast of Madagascar, and Mayotta island in the Comoro group.

The Comoro isles, four in number, are in the north part of the Mozambique Channel, and inhabited by Arab tribes.

Réunion or Bourbon, 400 miles east of Madagascar, is a colony of France, producing for export, coffee, sugar, cocoa, spices, and timber.

Mauritius, ceded to the British by the French in 1814, is 90 miles north-east of Bourbon. The sugar-cane is chiefly cultivated. Port Louis, the capital, beautifully situated, has 75,000 inhabitants. Within the jurisdiction of the Governor of the Mauritius are the islands of Rodriguez, the Seychelles, and the Amarante islands.

Socotra, a large island, east of Cape Jerdaffun, with an Arab and Negro population, has been known from early times; it belongs to the Imaum of Muscat. This island was long celebrated as producing the finest aloetic drug; it is found still to produce a fine kind of aloe, though much of what passed as Socotrine aloes really came from India. Gums, tobacco, and dates are also exported. (K. J.)

Note.—The above article was completed before it was known with certainty that the saddest event in the history of African exploration had occurred. Dr Livingstone, to whom the article justly assigns "the first place among African discoverers," died of dysentery near Lake Bangweolo on the 4th of May 1873. The story of his latest discoveries, and of the rare devotion with which his native attendants carried his remains with them during an eight months' march to the coast, belongs to a biographical notice. It is more fitting in this place to note, as some consolation for an almost irreparable loss, that Livingstone's death seems to have given a powerful stimulus to the prosecution of the task he had so nearly completed. The expedition of Lieutenant Cameron, above referred to, is being carried out with a vigour and intelligence that give ample promise of a further limitation of the region of the unknown, if not of the complete solution of all outstanding problems. In the spring of 1874 he had commenced a thorough exploration of Lake Tanganyika, which, from his professional experience as a hydrographical surveyor, is expected to lead to very valuable results. And the complete success of Stanley's first memorable mission in search of Livingstone warrants confident hopes in regard to a second expedition, also admirably organised and equipped, which has started under his direction.

AFRICANUS, Julius, called also Sextus by Suidas, a Christian historian of the 3d century, born, according to some, in Africa, and, according to others, in Palestine, of African parents. Little is known of his personal history, except that he lived at Emmaus, and that he went on an embassy to the emperor Heliogabalus to ask the restoration of that town, which had fallen into ruins. His mission succeeded, and Emmaus was henceforward known as Nicopolis. It is by no means certain that he was a bishop or even a priest, though the latter is probable. He wrote a history of the world (Πενταβιβλίον Χρονολογικόν) from the creation to the year 221 A.D., a period, according to his computation, of 5723 years. He calculated the period between the creation and the birth of Christ as 5499 years, and antedated the latter event by three years. This method of reckoning became known as the Alexandrian era, and was adopted by almost all the eastern churches. The history is no longer extant, but copious extracts from it are to be found in the *Chronicon* of Eusebius, besides fragments in Syncellus, Cedrenus, and the *Paschale Chronicon.* Eusebius has also given some extracts from his letter to Aristides, reconciling the apparent discrepancy between St Matthew and St Luke in the genealogy of Christ by a reference to the Jewish law, which compelled a man to marry the widow of his deceased brother, if the latter died without issue. His letter to Origen, impugning the authority of the apocryphal book of Susanna, and Origen's answer, are both extant, the former having been printed at Basle, 1674. The ascription to Africanus of a work entitled Κεστοί, treating of agriculture, natural history, military science, &c., has been disputed on account of the inconsistency between it and the author's other writings. Neander suggests that it was probably written by Africanus before he had devoted himself to religious subjects.

AFZELIUS, Adam, an eminent Swedish naturalist, born at Larf, West Gothland, in 1750. Having studied at Upsala under Linnæus, he became teacher of oriental literature in that university in 1777, and demonstrator of botany in 1785. For two years (1792-94) he resided on the west coast of Africa as botanist to the Sierra Leone Company. After acting for some time as secretary to the Swedish embassy in London, he returned home, became again a teacher in the university of Upsala, and was appointed professor of materia medica in 1812. He edited the autobiography of Linnæus (Upsala, 1823), a German translation of which appeared at Berlin in 1826. His literary work included also a large number of botanical papers contributed to the Linnæan Society of London and the Royal Academy of Stockholm, as well as treatises on certain plants of Guinea and Sweden. He died at Upsala in 1836, having bequeathed his botanical collection to the university. Several species of plants, known as *Afzelia*, are named after this distinguished botanist.

AFZELIUS, Arwid August, the Swedish historian, poet, and comparative mythologist, was born at Fjellåker in 1785. For a while he was a schoolmaster in Stockholm, but afterwards entered the church, and became parish priest of Enköping, where he worked for just half-a-century, till his death in 1871. His poetical career began in 1811 and closed in 1848, when he wrote his *Farewell to the Swedish Harp.* One great work of his life was to collect and publish, in conjunction with the eminent Geijer, three volumes of Swedish Folk-songs; but he will be best remembered by his *History of the Swedish People*, which has won him a European reputation. He did not live to bring this history lower down than 1709. (E. W. G.)

AGA, or Agha, a word, said to be of Tatar origin, signifying a dignitary or lord. Among the Turks it is applied to the chief of the janissaries, to the commanders of the artillery, cavalry, and infantry, and to the eunuchs in charge of the seraglio. It is also employed generally as a term of respect in addressing wealthy men of leisure, landowners, &c. The word is found with a somewhat similar usage in Tartary, Persia, and Algiers.

AGADES, the capital of the kingdom of Aïr, or Asben, in Central Africa, situated in 17° 2′ N. lat., 8° 5′ E. long. The town is built on the edge of a plateau, 2500 feet above the level of the sea, and is supposed to have been founded by the Berbers to serve as a secure magazine for their extensive trade with the Songhay empire. The language of the people is a dialect of Songhay. In former times Agades was a place of great traffic, and had a population of about 50,000. Its importance may be estimated by the fact that the king of Agades paid a tribute of 150,000 ducats to the king of Songhay. Since the beginning of the 16th century the prosperity of the place has gradually declined. Extensive quarters of the town, which has a circuit of 3½ miles, are deserted and ruinous. The occupied houses number only 600 or 700, and the population does not exceed 7000. The houses, which are built of clay, are low and flat-roofed; and the only building of importance is the chief mosque, which is surmounted by a tower 95 feet high. There is little traffic in the markets; no money is used, and the usual medium of exchange is millet. The chief trade is in grain. Agades derives its main importance from its situation on the direct route from the countries to the north-east to Sokoto and other important towns in the Hansa states. The great salt caravans pass through it, as well as pilgrims on their way to Mecca. From its healthy climate and advantageous position, the place might prove to be a good station for a European agent. (See Barth's *Travels in Central Africa*, vol. i.)

AGAMEMNON. The stern obligations of a king and the majesty of his office, as compared with his humane desires and occasional frailty, give the keynote to the character of Agamemnon. But the kingly office, like the sceptre which was the symbol of it, had come to him from Pelops (*Iliad*, ii. 100) through the stained hands of Atreus and Thyestes, and had brought with it a certain fatality, by which his misfortunes, and especially the catastrophe at the close of his life, were explained. As his title of Atrides implies, Agamemnon was a son of Atreus, his mother being Aërope. In a later account he is a son of Pleisthenes. But, apart from this difference, it is agreed that he succeeded to the sovereignty of Atreus over Argolis, Corinth, Achaia, and many islands, his seat being at Mycenæ, not, as Æschylus for political reasons asserts, at Argos. The succession had been usurped by Thyestes and Ægisthus. During the usurpation Agamemnon and his brother Menelaus visited Tyndareus, the king of Sparta, and obtained in marriage his two daughters—the former Clytæmnestra, the latter Helena: with his help Agamemnon was reinstated in his rights. Menelaus succeeded Tyndareus. The children born by Clytæmnestra were Chrysothemis, Iphigenia, Electra, and one son, Orestes. Elsewhere are mentioned also Iphianassa and Laodice; but the latter was the original name of Electra, it appears, and it has been suggested that Iphianassa stood in the same relation to Iphigenia. Agamemnon was then the most powerful prince in Greece; and to him of right, as well as naturally, his brother Menelaus turned for aid to compel the Trojans to give up his wife Helena, whom Paris had carried off. The various princes of Greece having been brought to unite in an expedition for this purpose, Agamemnon was chosen leader, he himself furnishing 100 ships and lending also 60 more to the Arcadians. It was not perhaps his fault that the Greeks landed by mistake on the coast of Mysia, from which, after plundering it, they took ship and were scattered in a storm; but it was owing to him (and this is the beginning of his ill-fate) that after again assembling in

Aulis, whence they had set out, the fleet was storm-bound. He had slain a deer sacred to Artemis, and boasted himself a better hunter than the goddess. This, as Calchas the seer read the divine will, could only be atoned for by his offering up his daughter Iphigenia in sacrifice. Compelled by his duty to the expedition, he allowed her to be sent for, the pretext given to Clytæmnestra being that she was to be married to Achilles. But when the moment of sacrifice came, the goddess substituted a stag, carried her off to the Tauri, and made her immortal. The fleet now sailed: and except the quarrel between him and Achilles at Tenedus or Lemnus, there was no incident in which Agamemnon figured particularly, until, in one of the raids on the towns round Troy, Briseis and Chryseis were brought captives, and assigned, the former to Achilles, the latter to Agamemnon,—who, having to yield up his captive to appease Apollo, claimed and took the other. Upon this Achilles withdrew from the war, and Agamemnon endeavoured at first to maintain it without him. In the face of disaster he repented, and offered reparation—sending costly presents by the hands of Phœnix, Ajax, and Ulysses. His offer rejected, he took the field himself, and did marvels of bravery, but was wounded and defeated. When Troy was finally taken and the captives distributed, he obtained Cassandra, and with her returned home; but before sailing the shade of Achilles appeared to him, foretold what would happen, and sought to restrain him. In his absence Clytæmnestra had yielded to the temptations of Ægisthus, and, to cover her shame, planned with him the death of her husband. The approach of Agamemnon being announced by a spy, a feast and an affected welcome were prepared for him and his followers. At the feast they were fallen upon by hired murderers, assisted by Ægisthus and Clytæmnestra, the latter herself slaying Cassandra (*Odyssey*, iv. 512–537; xi. 385–461). According to Æschylus, Agamemnon was slain in his bath, his wife first throwing a piece of cloth over him to prevent resistance. For his death vengeance was taken by his son Orestes. In the legends of the Peloponnesus, Agamemnon was regarded as the highest type of a powerful monarch, and in Sparta he was worshipped under the title of Zeus Agamemnon. His tomb was pointed out among the ruins of Mycenæ (Pausanias ii. 16. 5). (A. S. M.)

AGAPE, plur. AGAPÆ, the love-feast, or feast of charity, which among the primitive Christians usually accompanied the Eucharist. The word (ἀγάπη, love) is first employed in this sense in the Epistle of Jude, verse 12. The suggestion of a connection between Christian love-feasts and the ἔρανοι and ἑταιρίαι of Greece and Rome is both improbable and unnecessary. The feelings of love and brotherhood fostered by the new faith, strengthened as these must have been by the complete isolation of the little Christian community, are quite sufficient to account for the existence of the Agapæ, without referring them to other more or less similar institutions. According to Chrysostom, the Agape was a common feast, symbolising the community of goods when it no longer really existed, to which the rich brought provisions, and the poor, who brought nothing, were invited. At first it was observed probably every evening in immediate connection with the celebration of the Lord's Supper, though whether before or after is a point that has been much disputed. It closed with the holy kiss (φίλημα ἅγιον, φίλημα αγάπης). The Corinthian church was the first to pervert the Agape by destroying the community between rich and poor (1 Cor. xi. 21). Partly perhaps on account of such irregularities extending, and partly to escape the notice of persecutors, it became usual about the middle of the 2d century to separate the Lord's Supper from the Agape by celebrating the former at the close of morning service on Sunday, and the latter by itself after a considerable interval. Abuses becoming more frequent, love-feasts were gradually put under greater restrictions. The rich began habitually to absent themselves from the Agapæ, which came thus to be regarded as a provision for the poor alone; and the Council of Gangra (360), to correct the abuse, pronounced an anathema upon any who should despise the Agapæ. A number of synods and councils in succession condemned the holding of these feasts in churches, as well as the participation of the clergy in them, and at length the observance altogether died out. In modern times it has been revived in one form or other by the Moravian Brethren, the Wesleyan Methodists, and, in Scotland, by the followers of Robert Sandeman.

AGAPETUS, deacon of the St Sophia Church at Constantinople, presented to the Emperor Justinian a work entitled *Charta Regia*, composed in 527, which contained advice on the duties of a Christian prince. It is highly valued, and has been several times reprinted. The best edition is that contained in Bandauri's *Imperium Orientale* (Paris, 1711). There is an English translation by Thomas Paynell (1550); and a French translation, executed from a Latin version by Louis XIII., with the assistance of his tutor, David Rivault.

AGARDE, ARTHUR, a learned English antiquary, born at Foston, in Derbyshire, about 1540. He was trained a lawyer; but entering the exchequer as a clerk, he became deputy-chamberlain in 1570. This office, which he held for forty-five years, gave him unrivalled opportunities for carrying on his favourite study. Along with his intimate friends, Sir Robert Cotton and Camden, he was one of the original members of the *Society of Antiquaries*. He made a special study of the *Domesday Book*, and prepared an explanation of its more obscure terms, which is of little worth. Hearne, in his *Collection of Curious Discourses written by Eminent Antiquaries* (Oxford, 1720), includes six by Agarde on such subjects as the origin of parliament, the antiquity of shires, the authority and privileges of heralds, &c. Agarde died in 1615, and was buried in the cloister of Westminster Abbey. He bequeathed to the exchequer all his papers relating to that court, and to his friend Sir Robert Cotton his other manuscripts, amounting to twenty volumes.

AGASIAS, son of Dositheus, a famous sculptor of Ephesus, who is supposed to have lived about the 4th century. His celebrated work, known erroneously as the *Borghese Gladiator*, was discovered at the commencement of the 13th century in the ruins of an imperial palace at Antium, where the *Apollo Belvidere* was also found. It represents a figure in action, with the head uplifted as if to meet the attack of a horseman. According to Winckelmann, the representation of the figure is intensely real, without a touch of imagination. The statue forms part of the Louvre collection

AGASSIZ, LOUIS JOHN RUDOLPH, was the son of a Swiss Protestant clergyman. His father was the pastor of the parish of Motiers, a small town situated near the north-eastern angle of the Little Murtensee, and not far from the eastern extremity of the Lake of Neuchatel. Agassiz was born at this retired place on May 28, 1807. Educated first at home, then spending four years at the gymnasium of Bienne, he completed his elementary studies at the academy of Lausanne. Whilst at this latter place he already became conspicuous amongst his fellow-students, not only for his love of the natural sciences, but for the manifest talent he displayed in pursuing them. The close alliance between these subjects and the science of medicine led him to adopt the latter as his profession, for which he studied successively at the universities of Zurich, Heidelberg, and Munich; at the same time availing himself of the advantages afforded

by these universities for extending his knowledge of natural history, especially of botany. Having completed his academical course, he took his degree of doctor of medicine at Munich.

Up to this time he had no particular inclination for the study of ichthyology, which soon afterwards became the great occupation of his life. Agassiz always declared that he was led into ichthyological pursuits through the following circumstances:—In 1819-20, Spix and Martius were engaged in their celebrated Brazilian tour, and on their return to Europe, amongst other collections of natural objects, they brought home an important one of the freshwater fishes of Brazil, and especially of the Amazon river. Unfortunately Spix did not live long enough to work out the history of these fishes; hence it became necessary that some other naturalist should undertake the task of describing them. It is no insignificant proof of the reputation which Agassiz had already won, that, though little more than a youth just liberated from his academic studies, he was selected for this purpose. His attention being thus directed to the special subject of ichthyology, he at once threw himself into the work with that earnestness of spirit which characterised him to the end of his busy life. Thus, in 1828 we find him, after describing a new species of Cynocephalus, publishing a description of a new cyprinoid fish. This was followed by a yet more elaborate research into the history of the cyprinoid and other fishes found in the lake of Neuchatel. Rapidly enlarging his plans, the publication of the last-named work was succeeded by the issue, in 1830, of a prospectus of a *History of the Freshwater Fishes of Central Europe*. It was only in 1839, however, that the first part of this important publication appeared. The task of describing and figuring the Brazilian fishes of Spix and Martius was completed and the work published in 1829.

Acquiring fresh confidence through these labours, he now contemplated a yet greater task. Having become a professed ichthyologist, it was impossible that the fossil fishes with which the stratified rocks of his native mountains abound should fail to attract his attention. The rich stores furnished by the slates of Glarus and the limestones of Monte Bolca were already well known; but very little had been accomplished in the way of the scientific study of them. Agassiz at once threw himself into this new field of labour with his wonted enthusiasm, and began the publication of the work which, more than any other, made him known to foreign naturalists, and laid the foundation of his worldwide fame. Five volumes of his *Recherches sur les Poissons Fossiles* appeared at intervals between the years 1833 and 1844. They were magnificently illustrated, chiefly through the labours of Dinkel, an artist of remarkable power in delineating natural objects.

Agassiz soon found that his palæontological labours rendered a new basis of ichthyological classification absolutely necessary. The fossils rarely exhibited any traces of the soft tissues of fishes. They chiefly consisted of the teeth, scales, and fins, even the bones being perfectly preserved in but comparatively few instances. Hence the classifications of Cuvier and other naturalists were of little use to him in determining the mutual relations of the fossil forms. He therefore adopted his well-known classification, which divided fishes into four groups—viz., Ganoids, Placoids, Cycloids, and Ctenoids. The first of these groups was chiefly represented amongst living fishes by the Lepidosteus or bony pike of the great American rivers; by the Polypterus or Bischir of the Nile; and by the sturgeon. The last fish has a wide geographical range; but the other two, which best display the characters on which Agassiz based his Ganoid class, are limited to the fresh-water rivers of local geographical areas. But in the Palæozoic and Mesozoic ages it was strikingly otherwise. The Ganoids were the most remarkable as well as the most widely diffused of primeval fishes; we find them equally in the fresh-water deposits of the weald, in the marine deposits of the oolites, the chalk, and the magnesian limestone, and in the more mixed and dubious deposits of the coal measures. Agassiz, therefore, was fully justified in attaching very great importance to this hitherto unrecognised class. Indeed, later ichthyologists—*e.g.*, J. Müller and Professor Owen—have found it necessary to retain the class in their recent classifications, though in a modified form. The remaining portions of Agassiz' system have not been adopted by them; but though they do not accept the terms Placoids, Cycloids, and Ctenoids as representing classes, all zoologists employ them as new and convenient adjectives, of the utmost value to students of systematic ichthyology. One reason for the rejection of Agassiz' system by modern ichthyologists is the obvious one that he draws the characteristics of his classes from a single organ—the skin—and that not the most important. At the same time, it must be admitted that the Placoids, like the Ganoids, also constituted a natural group closely corresponding with the *Pisces cartilaginei* of Cuvier and others. The distinction between Cycloids and Ctenoids was a much more trivial one, and needlessly separated closely-allied forms. It is only those who are familiar with the magnitude and difficulties of the task thus undertaken that can appreciate the daring courage of the youth who grappled with it. Under twenty-five years of age, and, as already observed, with limited financial resources, he nevertheless seems to have known no fear. He soon announced to geologists several important generalisations, the correctness of which has been confirmed by all subsequent research. In particular, he pointed out that no examples of Cycloids and Ctenoids, comprehending the bulk of the fishes now seen in our markets, were to be found in rocks of older date than the cretaceous age.

As the work proceeded it became obvious that it would over-tax the resources of the intrepid young zoologist, unless some additional assistance could be afforded to him. The British Association for the Advancement of Science wisely came to his aid, and the late Earl of Ellesmere—better known in his youth as Lord Francis Egerton—gave him yet more efficient help. The original drawings made for the work, chiefly by Dinkel, amounted to 1290 in number. These were purchased by the earl; but, with princely liberality, he left all that were necessary for the further prosecution of his labours in the hands of Agassiz.

It was whilst he was thus engaged that Agassiz paid his first visit to England, for the purpose of studying the rich stores of fossil fishes with which this country abounds. He was then in his youthful prime—a model of manly vigour and scientific enthusiasm; but amongst his many qualities none were more remarkable than the quickness with which he detected the peculiarities of any new fossil, and the retentiveness of his memory, which enabled him to make ready use of his newly-acquired knowledge. The consciousness that he possessed these powers led him occasionally—though, it must be allowed, but rarely—to trust unduly to them, and made him sometimes hasty and offhand in his conclusions.

But fossil ichthyology, though a very large subject, was insufficient to occupy his energetic mind. In 1837 we find him issuing the "Prodrome" of a monograph on the recent and fossil Echinodermata, the first part of which appeared in 1838; and in 1839-40 he published, in addition, two quarto volumes on the fossil Echinoderms of Switzerland. This division of the invertebrate animals was evidently a favourite one with him, since we find it the subject of numerous memoirs which appeared from time to time during his later life.

It was by these great undertakings that he chiefly won his distinguished position as one of the greatest leaders in scientific research; but his observant faculties were by no means concentrated upon them exclusively. His intellectual *tentacula* expanded in every direction. The history of the Belemnites, the muscular system of recent and fossil shells, the principles of classification of the animal kingdom, the embryology of the salmon, and critical studies of special genera of fossil Mollusca—all engaged his attention. During his travels in England in 1834 he was ever on the alert for new specimens for the museum at Neuchatel. One characteristic incident of this kind may be referred to here. A fine porpoise had been caught by the Scarborough fishermen. Agassiz was weary with travel, and had but a few hours to remain in the town, but the chance could not be allowed to escape; the creature was purchased, and midnight saw Agassiz and the writer of this sketch working by the dim light of two tallow candles dissecting the animal, and shipping off its half-cleaned bones to Neuchatel, before he ventured to take the much-needed rest.

Subsequently to his first visit to England the labours of Hugh Miller, Dr Malcolmson, and other geologists brought to light the marvellous ichthyal fauna of the Devonian beds of the north-east of Scotland. Murchison and Sedgwick had some time previously directed attention to the existence of fishes of this geological age, especially amongst the bituminous shales of Caithness; but the more recent discoveries were of far greater interest than the earlier ones, because of the strange forms of the Pterichthys, the Coccosteus, and other species then made known to geologists for the first time. The supposition of Hugh Miller, that some of these fishes had vertical instead of horizontal mouths, suggestive of a transition from the crustacean to the ichthyal type, added fresh interest to the subject in the eyes of a philosophic inquirer like Agassiz. These fossils were reported upon by him more than once, and were finally made the subjects of a special monograph, which was published in 1844. Miller's interpretation of the structure of the mouth Agassiz soon demonstrated to be erroneous.

The year 1840 witnessed the inauguration of a new movement, which has proved to be of the utmost importance to geological science. Previously to this date De Saussure, Venetz, Charpentier, and others had made the glaciers of the Alps the subjects of special study, and Charpentier had even arrived at the important conclusion that the well-known erratic blocks of alpine rocks scattered so abundantly over the slopes and summits of the Jura mountains, had been conveyed thither by glaciers. The question having attracted the attention of Agassiz, he at once grappled with it in his wontedly enthusiastic manner. He not only made successive journeys to the alpine glaciers in company with Charpentier, but he had a rude hut constructed upon one of the Aar glaciers, which for a time he made his comfortless home, in order that he might the more thoroughly investigate the structure and movements of the ice. These labours resulted in the publication of his magnificent illustrated folio entitled *Etudes sur les Glaciers*. In this important work the movements of the glaciers, their moraines, their influence in grooving and rounding off the rocks over which they travelled, producing the striations and *roches moutonnés* with which we are now so familiar, were treated with a comprehensiveness which threw into the shade all the writings of previous labourers in this field. He not only accepted Charpentier's idea that some of the alpine glaciers had extended across the wide plains and valleys drained by the Aar and the Rhone, and thus landed parts of their remains upon the uplands of the Jura, but he went still further in the same direction. He concluded that, at a period geologically recent, Switzerland had been another Greenland; that instead of a few glaciers stretching their restricted lines across the areas referred to, one vast sheet of ice, originating in the higher Alps, had extended over the entire valley of north-western Switzerland until it reached the southern slopes of the Jura, which, though they checked and deflected its further extension, did not prevent the ice from reaching in many places the summit of the range. At a later period we shall find him holding a similar view in the case of the vast plains spread out between the Andes and the eastern coast of South America. The publication of this work gave a fresh impetus to the study of glacial phenomena in all parts of the world. In 1841 Agassiz spent many weeks in his hut on the Lower Aar glacier, where he received as his guest the late Professor James Forbes, who was also engaged upon the study of glacial phenomena. The latter philosopher, in his work on *Norway and its Glaciers*, recognised in the fullest manner his indebtedness to Agassiz for much new light respecting the details of glacial action.

Thus familiarised with the phenomena attendant on the movements of recent glaciers, Agassiz was prepared for a new and most unexpected discovery which he made in 1846, in conjunction with the late Professor Buckland. These two *savants* visited the mountains of Scotland together, and found in six different localities clear evidence of some ancient glacial action. The discovery was announced to the Geological Society of London in a joint communication from the two distinguished observers. Similar discoveries were subsequently made by Buckland, Lyell, Ramsay, and others in various parts of Scotland, Westmoreland, Cumberland, and North Wales. The former existence of glaciers in each of these mountainous districts is a fact that no one now presumes to doubt any more than that these glaciers, either directly, or indirectly in the shape of icebergs, have at least contributed largely to the accumulation of those wide-spread deposits with which geologists are familiar under the name of drift and boulder formations.

But we must now follow Agassiz to a new sphere of labour. In 1838 he was appointed to the professorship of natural history at Neuchatel, with a very limited income. In the autumn of 1846 he crossed the Atlantic, with the two-fold design of investigating the natural history and geology of the United States, and delivering a course of lectures on zoology at the Lowell Institute; and the tempting advantages, pecuniary and scientific, presented to him in the New World, induced him to settle in the United States, where he remained to the end of his life. He was appointed professor of zoology and geology in the university of Cambridge, U.S., in 1847. He left that post in 1851 for a medical professorship of comparative anatomy at Charlestown, but returned in 1853 to Cambridge.

This transfer to a new field, and the association with fresh objects of high interest to him, gave his energies a new stimulus. Volume after volume now proceeded from his pen: some of his writings were popular, and addressed to the multitude, but most of them dealt with the higher departments of scientific research. His work on Lake Superior, and his four volumes of *Contributions to the Natural History of the United States*, were of this latter character. But whilst thus working earnestly at American zoology, he still kept in view more generalised inquiries, the fruits of which appeared in 1854, with the title of *Zoologie Générale et Esquisses Générales de Zoologie contenant la Structure, le Développement, la Classification, &c., de tous les Types d'Animaux vivants et détruits.* Before leaving these literary labours, we must not overlook the valuable service he rendered to science by the formation, for his own use, of a catalogue of scientific memoirs—an

extraordinary work for a man whose hands were already so full. This catalogue, edited and materially enlarged by the late Hugh Strickland, was published by the Ray Society under the title of *Bibliographia Zoologiæ et Geologiæ.* Nor must we forget that he was building up another magnificent monument of his industry in the Museum of Natural History, which rose under his fostering care, at Cambridge. But at length the great strain on his physical powers began to tell. He then sought to restore his waning health by a southern voyage. His early labours among the fishes of Brazil had often caused him to cast a longing glance towards that country; and he now resolved to combine the pursuit of health with the gratification of his long-cherished desires. In April 1865 he started for Brazil, along with his admirable wife and an excellent class of assistants. Even on shipboard he could not be idle. In his outward voyage he delivered a course of lectures, open to all his fellow-passengers, but especially addressed to his assistants, and intended to instruct them in the nature and bearings of the great problems upon which they might hope to throw light during their stay in Brazil. An interesting account of this journey, to the success of which the emperor of Brazil contributed in every possible way, was published by Mrs Agassiz when they returned home, laden with the natural treasures of the Brazilian rivers.

In 1871 he made a second excursion, visiting the southern shores of the North American continent, both on its Atlantic and its Pacific seaboards. He had for many years yearned after the establishment of some permanent school where zoological science could be studied, not in class-rooms or museums of dead specimens, but amidst the living haunts of the subjects of study. Like all truly great teachers, he had little faith in any school but that of nature. The last, and possibly the most permanently influential, of the labours of his long and successful life was the establishment of such an institution, which he was enabled to effect through the liberality of Mr John Anderson, a citizen of New York. That gentleman not only handed over to Agassiz the island of Penikese, on the east coast, but also presented him with $50,000 wherewith permanently to endow it as a practical school of natural science, especially devoted to the study of marine zoology. Another American friend gave him a fine yacht, of 80 tons burden, to be employed in marine dredging in the surrounding seas. Had Agassiz lived long enough to bring all this machinery into working order, it is difficult to exaggerate the practical advantages which American science would have reaped from it when guided by such experienced hands. But it was otherwise ordained. The disease with which he had struggled for some years proved fatal on Dec. 14, 1873.

A letter to his old friend, Sir Philip M. de Grey Egerton, Bart., written but a few days before his death, and doubtless one of the last that he penned, showed that his spirit was still as indomitable and his designs as large as ever; and one of his latest expressed wishes was that he might be spared for four more years in order that the work he had contemplated might be completed.

Our available space will not allow us to give a detailed sketch of the opinions of this remarkable man on even the more important of the great subjects which he studied so long. From first to last he steadily rejected the doctrine of evolution, and affirmed his belief in independent creations. In like manner he retained his confidence in the former existence and agency of vast continental ice-sheets, rather than in the combined action of more limited glaciers and icebergs, which nearly all modern geologists recognise as the producers of the drifts and boulder-clays. When studying the superficial deposits of the Brazilian plains in 1865, his vivid imagination covered even that wide tropical area, as it had covered Switzerland before, with one vast glacier, extending from the Andes to the sea. His daring conceptions were only equalled by the unwearied industry and genuine enthusiasm with which he worked them out; and if in details his labours were somewhat defective, it was only because he had the courage to attempt what was too much for any one man to accomplish. (W. C. W.)

AGATE (from *Achates*, a river in Sicily, on the banks of which it is said to have been found), a name applied by mineralogists to a stone of the quartz family, generally occurring in rounded nodules or in veins in trap rocks. The number of agate balls in the rock often give it the character of amygdaloid; and when such a rock is decomposed by the elements, the agates drop out, and are found in the beds of streams that descend from it; or they may be obtained in quarrying. Great quantities are obtained from Oberstein and Idar, in Germany, where there are large manufactories for colouring and polishing the stones; and many are brought from India and Brazil. Agate occurs in considerable quantity in Scotland, whence the stone is familiarly known to lapidaries as *Scotch pebble;* and very large masses of calcedony, a variety of it, are brought from Iceland, the Faroe Islands, and Brazil. Agate chiefly consists of calcedony, with mixtures of common quartz and occasional patches of jasper and opal. The colour markings are often in concentric rings of varying forms and intensity, or in straight parallel layers or bands. The colours are chiefly gray, white, yellow, or brownish-red. The composition of agate is not uniform; but it usually contains from 70 to 96 per cent. of silica, with varying proportions of alumina, coloured by oxide of iron or manganese. The principal varieties are—

1. *Calcedony.* In this the colours are in parallel bands. The porosity of this stone, and the presence of iron in it, have given rise to a beautiful artificial process for heightening its natural colours, which has been long practised at Oberstein, and probably long known in India. The stones best suited for this purpose are such as when recently fractured imbibe moisture most readily. The stones are first dried without heat, then immersed in a mixture of honey and water, and afterwards placed in a heated oven, where they remain for two or three weeks, constantly covered with the liquid. They are then washed, dried, and put into an earthenware vessel containing sufficient sulphuric acid to cover them; this vessel is closed and placed in the oven for a space varying from one to twelve hours, according to the hardness of the stone. The agates are now removed, washed, and thoroughly dried; and after being kept in oil for twenty-four hours, are cleaned, cut, and polished. In the best specimens the gray streaks are increased in intensity; some exhibit brown streaks approaching to black, while white impenetrable parts assume a brighter hue by the contrast. This is the process employed to convert the veined calcedony or agate into *onyx,* especially for the production of *cameos* and *intaglios,* in imitation of the antique sculptured gems, of which admirable specimens are found in the cabinets of the curious, and especially in the Florentine Museum. In those minute but exquisite works the ancient Greeks especially excelled; and remarkable specimens of the art have been found in the tombs of Egypt, Assyria, and Etruria. In such works the figures, whether in relief or intaglio, appear of a different colour from the ground.

2. *Carnelian,* or red calcedony, when found, is almost always brownish or muddy. The following process is employed at Oberstein to convert both this sort and the yellowish-brown varieties into a rich red, so as to rival the Indian carnelian, which probably also has its colour heightened artificially:—After being thoroughly dried, the

tones are dipped in sulphuric acid, and immediately exposed n a covered earthenware crucible to a red heat: the whole s allowed to cool slowly, and when cold the stones are removed and washed.

3. *Mocha stones*, originally brought from the East, are clear grayish calcedonies, with clouds and dashes of rich brown of various shades. They probably owe their colour chiefly to art.

4. *Moss agates* are such as contain arborisations or *dendrites* of oxide of iron, some of which seem to be petrifactions of real vegetable forms.

5. *Bloodstone* is a dark-green agate containing bright red spots like blood-drops.

6. *Plasma*, a grass-green stone, found engraved in ruins at Rome, on the Schwartzwald, and on Mount Olympus, appears to be calcedony coloured by chlorite.

7. *Chrysoprase*, found in Silesia, is an agate coloured apple-green by oxide of nickel.

The agate can be cut or sawed easily, and is used for making cups, rings, seals, handles for knives and forks, sword-hilts, rosary beads, and a great variety of trinkets. Many stones of this kind are marked with representations of men, animals, or inanimate natural objects; but there can be no question that a very large proportion of these are to be regarded as productions of art.

AGATHARCHIDES, a celebrated Greek grammarian and geographer who flourished about 140 years B.C., was born at Cnidos. His works are lost, except those passages quoted by Diodorus Siculus and other authors, in which he describes the gold mines of Upper Egypt, and gives the first philosophical explanation of the inundations of the Nile, which he ascribed to the rains on the mountains of Ethiopia. (Hudson's *Greek Geographers*.)

AGATHARCHUS, a Greek painter, commemorated by Vitruvius for having first applied the laws of perspective to architectural painting, which he used successfully in preparing scenery for the plays of Æschylus. He flourished about 480 years B.C.

AGATHIAS, a Greek historian and poet, born at Myrina in Asia Minor, about 536 A.D. He was educated at Alexandria, and in 554 went to Constantinople, where, after studying Roman law for some years, he practised as an advocate. The title "Scholasticus," generally given to Agathias, was that by which advocates were known in Constantinople. Of the poetry by Agathias but little remains; his *Daphniaca* (Δαφνιακά), a collection of erotic poems, being entirely lost, and only the introduction to his Κύκλος, or anthology from earlier and contemporary writers, being extant. A number of his epigrams may be found in the *Anthologia Græca*. His principal work is his history, which begins, where Procopius ends, with the 26th year of the reign of Justinian (553), and carries on the narrative of events until 558. It is valuable as a chronicle, but the style is turgid, and great ignorance is shown of the history and geography of western Europe. It was printed in Greek, with a Latin translation by Bonaventura Vulcanius, at Leyden in 1594. The best edition is that of Niebuhr (Bonn, 1828). A French translation is included in the second volume of Louis Cousin's *History of Constantinople*.

AGATHO, an Athenian tragic poet, the disciple of Prodicus and Socrates, celebrated by Plato in his *Protagoras* for his virtue and his beauty. A tragedy of his obtained the prize in the fourth year of the 90th Olympiad, and he was crowned, in the presence of upwards of 30,000 persons, when a little over thirty years of age. There are no remains of his works, except a few quotations in Aristotle, Athenæus, and others.

AGATHOCLES, a famous tyrant of Sicily, was the son of a potter at Rhegium. By his singular vigour and abilities he raised himself through various gradations of rank till he finally made himself tyrant of Syracuse, and then of nearly all Sicily. He defeated the armies of the Carthaginians several times, both in Sicily and Africa but at length he met with a reverse, and his soldiers' pay being in arrears, they mutinied, forced him to fly his camp, and murdered his sons. Recovering himself, he relieved Corcyra, which was besieged by Cassander; burnt the Macedonian fleet; and revenged the death of his children by putting the murderers, with their wives and families, to the sword. After ravaging the sea-coast of Italy he took the city of Hipponium. The last years of his life were greatly harassed with ill-health and the turbulence of his grandson Archagathus. He died in the seventy-second year of his age, B.C. 290, after a reign of twenty-eight years.

AGDE, a town of France, in the department of Hérault, on the left bank of the river of that name, 30 miles S.W. of Montpellier. It is a place of great antiquity, and is said to have been founded, under the name of *Agathe*, by the Greeks. In the neighbourhood there is an extinct volcano, and the town is built of black volcanic basalt, which gives it a grim and forbidding aspect. It has a fine old Gothic cathedral, a college, and a school of navigation. The *Canal du Midi*, or Languedoc canal, uniting the Garonne with the Mediterranean Sea, passes under the walls of the town, and the mouth of the Hérault forms a convenient harbour, which is protected by a fort. Thus advantageously situated, the place commands an extensive coasting trade, more than 400 vessels annually entering the port. Soap and verdigris are manufactured, and the staple productions of southern France are largely exported. Population, 9747.

AGE, a term denoting generally any fixed period of time, is used more definitely in a variety of senses. Classical mythology divided the whole history of the earth into a number of periods. Hesiod, for example, in his poem *Works and Days*, describes minutely five successive ages, during each of which the earth was peopled by an entirely distinct *race*. The first or *golden* race lived in perfect happiness on the fruits of the untilled earth, suffered from no bodily infirmity, passed away in a gentle sleep, and became after death guardian dæmons of this world. The second or *silver* race was degenerate, and refusing to worship the immortal gods, was buried by Jove in the earth. The third or *brazen* race, still more degraded, was warlike and cruel, and perished at last by internal violence. The fourth or *heroic* race was a marked advance upon the preceding, its members being the heroes or demi-gods who fought at Troy and Thebes, and who were rewarded after death by being permitted to reap thrice a-year the free produce of the earth. The fifth or *iron* race, to which the poet supposes himself to belong, is the most degenerate of all, sunk so low in every vice that any new change must be for the better. Ovid, in his *Metamorphoses*, follows Hesiod exactly as to nomenclature and very closely as to substance. He makes the degeneracy continuous, however, by omitting the *heroic* race or age, which, as Grote points out, was probably introduced by Hesiod, not as part of his didactic plan, but from a desire to conciliate popular feeling by including in his poem the chief myths that were already current among the Greeks.

A definite period in history distinguished by some special characteristic, such as great literary activity, is generally styled, with some appropriate epithet, an age. It is usual, for example, to speak of the age of Pericles, the Augustan age, the Elizabethan age; of the age of the crusades, the dark ages, the middle ages, the age of steam. Such isolated periods, with no continuity or necessary connection of any kind, are obviously quite distinct from the ages or organically-related periods into which certain

eminent modern philosophers have divided the whole course of human history. According to Fichte's scheme there are five ages, distinguished by the relative predominance which instinct, external authority, and reason have in them respectively, instinct being supreme in the first and reason in the last. Comte's scheme distinguishes three ages according to the state of knowledge in each, and he supposes that we are now entering upon the third of these. In the first age of his scheme knowledge is *supernatural* or fictitious; in the second it is *metaphysical* or abstract; in the third it is *positive* or scientific. Schemes somewhat similar have been proposed by other philosophers, chiefly of France and Germany, and seem to be regarded by them as essential to any complete science of history.

In relation to individual as well as to social life, age is used with a considerable variety of application. It frequently denotes the total duration of life in man, animals, or plants, and in this sense belongs to the subject of LONGEVITY (*q.v.*) It also denotes in man the various periods into which his life may be divided, either from a physiological or from a legal point of view. In the former aspect perhaps the most common division is into the four ages of infancy, youth, manhood, and old age. These again have been increased to six or seven by some physiologists—infancy, childhood, boyhood or girlhood, adolescence, manhood or womanhood, age, and old age or second childhood. While both schemes have a sufficient basis of scientific accuracy, they have also each attracted the fancy of the poet. Ovid in his *Metamorphoses* (xv. 198–213) makes a beautiful comparison between the four ages of a man's life and the four seasons of the year, in a passage which has been frequently imitated; and the sevenfold division has been exquisitely cast into poetic form by Shakespeare in *As You Like It*, act ii. scene 7. The division of human life into periods for legal purposes is naturally more sharp and definite than the foregoing. It would be unscientific in the physiologist to name any precise year for the transition from one of his stages to another, inasmuch as that differs very considerably among different nations, and even to some extent among different individuals of the same nation. But the law must necessarily be fixed and uniform, and even where it professes to proceed according to nature, must be more precise than nature. The Roman law divided human life for its purposes into four chief periods, which had their subdivisions—(1.) *Infantia*, lasting till the close of the seventh year; (2.) The period between *infantia* and *pubertas*, males becoming *puberes* at fourteen and females at twelve; (3.) *Adolescentia*, the period between puberty and majority; and (4.) The period after the twenty-fifth year, when males become *majores*. The first period was one of total legal incapacity; in the second period a person could lawfully do certain specified acts, but only with the sanction of his tutor or guardian; in the third the restrictions were fewer, males being permitted to manage their own property, contract marriage, and make a will; but majority was not reached until the age of twenty-five. By English law there are two great periods into which life is divided—*infancy*, which lasts in both sexes until the twenty-first year, and manhood or womanhood. The period of infancy, again, is divided into several stages, marked by the growing development both of rights and obligations. Thus at twelve years of age a male may take the oath of allegiance; at fourteen both sexes are held to have arrived at years of discretion, and may therefore choose guardians, give evidence, and consent or disagree to a marriage. A female has the last privilege from the twelfth year, but the marriage cannot be celebrated until the majority of the parties without the consent of parents or guardians. At fourteen, too, both sexes are fully responsible to the criminal law. Between seven and fourteen there is responsibility only if the accused be proved *doli capax*, capable of discerning between right and wrong, the principle in that case being that *malitia supplet ætatem*. At twenty-one both males and females obtain their full legal rights, and become liable to all legal obligations. A seat in the British Parliament may be taken at twenty-one. Certain professions, however, demand as a qualification in entrants a more advanced age than that of legal manhood. In the church a candidate for deacon's orders must be twenty-three, and for priest's orders twenty-four years of age; and no clergyman is eligible for a bishopric under thirty. In Scotland infancy is not a legal term. The time previous to majority, which, as in England, is reached by both sexes at twenty-one, is divided into two stages: *pupilage* lasts until the attainment of puberty, which the law fixes at fourteen in males and twelve in females; *minority* lasts from these ages respectively until twenty-one. *Minority* obviously corresponds in some degree to the English *years of discretion*, but a Scotch minor has more personal rights than an English infant in the last stage of his infancy, *e.g.*, he may dispose by will of moveable property, make contracts, carry on trade, and, as a necessary consequence, is liable to be declared a bankrupt. Among foreign nations the law on this matter is somewhat varied. In France the year of majority is twenty-one, and the nubile age, according to the *Code Napoleon*, eighteen for males and fifteen for females, with a restriction as to the consent of guardians. In Germany majority is usually reached at twenty-four, though in some states (Bavaria, Saxony, Würtemburg, and Baden) the age is twenty-one. In the United States the age qualification for a president is thirty-five, for a senator thirty, and for a representative twenty-five.

AGELADAS, an eminent statuary of Argos, and the instructor of the three great sculptors, Phidias, Myron, and Polycletus. There is considerable difference in the statements of the date when he flourished. Thiersch meets the difficulty by supposing that there was another artist of the same name.

AGELNOTH, ÆTHELNOTH, or ETHELNOTH, known also as *Achelnotus*, son of Egelmaer the Earl, Archbishop of Canterbury in the reign of Canute, was trained in the monastery at Glastonbury, for which he afterwards obtained new privileges from the king. According to William of Malmesbury, he exercised a great and salutary influence over Canute in the way both of encouragement and restraint. He was appointed dean of Canterbury and chaplain to the king, and was raised to the archbishopric on the death of Living in 1020. He wisely counselled Canute to that course of policy which ultimately led to the fusion of Danes and Saxons, and their united resistance to the invasion of the Normans; and similar pacific counsels in the church brought about a temporary cessation of the mutual persecution on the part of the Benedictine and secular clergy. It being necessary that the archbishop should visit Rome in person to receive the pall, he repaired thither in 1022, and was received by Pope Benedictine VIII. with every mark of honour. At Pavia, on his way home, he purchased a relic, which was said to be the right arm of St Augustine of Hippo, at the cost of 100 talents of silver and 1 of gold. This he sent as a present to Leofric, the young Earl of Mercia. With his own wealth and liberal grants from Canute he restored and adorned his cathedral. When Canute died, he made the archbishop promise to be faithful to his sons by Emma, and the promise was so truly kept that Harold, the usurper, remained unconsecrated until after the death of Agelnoth (1038).

AGEN, the chief town of the department of Lot-et-Garonne in France, is situated on the right bank of the Garonne, 73 miles S.E. of Bordeaux. Through its excellent water communication it affords an outlet for the

agricultural produce of the district, and forms an *entrepôt* of trade between Bordeaux and Toulouse. Its chief manufactures are sail-cloth, cotton, linen, leather, and starch. It has a college and several literary institutions, and is the seat of a bishop and a high court of justice. There is a fine bridge of eleven arches over the Garonne. In 1872 the population was 18,887.

AGENT, in *Diplomacy*, *Commerce*, and *Jurisprudence*, is a name applied generally to any person who acts for another. It has probably been adopted from France, as its function in modern civil law was otherwise expressed in Roman jurisprudence. Ducange (s.v. *Agentes*) tells us that in the later Roman empire the officers who collected the grain in the provinces for the troops and the household, and afterwards extended their functions so as to include those of government postmasters or spies, came to be called *agentes in rebus*, their earlier name having been *frumentarii*.

In *Diplomacy*, a class of semi-ambassadors termed agents have been employed generally between states of unequal power. The small community might send an agent to propitiate some powerful government, and secure its protection. A great power would, on the other hand, distribute its agents among the petty states which it kept in clientage, to see that no counteracting influence was at work among them. In this shape our Indian government keep agencies in the protected and other neighbouring states. Similarly, though this class does not fall within the scope of public international law, the self-governing British colonies now employ agents to attend to their interests and represent them in the mother country. The status of diplomatic agents, not of the classes of ambassadors, envoys, ministers, or *chargés d'affaires*, is extremely ill-defined and uncertain. (Phillimore's *International Law*, ii. 246; Heffter *Europäisches Völkerrecht*, § 222.) See AMBASSADOR; DIPLOMACY.

The law of PRINCIPAL AND AGENT has its origin in the law of mandate among the Romans, and fortunately even in England the spirit of that system of jurisprudence pervades this branch of the law. The law of agency is thus almost alike throughout the whole British empire, and a branch of the British commercial code, in which it is of great importance that different nations should understand each other's system, differs only slightly from the law of the rest of Europe.

In a general view of the law of agency it is necessary to have regard to the rights and duties of the principal, the agent, and the public. The agent should not do what he has no authority for; yet if he be seen to have authority, those with whom he deals should not be injured by secret and unusual conditions. The employer is bound by what his agent does in his name, but the public are not entitled to take advantage of obligations which are known to be unauthorised and unusual. The agent is entitled to demand performance by the principal of the obligations undertaken by him within the bounds of his commission, but he is not entitled to pledge him with a recklessness which he would certainly avoid in the management of his own affairs. It is in the regulation of these powers and corresponding checks in such a manner that the legal principle shall apply to daily practice, that the niceties of this branch of the law consist.

Agents are of different kinds, according to their stipulated or consuetudinary powers. The main restraint in the possible powers of an agent is in the old maxim, *delegatus non potest delegare*, designed to check the complexity that might be created by inquiries into repeatedly-deputed responsibility. The agent cannot delegate his commission or put another in his place; but in practice this principle is sometimes modified, for it so may arise from the nature of his office that he is to employ other persons for the accomplishment of certain objects. Thus, there is nothing to prevent a commercial agent from sending a portion of the goods entrusted by him to his own agent for disposal.

In the general case agency is constituted by the acceptance of the mandate or authority to act for the principal, and the evidence of this may be either verbal or in writing. The English statute of frauds requires an agent to have authority in writing for the purposes of its 1st, 2d, and 3d clauses relating to leases. "And it is a general rule, that an agent who has to execute a deed, or to take or give livery or seisin, must be appointed by deed for that purpose. Moreover, as a corporation aggregate can in general act only by deed, its agent must be so appointed, though it would seem that some trifling agencies, even for corporations, may be appointed without one." (Smith's *Mercantile Law*, B. I. chap. iv.) It is a general rule that those obligations which can only be undertaken by solemn formalities cannot be entered on by a delegate who has not received his authority in writing. But it is often constituted, at the same time that its extent is defined, by mere appointment to some known and recognised function—as where one is appointed agent for a banking establishment, factor for a merchant, broker, supercargo, traveller, or attorney. In these cases, usage defines the powers granted to the agent; and the employer will not readily be subjected to obligations going beyond the usual functions of the office; nor will the public dealing with the agent be bound by private instructions inconsistent with its usual character. While, however, the public, ignorant of such secret limitations, are not bound to respect them, the agent himself is liable for the consequences of transgressing them. Agency may also be either created or enlarged by *implication*. What the agent has done with his principal's consent the public are justified in believing him authorised to continue doing. Thus, as a familiar instance, the servant who has continued to purchase goods for his master at a particular shop on credit is presumed to retain authority and trust, and pledges his master's credit in farther purchases, though he should, without the knowledge of the shopkeeper, apply the articles to his own uses. The law is ever jealous in admitting as accessories of a general appointment to any particular agency the power to borrow money in the principal's name, to give his name to bill transactions, and to pledge him to guaranties; but all these acts may be authorised by implication, or by being the continuation of a series of transactions, of the same kind and in the same line of business, to which the principal has given his sanction. Thus an employer may, by the previous sanction of such operations, be liable for the bills or notes drawn, indorsed, and accepted by his clerk or other mandatary; nay, may be responsible for the obligations thus incurred after the mandatary's dismissal, if the party dealing with him knew that he was countenanced in such transactions, and had no reason to suppose that he was dismissed. In questions of this kind the distinction between a general and a special agent is important. A general agent is employed to transact all his principal's business of a particular kind, at a certain place,—as a factor to buy and sell; a broker to negotiate contracts of a particular kind; an attorney to transact his legal business; a shipmaster to do all things relating to the employment of a ship. Such an agent's power to do everything usual in the line of business in which he is employed is not limited by any private restriction or order unknown to the party with whom he is dealing. On the contrary, it is incumbent on the party dealing with a particular agent, *i.e.*, one specially employed in a single transaction, to ascertain the extent of his authority. The law applicable to a mercantile agent's power to pledge or otherwise dispose of the goods entrusted to him

being in an unsatisfactory state, a statutory remedy was applied to it by an Act of 1825 (6 Geo. IV. c. 94), which required amendment in 1842 (5 and 6 Vict. c. 39).

The general object of these measures, which appear to extend to Scotland, is to make transactions with an agent in possession of goods as safe as dealing with the owner, to all who treat with him, as purchasers or otherwise, in good faith, and in ignorance of his want of ownership. Thus, when an agent ships goods in his own name, the consignee is entitled to a lien on them for any advances to the agent, or liabilities on bills or notes, if he has not notice by the bill of lading or otherwise at or before the time of the advance or receipt that such person is not the actual and *bonâ fide* owner. The presumption in such cases is ownership; and the burden of disproving it, as well as of showing that the consignee was aware of the mere agency, falls on the person questioning the validity. By the statutes, the person entrusted with and in possession of a bill of lading, dock warrant, warehouse-keeper's certificate, wharfinger's certificate, or other delivery warrant, is held the owner of the goods it represents, so as to render valid any transaction for their sale or disposition of the goods, or the deposit or pledge thereof, or of any part thereof, to parties ignorant of the limited ownership. Besides their effect in rendering valid, in this more comprehensive manner, operations conducted under the appearance and supposition of absolute ownership, the acts have separate provisions for the security of those who deal with agents, knowing them to be such. The acts, however, must be studied in their very words, which are not remarkable for clearness. The following brief description of their general effect, taken from Chitty's *Collection of Statutes*, may be useful:—"First, where goods or documents for the delivery of goods are pledged as a security for present or future advances, with the knowledge that they are not the property of the factor, but without notice that he is acting without authority, in such a case the pledgee acquires an absolute lien. Secondly, where goods are pledged by a factor without notice to the pledgee that they are the property of another, as a security for a pre-existing debt, in that case the pledgee acquires the same right as the factor had. Thirdly, where a contract to pledge is made in consideration of the delivery of other goods or documents of title, upon which the person delivering them up had a lien for a previous advance (which is deemed to be a contract for a present advance), in that case the pledgee acquires an absolute lien to the extent of the value of the goods given up." The statutes are applicable only to proper mercantile transactions, and not, for example, to advances upon the security of furniture in a furnished house to the apparent owner. (See Smith's *Leading Cases*, vol. i. p. 759 *sqq.*, 6th ed.)

The obligations of the principal are—to pay the agent's remuneration, or, as it is often called, *commission*, the amount of which is fixed by contract or the usage of trade; to pay all advances made by the agent in the regular course of his employment; and to honour the obligations lawfully undertaken for him. The agent is responsible for the possession of the proper skill and means for carrying out the functions which he undertakes. He must devote to the interests of his employer such care and attention as a man of ordinary prudence bestows on his own—a duty capable of no more certain definition, the application of it as a fixed rule being the function of a jury. He is bound to observe the strictest good faith; and in some instances the law interposes to remove him from temptation to sacrifice his employer's interests to his own: thus, when he is employed to buy, he must not be the seller; and when employed to sell, he must not be the purchaser. He ought only to deal with persons in good credit, but he is not responsible for their absolute solvency unless he guarantee them. A mercantile agent guaranteeing the payments he treats for is said to hold a *del credere* commission.

In Scotland the procurators or solicitors who act in the preparation of cases in the various law-courts, and all who take out the attorney licence, are called agents. See ATTORNEY.

In France, the *Agents de Change* were formerly the class generally licensed for conducting all negotiations, as they were termed, whether in commerce or the money market. Of late the term has been practically limited to those who conduct, like our stockbrokers, transactions in public stock; and it is understood that it is rather as speculators than as agents that the majority of them adopt the profession. The laws and regulations as to *courtiers*, or those whose functions were more distinctly confined to transactions in merchandise, have been mixed up with those applicable to *agents de change*. Down to the year 1572 both functions were free; but at that period, partly for financial reasons, a system of licensing was adopted at the suggestion of the Chancellor l'Hôpital. Among the other revolutionary measures of the year 1791, the professions of agent and *courtier* were again opened to the public. Many of the financial convulsions of the ensuing years, which were due to more serious causes, were attributed to this indiscriminate removal of restrictions, and they were reimposed in 1801. From that period regulations have been made from time to time as to the qualifications of agents, the security to be found by them, and the like. They are now regarded as public officers, appointed, with certain privileges and duties, by the government, to act as intermediaries in negotiating transfers of public funds and commercial stocks, and for dealing in metallic currency.

AGESILAUS, king of the Lacedæmonians, the second of the name, son of Archidamus II., was, through the influence of Lysander, raised to the throne in 398 B.C., in opposition to the superior claim of his nephew Leotychides. Immediately on his accession he advised the Lacedæmonians to anticipate the king of Persia, who was making great preparations for war, and attack him in his own dominions. He was himself chosen for this expedition, and gained so many advantages over the enemy that, if the league which the Athenians and the Thebans formed against the Lacedæmonians had not obliged him to return home, it seems probable that he would have carried his victorious arms into the very heart of the Persian empire. But he readily gave up all these triumphs to come to the succour of his country, which he happily relieved by his victory over the allies at Chæronea, in Bœotia, 394 B.C. He obtained another near Corinth; but, to his great mortification, the Thebans afterwards gained several victories over the Lacedæmonians. This at first raised a clamour against him. He had been ill when the course of victory turned in favour of the enemy; but as soon as he was able to act in person his valour and prudence prevented the Thebans from reaping the advantages of their successes; so that it was generally believed that, had he been in health at the beginning, the Lacedæmonians would have sustained no losses, and that without him all would have been lost. It cannot be denied, however, that his fondness for war occasioned many losses to his countrymen, and led them into enterprises which in the end contributed much to weaken their power. He died in the third year of the 103d Olympiad, being the 84th year of his age and 38th of his reign, and was succeeded by his son Archidamus. Agesilaus, though a vigorous ruler and great general, was of small stature, and lame from his birth. His accession to the throne was, indeed, opposed on this ground, an oracle having foretold evils to Sparta under a lame sovereignty. As we have seen, the oracle was

so far fulfilled that many troubles befell the state during his reign. Few of these, however, are traceable to the policy of the king, whose public life was illustrated by a series of brilliant victories over the enemies of his country. In character, Agesilaus seems to have possessed the Spartan virtues of courage, temperance, and fortitude, without the Spartan vices of hardness, cupidity, and injustice. His life and merits have been commemorated by Xenophon, Plutarch, Diodorus Siculus, and Cornelius Nepos.

AGGREGATION, STATES OF, the three states—*solid*, *liquid*, and *gaseous*—in which matter occurs, depending on the degree of cohesion that subsists between the molecules or atoms of material bodies. In the solid state, the molecules cohere so firmly that their relative positions cannot be changed without the application of force, and the body retains a definite form; in the liquid state, they move freely and readily on each other, the cohesion that exists being so slight that the body has itself no form; in the gaseous state, they are affected by an elastic force that amounts to repulsion, tending to separate them, and so diffuse them through an increased space. The metals, glass, wood, &c., are solids; water and atmospheric air are the most familiar types of liquid and gaseous bodies. The name *fluid* is sometimes used to denote both gases and liquids, which are designated *elastic* and *non-elastic* fluids respectively. These states of aggregation are not in every case—many now believe they are not in any case—permanent and unchangeable. Metals can be melted and vaporised; the liquid water is convertible into ice and into steam; and a number of what were formerly reckoned fixed or permanent gases have been liquified and solidified. Solids are reduced to liquid, and liquids to gaseous forms, principally by heat; pressure effects changes of the opposite kind.

AGHRIM, or AUGHRIM, a small village in Galway, 4 miles W. of Ballinasloe, is rendered memorable by the decisive victory gained there, on 12th July 1691, by the forces of William III., under General Ginkell, over those of James II., under the French general St Ruth. The Irish, numbering 25,000, and strongly posted behind marshy ground, at first maintained a vigorous resistance; but Ginkell, having penetrated their line of defence, and their general being struck down by a cannon-ball at this critical moment, they were at length overcome and routed with terrible slaughter. The loss of the English did not exceed 700 killed and 1000 wounded; while the Irish, in their disastrous flight, lost about 7000 men, besides the whole material of the army. This defeat rendered the adherents of James in Ireland incapable of farther efforts, and was speedily followed by the complete submission of the country.

AGINCOURT, or AZINCOURT, a French village, in the department of Pas de Calais, situated in 50° 35′ N. lat., 2° 10′ E. long., famous on account of the victory obtained there by Henry V. of England over the French. Following the example of several of his predecessors, the young king crossed over to France in the third year of his reign on a military expedition. Having landed at the mouth of the Seine, he took and sacked Harfleur after a siege of thirty-six days, but the army was so much reduced in strength, especially by disease, that some of Henry's advisers counselled a return home without following up the advantage. The proud spirit of the young king, however, would not submit to this, and he resolved on a march through the country to what was then the English fortified town of Calais, though he knew that a force vastly superior to his own was in the field to oppose him. On the morning of Friday, the 25th of October, 1415 A.D., St Crispin's day, the English and French armies were ranged in order of battle, each in three lines, with bodies of cavalry on both wings. The Constable d'Albert, who commanded the French army, fell into the snare that was laid for him, by drawing up his army in a narrow plain between two woods. This deprived him in a great measure of the advantage he should have derived from the prodigious superiority of his numbers, by obliging him to make his lines unnecessarily deep, and to crowd his troops, particularly his cavalry, so close together that they could hardly move or use their arms. The numbers of the French are differently estimated at from 50,000 to 150,000 men, but the latter number is a gross exaggeration. The first line was commanded by the Constable d'Albert, the dukes of Orleans and Bourbon, and many other nobles; the dukes of Alençon, Brabant, and Barre conducted the second line; and the earls of Marle, Damartine, Fauconberg, &c., were at the head of the third line. The king of England placed 200 of his best archers in ambush in a low meadow on the flank of the first line of the French. His own first line consisted wholly of archers, each of whom, besides his bow and arrows, had a battle-axe, a sword, and a stake pointed with iron at both ends, which he fixed before him in the ground, the point inclining outwards, to protect him from cavalry. This was a new invention, and had a happy effect. That he might not be encumbered, Henry dismissed all his prisoners on their word of honour to surrender themselves at Calais if he obtained the victory, and lodged all his baggage near the village of Maisoncelles, in his rear, under a slender guard. The main body of the English army, consisting of men-at-arms, was commanded by Henry in person; the vanguard, committed to Edward Duke of York at his particular request, was posted as a wing to the right; and the rearguard, commanded by Lord Camois, as a wing on the left. The archers were placed between the wings, in the form of a wedge. The lines being formed, the king, in shining armour, mounted on a fine white horse, rode along them, and addressed each corps with a cheerful countenance and in encouraging language. To inflame their resentment against their enemies, he spoke of the cruelty practised by the French against their prisoners; and to rouse their love of honour, he declared that every soldier in the army who behaved well should thenceforth be deemed a gentleman, and entitled to bear coat armour. The two armies, drawn up in this manner, stood a considerable time gazing at one another in silence. But the English king, dreading that the French would discover the danger of their situation and decline a battle, commanded the charge to be sounded, about ten o'clock in the forenoon. At that instant the first line of the English kneeled down and kissed the ground; and then starting up, discharged a flight of arrows, which did great execution among the crowded ranks of the French. Immediately after, upon a signal being given, the archers in ambush arose, and, discharging their arrows on the flank of the French line, threw it into some disorder. The battle now became general, and raged with great fury. The English archers, having expended all their arrows, threw away their bows, and rushing forward, made dreadful havoc with their swords and battle-axes. The first line of the enemy was by these means defeated, its leaders being either killed or taken prisoners. The second line, commanded by the Duke d'Alençon (who had made a vow either to kill or take the king of England, or to perish in the attempt), now advanced, and was met by the second line of the English, led by the king. The duke forced his way to the king, and assaulted him with great fury; but Henry brought him to the ground, where he was instantly despatched by the surrounding soldiers, receiving innumerable wounds. Discouraged by this disaster, the second line made no more resistance, and the third fled without striking a blow; yielding a complete and glorious victory to the English, after a violent struggle of three hours' duration. In the

circumstances, the victory could not be followed up. Henry and his army returned at once by Calais to England, and entered London with a pageant of unprecedented splendour. The number slain in the battle is variously stated. The loss to the conquerors is generally reckoned at 1600 men, and the French are said to have left 10,000 slain on the field, including the constable, three dukes, five counts, and ninety barons. (See the Histories of Britain; and *Battle of Agincourt*, by Sir Harris Nicolas.)

AGIO (Ital. *aggio*, exchange, discount), a term used in commerce to denote the difference between the real and the nominal value of money. In some states the coinage is so debased, owing to the wear of circulation, that the real is greatly reduced below the nominal value. Where this reduction amounts, *e.g.*, to 5 per cent., if 100 sovereigns were offered as payment of a debt in England while such sovereigns were current there at their nominal value, they would be received as just payment; but if they were offered as payment of the same amount of debt in a foreign state, they would be received only at their intrinsic value of £95, the additional £5 constituting the agio. Where the state keeps its coinage up to a standard value, no agio is required. The same principle is applied to the paper currency of a country when reduced below the bullion value which it professes to represent. According as there is more demand for gold or for paper money for the purposes of commerce, it often becomes necessary, in order to procure the one of the higher current value, to pay a premium for it, which is called the agio. In countries where silver coinage is the legal tender, agio is sometimes allowed for payment in the more convenient form of gold.

AGIS. Four kings of this name reigned at different periods in Sparta. The first of the name was the son of Eurysthenes, and is supposed to have reigned about 1032 B.C. The designation of *Helots* is said to have had its rise in his time, from the unsuccessful revolt of the inhabitants of Helos, and their final enthralment by the Spartans.

Agis II. succeeded his father Archidamus, and reigned from 427 to 399 B.C. He distinguished himself during the Peloponnesian war as an able and successful general, and headed the Spartans at the great and decisive battle of Mantinea.

Agis III. succeeded his father Archidamus III., 338 B.C. He took an active part in the league of the Grecian states against Alexander the Great, and at the head of their forces defeated a Macedonian army under Corragus. He was slain, about 331 B.C., in a battle with Antipater, under the walls of Megalopolis.

Agis IV., son of Eudamidas II., and lineally descended from Agesilaus II., succeeded his father 244 B.C., and reigned four years. He was more distinguished for the social reforms he attempted to introduce at Sparta than for his success as a general. The degenerate state of the Spartan commonwealth led him to attempt a reformation by restoring the institutions of Lycurgus, and, in the spirit of a true reformer, he set the example in his own person and household. His excellent intentions were seconded by all the younger and poorer portion of the community; but the rich and luxurious were vehemently opposed to measures which threatened to interfere so seriously with their influence and pleasures. His colleague, Leonidas, headed the opposition, and busily propagated the suspicion that Agis aspired to tyranny, by obliterating the distinctions of society and increasing the power of the multitude. Agis was supported by the influence of his uncle Agesilaus, who, being deeply in debt, was highly favourable to the proposed changes. Lysander and Mandroclides, two of the ephori, were also strenuous promoters of the reform. When the time came for Agis to propose in the senate a general discharge of debts and a new division of lands, the measure was lost by a minority of one. The triumph of Leonidas, however, was short. Being accused by Lysander of having violated the laws, he took refuge in the temple of Minerva, and refusing to appear in his own defence, was degraded from his dignity and banished to Tegæa. His son-in-law, Cleombrotus, was elected in his stead. The next election of ephori proved unfavourable to the party of Agis. Lysander and Mandroclides were tried for innovation, but succeeded in persuading the two kings to eject the new magistrates from office, which was effected in the midst of much tumult. The reformation might now have been established but for the intrigues of Agesilaus, whose selfish schemes counteracted the good intentions of the two kings. At this time the Achæans sent to Sparta for assistance in the war with the Ætolians, which was granted. Agis received the command of the troops, and though he gained no advantage over the cautious Aratus, the Achæan general, he conducted the campaign with considerable credit from the good discipline he maintained in his army. On his return he found that the misconduct of Agesilaus had resulted in a revolution and the recall of Leonidas. He took refuge in the temple of Minerva, Cleombrotus in that of Neptune. Leonidas contented himself with banishing his son-in-law, but resolved on the ruin of Agis. The unfortunate king was accordingly seized and cast into prison, where, after a mock trial, he was sentenced to be strangled. His mother and grandmother in vain entreated to gain him a public hearing: they were insidiously permitted to visit him in prison, where they shared his fate.

AGISTMENT (from the old French *gésir* or *gir*, to lie; see *Edin. Rev.*, vol. cxxviii. p. 79), the profit arising from taking in cattle to lie and pasture in one's lands, applied more particularly, in the first instance, to the proceeds of pasturage in the king's forests. The tithe of agistment, or "tithe of cattle and other produce of grass lands," was formally abolished by the Act of Union, on a motion submitted with a view to defeat that measure. (See *Edin. Rev.*, vol. xxxiv. p. 73.)

AGNANO, Lago d', a small circular lake near Naples, about two miles in circumference, and evidently situated in the crater of an extinct volcano. On its banks are the *stufe*, or natural vapour-baths of San Germano, beneficial in cases of rheumatic disease; and on its opposite shore is the famous *Grotta del Cane*, from the floor of which carbonic acid is continually evolved, rising to a height of about 18 inches, in such quantity as to kill dogs that enter it, while a man, on account of his erect posture, wholly escapes the effects of the gas. (See Spallanzani's *Travels*.) The grotto is a small artificial excavation, 12 feet long by 4 or 5 wide and 6 feet high, seemingly made for obtaining puzzolano, or earthy volcanic tufa.

AGNATES (*Agnati*), in *Roman Law*, are persons related through males only, as opposed to cognates. Relationship by agnation was founded on the idea of the family held together by the *patria potestas*; *cognatio* involves simply the modern idea of kindred.

AGNESI, Maria Gaetana, an Italian lady preeminently distinguished for her scientific attainments, was born at Milan on the 16th of May 1718, her father being professor of mathematics in the university of Bologna. When only nine years old, she had such command of Latin as to be able to publish an elaborate address in that language, maintaining that the pursuit of liberal studies was not improper for her sex. By her thirteenth year she had acquired Greek, Hebrew, French, Spanish, German, and other languages. She was in consequence generally known as "the Walking Polyglot." Two years later her father began to assemble in his house at stated intervals a circle of the most learned men in Bologna, before

whom she read and maintained a series of theses on the most abstruse philosophical questions. President De Brosses has given an interesting account of one of those meetings, at which he was present, in his *Lettres sur l'Italie* (tom. i. p. 243); and a permanent record of Agnesi's share in them has been preserved in the *Propositiones Philosophicæ*, which her father caused to be published in 1738. These displays, being probably not altogether congenial to Maria, who was of a retiring disposition, ceased in her twentieth year, and it is even said that she had at that age a strong desire to enter a convent. Though the wish was not gratified, she lived from that time in a retirement almost conventual, avoiding all society, and devoting herself entirely to the study of mathematics. The most valuable result of her labours was the *Instituzioni Analitiche ad Uso della Gioventu Italiana*, which was published at Milan in 1748. The first volume treats of the analysis of finite quantities, and the second of the analysis of infinitesimals. A French translation of the second volume, by D'Antelmy, with additions by Bossut, appeared at Paris in 1775; and an English translation of the whole work by Colson, the Lucasian professor of mathematics at Cambridge, was published after his death at the expense of Baron Masères. The great merit of the work was universally recognised at the time of its publication; and though in the long interval that elapsed before the English translation appeared the methods of analysis had been greatly improved, it was recognised by a writer in the *Edinburgh Review* (1803) as still the best introduction to the works of Euler and other mathematicians of the continent. Madame Agnesi also wrote a commentary on the *Conic Sections* of the Marquis de l'Hôpital, which, though highly praised by those who saw it in manuscript, was never published. In 1750, on the illness of her father, she was appointed by Pope Benedict XIV. to occupy the chair of mathematics and natural philosophy at Bologna. After the death of her father, in 1752, she carried out a long-cherished purpose by giving herself to the study of theology, and especially of the fathers. Another purpose, which seems also to have been long cherished, was now also fulfilled. After holding for some years the office of directress of the Hospice Trivulzio for Blue Nuns at Milan, she herself joined the sisterhood, and in this austere order ended her days (1799).

AGNESI, Maria Teresa, sister of the above (died 1780), was well known as a musician, having composed a number of cantatas, besides three operas—*Sophonisbe, Ciro in Armenia*, and *Nitocri*.

AGNOETÆ (from ἀγνοέω, to be ignorant of), in *Church History*, a sect of ancient heretics who maintained that Christ's human nature did not become omniscient by its union with His divinity. Its founder was Themistius, a deacon of the Monophysites in Alexandria in the 6th century. The sect was anathematised by Gregory the Great.

AGNOLO, Baccio d', wood-carver, sculptor, and architect, was born at Florence in 1460. The first was his original calling, and he attained considerable distinction in it before he turned his attention to architecture, which he went to Rome to study in 1530. He still carried on wood-carving, and his studio was the resort of the most celebrated artists of the day—Michael Angelo, Sansovius, the brothers Sangallo, and others. On his return to Florence he devoted himself chiefly to architecture, and planned many of the finest palaces and villas of that city, such as the Villa Borghese and the Palais Bartolini. The latter was the first dwelling-house which had what had previously been confined to churches—frontispieces of columns to the doors and windows. For introducing this fashion Agnolo incurred the ridicule of the Florentines; but it nevertheless established itself firmly. Another much-admired work of this architect is the campanile or bell-tower of the church *Di Santo Spirito* in Florence. He was also engaged to complete the drum of the cupola in the metropolitan church *Di Santa Maria del Fiore;* but Michael Angelo found fault with his plans, and the work remains unexecuted to this day. He died in 1543, leaving three sons, archite ts, one of whom, Giuliano, completed his father's unfinished works.

AGNONE, a town of South Italy, at the foot of Monte Capraro, 20 miles N.W. of Campobasso. It has 10,230 inhabitants, chiefly employed in the manufacture of copper wares, for the excellence of which it is celebrated.

AGNUS DEI, the figure of a lamb bearing a cross, symbolical of the Saviour as the "Lamb of God." The device occurs in mediæval sculptures, but the name is especially given in the Church of Rome to a small cake made of the wax of the Easter candles, and impressed with this figure. Since the 9th century it has been customary for the popes to bless these cakes, and distribute them, on the Sunday after Easter, among the faithful, by whom they are highly prized as having the power to avert evil. In modern times the distribution has been limited to persons of distinction, and is made by the pope on his accession, and every seven years thereafter.

Agnus Dei is also the popular name for the anthem beginning with these words, which is said to have been introduced into the missal by Pope Sergius I. (687–701). Based upon John i. 29, the Latin form is *Agnus Dei, qui tollis peccata mundi, miserere nobis*. In the celebration of the mass it is repeated three times before the communion, and it is also appended to many of the litanies.

AGOBARD, a Frank, born in 779, became coadjutor to Leidrad, archbishop of Lyons, in 813, and on the death of the latter succeeded him in the see (816). He was one of the chief supporters of Lothaire and Pepin in their conspiracy against their father, Louis le Debonnaire, and was in consequence deposed by the council of Thionville (835). On making an apology for his conduct, and becoming reconciled to the emperor, he was reinstated in 837. Agobard's works, which were edited by Baluze in 1665 (2 vols. 8vo), show him to have been a man of clear intellect, strongly opposed to the superstitious notions of the time. He wrote against image-worship, the belief in witchcraft, the ascription of tempests to the influence of sorcerers, and trial by the ordeal of fire and water. In the adoptionist controversy Agobard took a prominent part on the orthodox side. He died at Saintonge in 840.

AGONALIA, in *Roman Antiquity*, festivals celebrated on the 9th January, 21st May, and 11th December in each year, in honour of Janus, whom the Romans invoked before undertaking any affair of importance. Ovid, in his *Fasti*, i. 319–332, mentions various etymologies of the word.

AGONIC LINES (from ἀ privative, and γωνία, an angle), the imaginary lines on the earth's surface where the magnetic needle indicates no declination or deviation from the terrestrial meridian—that is, points to the true north and south. There are two great primary agonic lines, varying from time to time, the courses of which for the epochs 1787 (from Hansteen's *Magnetismus der Erde*) and 1840 (by General Sir E. Sabine) are figured in Keith Johnston's *Physical Atlas*.

AGONOTHETA, or Agonothetes (ἀγών and τίθημι), in *Grecian Antiquity*, was the president or superintendent of the sacred games. At first the person who instituted the games and defrayed the expenses was the Agonothetes; but in the great public games, such as the Olympic, Pythian, &c., these presidents were the representatives of different states, or were chosen from the people in whose country the games were celebrated. They received the several titles of αἰσυμνῆται, βραβευταί, ἀγωνάρχαι, ἀγωνοδίκαι,

ἀθλοθέται. They were also called ῥαβδοῦχοι or ῥαβδονόμοι, from the rod or sceptre emblematic of their authority.

AGORA (ἀγείρω, to congregate), the place used among the ancient Greeks as a public market, and corresponding in general with the Roman forum. From its convenience as a meeting-place, it became in most of the cities of Greece the general resort for social and political purposes. In Thessaly, however, the market-place was kept apart from "the field of freedom," where the commons met; and at Sparta a similar provision was made by the institutions of Lycurgus, that nothing might distract the attention of the auditors. At Athens, with the increase of commerce and political interest, it was found advisable to call public meetings at the Pnyx or the temple of Bacchus; but the important assemblies there, such as meetings for ostracism, were held in the agora. In the best days of Greece the agora was the place where nearly all public traffic was conducted. To frequent it, therefore, was equivalent to being actively engaged in business; and "he has forsaken the agora," indicated that a man was a suspicious character. The agora was most frequented in the forenoon, and then only by men. Slaves did the greater part of the purchasing, though even the noblest citizens of Athens did not scruple to buy and sell there. The name ἀγορά was also given (and this is perhaps the primary use of the word) to the assemblies of the people in the Grecian states. These assemblies were convened by proclamation by order of the sovereign power, a herald inviting all concerned to the agora. The right of speech and of vote in these assemblies appears to have been restricted to the nobles, all that was allowed to the populace being the indication of their sentiments on the topics brought before them by signs of applause or disapproval. At Athens the old agora lay to the west of the citadel. It was adorned with trees planted by Cimon the conqueror of the Persians; and around it numerous public buildings were erected, such as the senate hall and the law courts. The new agora lay to the north of the Acropolis, in the Eretrian quarter. Pausanias is the great architectural authority on the agoræ of Megalopolis, Corinth, Elia, Messina, Sparta, &c. Palladius and Vitruvius also give details. The remains of different agoræ are described in the works of Texier, Newton, Barth, and other travellers.

AGORANOMOI, magistrates in the republics of Greece, whose position and duties were similar to those of the ædiles of Rome. In Athens there were ten, chosen annually by lot, five of whom took charge of the city, and five of the harbour. The former saw to the maintenance of order and decency in the markets, took cognisance of the purity of the articles exposed for sale and of all weights and measures, and collected the dues; the latter received the harbour dues and enforced the shipping regulations.

AGORDO, a town in North Italy, 12 miles N.W. of Belluno. The valley of Imperina, in its vicinity, contains the richest copper mines in Italy. Population, 3000.

AGOSTA, or AUGUSTA, a city of Sicily, 14 miles N. of Syracuse, and in the province of that name. It is built on a peninsula, and is united to the mainland by a narrow causeway. By some writers it is supposed to occupy the site of ancient *Megara Hyblæa*. The modern city, which was founded by the emperor Frederick II. in 1229–33, suffered severely during the wars of succeeding centuries, and was several times sacked. It had, however, attained considerable opulence when, in 1693, it was overthrown by an earthquake, the effects of which were aggravated by the explosion of the powder magazine of the citadel. One-third of the inhabitants perished in this disaster. When the city was rebuilt, the streets were laid out in parallel lines, and the houses were constructed with low roofs, so as to mitigate the results of any recurrence of the calamity. Agosta is fortified towards both sea and land; and the harbour, though rather difficult of access, is commodious and well sheltered. The chief trade of the town is in salt; and the other exports include wine, cheese, oil, honey, and sardines. Near Agosta the Dutch were defeated by the French in a naval engagement in 1676, and their famous admiral, De Ruyter, was mortally wounded. Population (1865), 9735.

AGOSTINI, LEONARDO, an eminent antiquary of the 17th century, born at Siena. After being employed for some time by Cardinal Barberini to collect works of art for the Barberini palace, he was appointed by Pope Alexander VII. superintendent of antiquities in the Roman states. He issued a new edition of Paruta's *Sicilian Medals*, with engravings of 400 additional specimens; but a promised volume of letterpress explanation never appeared. In conjunction with Bellori he also published a work on antique sculptured gems, which was translated into Latin by Gronovius (Amsterdam, 1685).

AGOSTINO and AGNOLO (or ANGELO) DA SIENA, two brothers, architects and sculptors, who flourished in the first half of the 14th century. Della Valle and other commentators deny that they were brothers. They certainly studied together under Giovanni Pisano, and in 1317 were jointly appointed architects of their native town, for which they designed the Porta Romana, the church and convent of St Francis, and other buildings. On the recommendation of the celebrated Giotto, who styled them the best sculptors of the time, they were chosen to execute the tomb of Guido, bishop of Arezzo, which that artist had designed. It was esteemed one of the finest artistic works of the 14th century, but unfortunately was destroyed by the French under the Duke of Anjou.

AGOSTINO, PAOLO, an eminent Italian musician, born at Valerano in 1593. He studied under Nanini, and succeeded Ugolini as conductor of the Pope's orchestra in St Peter's. His musical compositions are numerous and of great merit, an *Agnus Dei* for eight voices being specially admired. He died in 1629.

AGOUTI, a genus of mammals (the *Dasyprocta*) found in South America and in some of the West Indian islands, belonging to the same family as the guinea-pig, viz., that of *Cavidæ* in the order *Rodentia*. The largest and commonest species is the *D. Aguti*, somewhat resembling a rabbit, but about the size of a hare, whence it is sometimes called the rabbit or hare of South America. The feet have large and strong claws, but the animal does not burrow; the hind legs are very long, and when eating it squats on them, feeding itself with its fore-paws; and the tail is, except in one species, a very short naked stump. The agoutis are gregarious, live chiefly in woods, and feed on vegetables exclusively, especially on roots and nuts. They commit great havoc in sugar plantations by gnawing the roots of the canes, and in sugar-growing localities are therefore destroyed as vermin. The flesh, which is tender and well-flavoured, is a common article of diet in Guiana and Brazil. When the Antilles and Bahamas were discovered they are said to have been overrun with these animals, which were the largest quadrupeds then found in the islands.

AGRA, a division, district, and city of British India, under the jurisdiction of the lieutenant-governor of the North-Western Provinces. THE AGRA DIVISION comprises the six districts of Agra, Etáwah, Mainpurí, Farrakhábád, Etah, and Mathurá. It is bounded on the N. by the Alígarh district; on the W. by the Bhartpur, Dholpur, and Gwalior states; on the S. by the Jalaun and Cawnpur districts; and on the E. by the Ganges. Agra division contains, according to the census of 1872, a population of 5,038,136 souls; of whom 4,607,946 are Hindus, 427,834 Mahometans, and 2356 Christians and others.

AGRA DISTRICT lies between 26° 43′ 45″ and 27° 24′ 15″ N. lat., and between 77° 28′ and 78° 53′ E. long.

It is bounded on the N. by the district of Mathurá; on the E. by the Mainpurí and Etáwah districts; on the S. by the Gwalior territory and the Dholpur state; and on the W. by the Bhartpur territory. Its area in 1872 was returned at 1873 square miles, and its population at 1,094,184 souls. The general appearance of the district is that common to the Doab, a level plain intersected by watercourses (nálás) and ravines. The only hills are the sandstone elevations in the west and south-west of the district. The principal rivers are the Jamná, Chambal, Uttangan, and Kharí. The Jamná intersects the district, cutting off the subdivisions of Itmadpur and Firozábád; and a branch of the Aligarh division of the Ganges Canal passes through its northern parts. The general elevation of the district is estimated at from 650 to 700 feet above the level of the sea. The soil is sandy; many of the wells are brackish, and the local water supply is scanty. The failure of the periodical rains during the monsoon suffices to produce great scarcity, sometimes reaching the famine point. Only five towns are returned by the census as containing upwards of 5000 inhabitants, viz., Agra city (the capital of the district), population 149,008; Fathipur Sikrí, the site of Akbar's famous mosque and palace, 6878; Firozábád, 14,255; Pináhát, 6571; and Saimrá, 5704. There are three municipalities, viz., Agra city, Firozábád, and Fathipur Sikrí. These muncipalities derive their local revenue from octroi and from property within the municipal limits. The total municipal income and its incidence per head of the population are as follows:—Agra city, municipal income, £15,441, incidence per head, 2s. 0¾d.; Firozábád, £724—1s. per head; Fathipur Sikrí, £366—1s. per head. The land revenue of the whole district was stated in 1871 at £162,882, and the gross revenue at £660,526. A scheme of rural instruction by means of indigenous schools was introduced in 1848. In 1871–72 there were 431 schools in the district, attended by 10,823 pupils, of whom 8820 were Hindus, 1293 Mahometans, and 710 of other denominations. The educational establishments within the city will be described below. The police force consisted of 1358 regular police in 1871, equal to one man to every 1·37 square miles of area, or one to every 805 inhabitants; and a village watch or rural constabulary of 1921 men, being one man to every 0·97 square miles of area, or one to every 570 inhabitants. The chief crimes of the district, in common with the rest of the Doab, are burglary and theft.

Agra City, situated on the banks of the Jamná river, in 27° 10′ N. lat., and 78° 5′ E. long., is the head-quarters of the division and capital of the district. Formerly it was the provincial capital also, but since the mutiny the seat of government has been removed from Agra to Allahábád. The city, which is about 4 miles in length by 3 in breadth, sweeps along the banks of the river in a semicircle. The principal thoroughfares are a fine broad street intersecting the town from north to south; and the Strand, which runs along the banks of the river for a distance of 2 miles. This road measures 80 feet in width, and is said to have been constructed by the destitute poor during the famine of 1838. In 1846 the population of the city was estimated at 66,000; in 1872 it was ascertained to be 149,000. The conservancy and improvement of the town are in the hands of a municipal committee, which derives its funds principally from octroi duties. In 1871–72, the municipal income was returned as follows:—Octroi duties, £13,587; miscellaneous receipts, such as rent from land belonging to the municipality, &c., £1854—total, £15,441. The details of municipal expenditure were as follow:—Establishment and cost of collection, £1667, 12s.; police, £4041, 12s.; conservancy, £1749, 12s.; lighting, £672, 14s.; watering, £255, 10s.; original works, £3561, 16s.; repairs, £1429, 2s.; education, £120; vaccination, £36, 6s.; dispensary, £360; charities, £240; grants to cantonments, museum, &c., £1465, 2s.—total, £15,599, 6s. The principal educational establishment in Agra is the Government College, a handsome building, situated in the civil lines a short distance from the town. It was established in 1820; in 1872 it contained 385 pupils. The other chief schools are the St John's College, established by the Church Missionary Society in 1854; the Victoria College, established in 1862; and St Peter's Catholic College. These three colleges in 1872 had 643 pupils on their rolls. There is also a medical college, founded in 1853. The total number of students admitted into it during the sixteen years from 1855 to 1870 inclusive, was 1168, of whom 235 passed the prescribed examination and received appointments in the government medical service. The Agra fort has a very imposing appearance, but is of no great strength. It occupies a large space of ground on the banks of the river, enclosed by high walls and towers of red stone. The fortress was constructed by the Emperor Akbar in the latter part of the 16th century, and exceeds a mile in circuit. In 1803 the place was held by the Marhattás; but being invested by Lord Lake's army, it surrendered after a day's bombardment. During the mutiny of 1857 it formed a place of refuge for the European and Christian community of Agra, and was threatened by the insurgent sepoys. The buildings of most note within the walls of the fort are the palace and hall of audience of Sháh Jahán, and the Motí Masjid, or "Pearl Mosque."

"In the centre of the palace," says Mr Fergusson in his *History of Architecture*, vol. ii., pp. 699–700, "is a great court 500 feet by 370, surrounded by arcades, and approached at the opposite ends through a succession of beautiful courts opening into one another by gateways of great magnificence. On one side of this court is the great hall of the palace, the Díwáni-Khás, 208 feet by 76, supported by three ranges of arcades of exquisite beauty. It is open on three sides, and with a niche for the throne at the back. This hall is now used as an arsenal. Behind it are two smaller courts, the one containing the Díwáni-Am or hall of private audience, the other the harem. The hall in the former is one of the most elegant of Sháh Jahán's buildings, being wholly of white marble inlaid with precious stones, and the design of the whole being in the best style of his reign."

The Motí Masjid or Pearl Mosque is the most elegant mosque of Indian-Mahometan architecture. Mr Fergusson describes it as follows:—

"Its dimensions are considerable, being externally 235 feet east and west, by 190 feet north and south, and the courtyard 155 feet square. The mass is also considerable, as the whole is raised on a terrace of artificial construction, by the aid of which it stands well out from the surrounding buildings of the fort. Its chief beauty consists in its courtyard, which is wholly of white marble from the pavement to the summit of its domes. In design it somewhat resembles the great Dehli mosque, except that the minarets are omitted, and the side gateways are only recesses. The western part, or mosque properly so called, is of white marble inside and out; and, except an inscription from the Kurán inlaid with black marble as a frieze, has no ornament whatever beyond the lines of its own graceful architecture."

Agra, however, is even more famous for the Táj-Mahal, a splendid mausoleum built by the Emperor Sháh Jahán for the remains of his favourite wife, Mumtázá Mahal, and where he himself is also buried. The building is of white marble, with four tall minarets of the same material, one at each corner. The whole rises from an elevated marble terrace. The following account is extracted from Mr Fergusson's *History of Architecture*, pp. 692–694:—

"The enclosure, including the gardens and outer court, is a parallelogram of 1860 feet by more than 1000 feet. The outer court, surrounded by arcades and adorned by four gateways, forms an oblong, occupying in length the whole breadth of the inclosure, by about 450 feet in depth. The principal gateway, measuring 110 feet by 140, leads from the court to the gardens, which, with their marble canals and fountains and cypress trees, are almost as beautiful as the tomb itself. The tomb stands on a raised platform 18 feet high, faced with white marble, and is exactly 313 feet square.

At each corner of this terrace stands a minaret 133 feet in height, and of the most exquisite proportions—more beautiful, perhaps, than any other in India. In the centre of the marble platform stands the mausoleum, a square of 186 feet, with the corners cut off to the extent of 33 feet 9 inches. The centre of this is occupied by the principal dome, 58 feet in diameter and 80 feet in height, under which is an inclosure formed by a screen of trellis-work of white marble, a *chef-d'œuvre* of elegance in Indian art. Within this stand the two tombs. These, however, as is usual in Indian sepulchres, are not the true tombs; the bodies rest in a vault level with the surface of the ground, beneath plainer tombstones placed exactly underneath those in the hall above. In each angle of the building is a smaller dome of two storeys in height, 26 feet 8 inches in diameter, and connected by various passages and halls. The light to the central apartment is admitted only through double screens of white marble trellis-work of the most exquisite design, one on the outer and one on the inner face of the walls. In our climate this would produce nearly complete darkness; but in India, and in a building wholly composed of white marble, this was required to temper the glare, which otherwise would have been intolerable. As it is, no words can express the chastened beauty of that central chamber, seen in the soft gloom of the subdued light which reaches it through the distant and half-closed openings that surround it. When used as a pleasure palace, it must have been the coolest and the loveliest of garden retreats; and now that it is sacred to the dead, it is the most graceful and most impressive of the sepulchres of the world. This building is an early example of that system of inlaying with precious stones which became the great characteristic of the style of the Mughuls after the death of Akbar. All the spandrils of the Táj, all the angles and more important architectural details, are heightened by being inlaid with precious stones, such as agates, bloodstones, jaspers, and the like. These are combined in wreaths, scrolls, and frets, as exquisite in design as they are beautiful in colour; and, relieved by the pure white marble in which they are inlaid, they form the most beautiful and precious style of ornament ever adopted in architecture. It is lavishly bestowed on the tombs themselves and the screens that surround them, but more sparingly introduced on the mosque that forms one wing of the Táj, and on the fountains and surrounding buildings. The judgment, indeed, with which this style of ornament is apportioned to the various parts is almost as remarkable as the ornament itself, and conveys a high idea of the taste and skill of the Indian architects of this age."

Tavernier, in his *Travels* (vol. iii., p. 94), mentions that 20,000 workmen were incessantly employed on this work during a period of twenty-two years. The tomb of the Emperor Akbar is contained in a splendid mausoleum at Sikandrá, a suburb of Agra city.

AGRAM, or ZAGRAB, the capital of the Austrian province of Croatia, is finely situated on a hill near the banks of the Save, in 45° 49′ N. lat. and 16° 1′ E. long., 160 miles south of Vienna. It is the seat of the governor of Slavonia and Croatia, of a bishop, of the courts of justice, and of the meetings of the provincial diet. Agram is divided into three parts, called the upper and lower towns, and the town of the bishop. It has a lyceum, library, museum, gymnasium, an ancient cathedral, and a large library. Some silk and porcelain are manufactured, and a brisk trade is carried on in grain, potash, tobacco, and honey. Population in 1869, 19,857.

AGRARIAN LAWS (*Leges Agrariæ*), when used in the most extended signification of the term, are laws for the distribution and regulation of property in land. The history of these enactments is not only important as explanatory of the constitution of the ancient republics, but is rendered highly interesting by the conflicting opinions which have been entertained respecting their object and operation. It seems to have been a notion generally entertained in the ancient world that every citizen of a country should be a landholder; and that the territory of a state, so far as it was not left uninclosed or reserved for public purposes, should be divided in equal portions among the citizens. Such a distribution of public land seems to have been acted upon as a recognised principle from the earliest period to which existing historical records extend. Hence we find the Almighty giving express instructions to Moses as to the manner in which the land of Canaan was to be portioned out among the Hebrews (Num. xxxiii. 54), and naming the persons to whom the division was to be entrusted (Num. xxxiv. 16–18). A division of the land was accordingly made, and the portion assigned to each man became his inalienable property, and descended in perpetuity to his heirs and successors. By the law of Jubilee, all lands were restored free of encumbrances on the recurrence of the "year of release;" so that, though a man's estate might, in the interval, have been repeatedly sold or alienated, yet on the return of the fiftieth year it reverted to the heirs of the original possessor (Levit. xxv. 10). In the republics of ancient Greece, and also in the Grecian colonies, a similar principle of division of land prevailed (Thuc. v. 4, Herod. iv. 159). Lycurgus is represented by Plutarch (*Lycur.*) as redividing the whole territory of Laconia into 39,000 parcels, of which 9000 were assigned in equal lots to as many Spartan families, and 30,000, also in equal lots, to their free subjects; and although this statement is not borne out by any of the early Greek historians, and is even inconsistent with the assertion of Aristotle (*Polit.* ii. 4), yet it is valuable as recognising the principle of the division of the public lands. (See Thirlwall's *Hist. of Greece*, chap. viii., and Grote's *Hist. of Greece*, part ii. chap. vi., with the authorities there quoted.)

It was long a prevalent and undisputed opinion that the territories of the Hebrews, and of the republics of ancient Greece, were divided into equal portions, and that the object of such a distribution was to maintain a state of equality among all the members of the community. This, however, does not appear to be consistent with the distinctions of rank which we find admitted in Scripture (Josh. ix. 15; xxii. 14; 1 Sam. ix. 21, &c., &c.); and from a remark of Thucydides (i. 6), taken in connection with the statement of Aristotle (*Polit.* ii. 9), it may be legitimately inferred that property did not continue to be equally distributed at Lacedæmon. Distinctions of rank are clearly recognised in the legislation of Solon. Aristotle, in the Second Book of his *Politics* (chap. vi., &c.), explains the constitutions of several of the ancient republics, and endeavours to show how the population is to be accommodated to this equal division of land; but it would be foreign to our object to review his arguments. It may be sufficient to remark that such an attempt to arrest the progress of enterprise is altogether inconsistent with the spirit of liberty which gave life and energy to the ancient republics; and that, though it might have been carried into effect under the despotism of Persia or the predominant rule of the kings of Macedonia, it was entirely at variance with the freedom of opinion which prevailed in Greece, and the stubborn resistance to control which animated the Romans after the expulsion of the kings. But granting that such a policy had been practicable, it would have been highly inexpedient. The ignorant Hindu might remain satisfied with the caste which nature had transmitted to him through successive generations, because his progenitors had been prevented from emerging from their obscurity; but the citizens of Greece and Italy, being themselves constituent members of the body politic, and not ignorant of the power thereby conferred on them, could not have been kept in check by the same principle of fear. Such an attempt, moreover, to prevent the acquisition of property would have obstructed the advancement of the arts of civilised life, would have extinguished those feelings of patriotism which led the Greeks so often to hazard their lives in defence of their country, and, by engendering discontent and exciting internal commotions, would have made them an easy prey to their enemies.

The expression Agrarian Laws, however, is more commonly applied to the enactments among the Romans for the management of the public domains (*ager publicus*); and to an account of these the remainder of our space must be devoted. It is a singular fact that, while almost every other

subject connected with the Roman constitution had been successfully investigated and explained, the object and intention of the agrarian laws were entirely misunderstood by scholars for many centuries after the revival of letters. They were invariably represented as intended to prohibit Roman citizens from holding property in land above a certain fixed amount; and as authorising the division among the poorer citizens of the estates of private individuals when these exceeded the prescribed limit; thus legalising a system of plunder which would have been subversive of all social order. No such doctrine had, indeed, been admitted in any well-regulated state, ancient or modern; nor did anything analogous to it appear in the principles or practice of the Roman constitution; yet the expressions used by the ancient authors in reference to these enactments, and the disturbances to which they invariably gave rise, seemed to justify an unfavourable interpretation; and the opinion, when once propounded, was unconditionally received by successive generations of learned men, notwithstanding the many embarrassments and contradictions to which it led.

Romulus is represented as dividing his small territory among the members of his infant community at the rate of two *jugera* (each extending to two-thirds of an English acre) a-piece, as inheritable property. The whole district, however, was not thus assigned; one portion was set apart for the service of the gods and for the royal domains; and another was reserved as common land for pasture. The stock kept on the common land served to eke out a maintenance which two *jugera* could not otherwise have furnished to a family, and an agistment was paid to the commonwealth for the pasturage. It is probable that the same principle prevailed under the regal government, and that successive adjustments of the territory were made. Such a law existed among those of Servius Tullius. The equality of property thus established seems to have been considered as a fundamental principle of the Roman constitution; and the agrarian laws were regarded as the necessary means of wresting from the large proprietors the possessions which they had illegally acquired. Machiavelli and Montesquieu both participate in this mistake, and are far from condemning the agrarian laws, even when taken in the common meaning. The former alleges that the interest of every republic requires that the state should be rich and the citizens poor, and thus justifies the assumed spoliation; while Montesquieu receives it as an historical fact that Romulus adopted the principle of equality in his original distribution of the territory of Rome as the future ground of her strength, and that the tribunitian contests were but attempts to restore the original constitution. Adam Smith (*Wealth of Nations*, b. iv. chap. vii. part i.) assents to the same interpretation, without, however, any expression of approval.

The correct interpretation of the agrarian laws must thus be considered as of modern date. Amidst the violence of the French Revolution a scheme for the equal division of the national property was advocated, with great popular favour, by some of the frantic leaders, who sought a sanction for their extravagances in precedents drawn from the ancient republics, and particularly from the agrarian laws of the Romans. The subject was thus invested with a new interest, and engaged the attention of Professor Heyne of Göttingen, who in 1793 (*Opus. Acad.* iv. 350–373) addressed to the members of his university a paper in which he successfully combated the opinions which, up till that time, had been entertained respecting them, and showed that their object had been entirely misunderstood. Other writers, as Heeren and Hegewisch, embraced and illustrated his views; but it was reserved for the acuteness and learning of Niebuhr fully to develop the theory which had been suggested, and to demonstrate the fact "that the agrarian laws of the Romans were in no case intended to interfere with or affect private property in land, but related exclusively to the public domain." The theory of Niebuhr was too startling to meet with universal approval. It has accordingly been assailed by Rudorff, Dureau de la Malle (*Econ. Polit. des Romaines*), Puchta, and others, who have ingeniously and plausibly supported the opinions formerly maintained; but their arguments fail to produce conviction. (*Class. Mus.*, vol. ii.) The language of Livy *passim*, when referring to the agrarian laws, is inexplicable unless the interpretation of Niebuhr be adopted:—

"If," says Dr Arnold, "amongst Niebuhr's countless services to Roman history, any single one may claim our gratitude beyond the rest, it is his explanation of the true nature and character of the agrarian laws. Twenty-four years have not yet elapsed since he first published it, but it has already overthrown the deeply-rooted false impressions which prevailed universally on the subject; and its truth, like Newton's discoveries in natural science, is not now to be proved, but to be taken as the very corner-stone of all our researches into the internal state of the Roman people" (*Hist. of Rome*, vol. ii.)

In almost all countries the legal property of the land has been originally vested in the sovereign, whether we are to understand under that name a single chief, a particular portion of the nation, or the people at large. In the same manner, the property of all the land in a conquered country was held to be transferred to the sovereign power in the conquering state, and was assumed with more or less rigour as circumstances seemed to require. From the earliest times a portion of the Roman territory was thus regarded as the property of the state, and the profits arising from it were applied to the public service. The public domain (*ager publicus*) was at first small, but was gradually extended by the right of conquest till it embraced a large portion of the whole peninsula. In this process of extension the subjugated communities were frequently mulcted of a proportion of their lands, varying according to the alleged offence or the resistance which they had offered to the arms of the conquerors. Thus the Boii were deprived of one-half of their territory; the Hernici forfeited two-thirds; and the whole of the *ager Campanus*, the richest district in Italy, was taken from the inhabitants of Capua on the capture of their city after its revolt to Hannibal.

The lands thus acquired were disposed of in various ways. A portion of them was frequently sold by auction to meet the immediate necessities of the state, and was thus conveyed in perpetuity to the purchasers. The disposal of the remainder depended on the nature and condition of the land, and its position in reference to the bulk of the community. If in good condition and at no great distance from the city, it was frequently assigned, in small allotments of seven jugera (between 4 and 5 acres), to those of the poorer citizens, whose services in war gave them a claim upon the state; while in hostile districts and on exposed frontiers military colonies were planted, each colonist receiving a fixed quantity of land. In both these cases the land so assigned ceased to form part of the public domain, and became the property of the recipients. In some cases the land, after having been assumed as public property, was allowed to remain in the hands of the former owners, who became the tenants of the state for a fixed period, and paid a certain rent to the Roman exchequer.

The preceding remarks refer only to arable or meadow land, vineyards, or olive-gardens, which could be turned to immediate advantage. It is obvious, however, that in a country the greater part of which was acquired by conquest, large districts must have been laid waste, the inhabitants with their houses destroyed, and neither cultivators nor the means of cultivation left. Arrangements of a different description were therefore necessary for lands in this

position. Wide ranges of country, fit only for pasture, had to be disposed of, and were available to those alone who were able to stock them with flocks and herds, and to provide slaves to attend to and protect their property. Hence it was usual for the state to invite persons possessed of the necessary means to enter upon the occupation of such lands on advantageous terms; an invitation with which the patricians, as being the wealthy class, could alone comply. The ordinary conditions were, that after the land was again brought into cultivation, the occupants should pay as rent one-tenth of the produce of the corn-lands, and one-fifth of the vines and fruit-trees, with a moderate rate per head for sheep and cattle grazing on the public pastures. The lands were not assigned for any definite period; the occupants were merely tenants at will, liable to extrusion whenever the state found it necessary to employ the land for any other purpose. It was a fundamental principle of Roman law that prescription could not be pleaded against the state; and consequently, though the right of occupancy might not only be transmitted from heir to heir, but might also be sold, no length of time could alter the precarious nature of the tenure by which the lands were held. The state always reserved to itself the power of resuming possession when it thought fit; and though such resumption might in many cases be attended by individual hardship, it was nevertheless justified by the original contract.

Much of the obscurity connected with the Roman agrarian laws has arisen from a misapprehension of the meaning of the words *possidere*, *possessor*, and *possessio*. These terms, when used in a strictly legal sense, denote merely occupancy by a tenant, and never imply an absolute right of property. The act of occupancy was termed *usus*, and the benefit derived by the state *fructus*.

"The *ager publicus*," says Professor Ramsay, "having been acquired and occupied as explained above, numerous abuses arose in process of time, especially among the tenants belonging to the second class. These being, as we have said, in the earlier ages, exclusively patricians, who at the same time monopolised the administration of public affairs, they were in the habit of defrauding the state, either by neglecting altogether to pay the stipulated proportion of the produce, or by paying less than was due; or, finally, by claiming, what was in reality *ager publicus*, as their own private property; it being easy, of course, in the absence of all strict superintendence and of scientific surveys, to shift the land-marks which separated public from private property. Meanwhile the deficiencies in the public treasury were made up by heavier taxes; and the plebeians complained that they were impoverished by new imposts, while the lands belonging to the community, which they had acquired by their blood, if fairly managed, would yield a sufficient return to meet all demands upon the exchequer; or, if portioned out in allotments among themselves, afford them the means of supporting the increased burdens. These complaints, unquestionably founded in justice, were soon vehemently expressed, and were revived from time to time more or less loudly, and enforced more or less earnestly, according to the state of public feeling and the energy of the popular champions. It is true that the wealthier plebeians soon became tenants of the *ager publicus* as well as the patricians; but although this circumstance materially strengthened the hands of the occupiers, it did not improve the condition of the poor, or make them less keenly alive to the injustice of the system against which they protested." (*Manual of Rom. Antiq.* p. 228.)

Assuming, then, that the agrarian laws had for their sole object the distribution and management of the public lands (*ager publicus*), their effect must have been felt in two ways:—(1.) In enforcing the regular payment of rent from the occupants, preventing them from exceeding the limits assigned to them, and compelling the surrender of portions for division among the poorer citizens; and (2.) In insisting upon the immediate application of newly-acquired territories to the establishment of colonies, or its assignment to individuals. It is obvious that the laws first referred to, as involving long-established interests, would necessarily lead to violent contests.

The first agrarian law, properly so called, was proposed and passed by Sp. Cassius Viscellinus, when consul, 486 B.C. (Liv. ii. 41, Dionys. viii. 76), but respecting the provisions of this we have no precise information. Cassius was himself a patrician, and we may therefore infer that the law did not encroach upon the just rights of the dominant class to which he belonged. It is not the object of this article to trace in detail the various measures which were proposed, and the agitations with which they were severally attended. Three such are recorded during the 4th century B.C. (Liv. iv 36, 47, 48); but by far the most important measure of this class, and that which served as the model of nearly all subsequent agrarian laws, was that carried by C. Licinius Stolo, when tribune of the people, in 367 B.C. (Liv. vi. 42). The provisions of this law were: (1.) That no one should occupy more than 500 jugera (about 338 acres) of the public land; (2.) That none should have more than 100 large and 500 small cattle grazing on the public pastures; and (3.) That every occupant of the public lands should employ a certain proportion of free labourers in cultivating it. Niebuhr (vol. iii. p. 11, &c. *Eng. transl.*) has endeavoured to supply the other details; but these can be received merely as ingenious, and it may be successful, conjectures. For an able controversy as to this law see *Class. Museum*, vol. ii.

After the excitement occasioned by the passing of the Licinian law had subsided, two centuries were allowed to pass with only a single interference (Valer. Max. v. 4, 5; Polyb. ii. 21) with the occupants of the public lands; and during that time large additions had been made to the possessions of the state by the confiscations consequent upon the second Punic war. In the meantime the wealthier families had extended their possessions greatly beyond the limits prescribed by the Licinian law; while the small proprietors had disappeared, and the poor continued to increase. In 133 B.C., Tiberius Gracchus proposed and carried a modification of the Licinian law (Liv. *Epit.* lviii.; Appian. i. 9), which his premature death prevented from being carried into effect; and a similar result attended the enactment of his brother (Liv. *Epit.* lx.) Both were set aside or eluded after the death of Caius. During the period which preceded the subversion of the republic various other laws were passed for the distribution of the public lands; but these it is not necessary to enumerate. It may be mentioned, in conclusion, as a significant fact, that the prominent advocates of the agrarian laws, Cassius, Licinius, and the Gracchi, all belonged to the class which would have been injured by their operation had they led to an undue interference with private property. (G. F.)

AGREDA, a town of Spain, in the province of Old Castile, 23 miles N.E. of Soria. It is the chief town of the mountainous district of the same name, and is built on the skirts of the Sierra Moncayo. At Agreda the river Queiles is crossed by a fine stone bridge of one arch. Population, 3120.

AGRICOLA, Cnæus Julius, was born at Forum Julii, now *Frejus*, in Provence, 37 A.D., and was in Vespasian's time made lieutenant to Vettius Bolanus in Britain. Upon his return he was ranked by that emperor among the patricians, and made governor of Aquitania. This post he held for three years; he then was recalled to Rome, and chosen consul, Britain being assigned to him as his province (78 A.D.) Here he reformed many abuses created by his predecessors, put a stop to extortion, and caused justice to be impartially administered. In the spring of 79 he marched towards the north, where he made new conquests, and ordered forts to be built for the Romans to winter in. He spent the following winter in concerting schemes to bring the Britons to conform to the Roman customs. He thought the best way of diverting them from their warlike propensities was to soften their rough manners by proposing to them new kinds of pleasure, and inspiring them with a desire of imitating the Roman manners. He encouraged the erection of magnificent temples, porticoes, baths, and other fine buildings. The British nobles at length had their sons educated; and they who before had the utmost aversion to the Roman language now began to study it with great assiduity. They likewise adopted the Roman dress; and, as Tacitus observes, they were brought to consider those things as marks of politeness which were only so many badges of slavery. Agricola, in his third campaign, advanced as far as the Solway; and in his fourth he subdued the nations betwixt the Solway and the friths of Forth and Clyde, into which the rivers Bodotria and Glotta discharged themselves; and here he built a chain of fortresses to check the nations yet

unconquered. In his fifth he fixed garrisons along the western coasts, over against Ireland. In his sixth campaign he passed the river Bodotria; ordering his fleet, the first which the Romans ever had in those parts, to row along the coasts and take a view of the northern parts. The fleet sailed round by the northern and western coasts, and first proved Britain to be an island. In the following spring, the Britons raised an army of 30,000 men, under the command of Galgacus, to oppose the invaders. In the engagement that ensued at the foot of the Grampians the Romans gained the victory, and 10.000 of the Britons are said to have been killed. This happened in the reign of the emperor Domitian, who, growing jealous of the glory of Agricola, recalled him, under pretence of making him governor of Syria. Agricola was in Britain fully seven years, from 78 to 85 A.D.; and he died on the 23d August, 93 A.D., when he had attained the age of 55. Agricola was a man of great integrity; he possessed high military talents, together with administrative abilities of the first rank. The Life of Agricola, written by his son-in-law, the historian Tacitus, is a model of simple and dignified biography.

AGRICOLA, CHRISTOPH LUDWIG, landscape-painter, was born at Regensburg on the 5th Nov. 1667, and died at the same place in 1719. He spent a great part of his life in travel, visiting England, Holland, and France, and residing for a considerable period at Naples. His numerous landscapes, chiefly cabinet pictures, are remarkable for fidelity to nature, and especially for their skilful representation of varied phases of climate. In composition his style shows the influence of Caspar Poussin, while in light and colour he imitates Claude Lorraine. His pictures are to be found in Dresden, Brunswick, Vienna, Florence, Naples, and many other towns of both Germany and Italy.

AGRICOLA (originally LANDMANN), GEORG, a famous mineralogist, born at Glauchau in Saxony, on the 24th March 1494. After studying at Leipsic and in Italy, he practised for some time as a physician at Joachimsthal in Bohemia. In 1531 he was enabled to gratify his natural inclination towards the study of geology and mineralogy by removing to the mining district of Chemnitz in Saxony, where he had been appointed professor of chemistry. The results of his laborious investigations are chiefly to be found in his great work *De Re Metallica* (Basle, 1546), which describes minutely the various methods of mining, of raising and dressing the ore, and of smelting, and contains a number of curious woodcuts. It has been several times reprinted, and a German translation by Lehmann appeared at Freyberg in 1806-10. He also wrote *De Ortu et Causis Subterraneorum, De Animantibus Subterraneorum, De Natura Fossilium,* besides other works. Agricola was the first to raise mineralogy to the dignity of a science, and he developed it to such an extent that no substantial advance was made upon his results until the middle of the 18th century. He died at Chemnitz on the 21st November 1555.

AGRICOLA, JOHANN FRIEDRICH, musician, was born at Dobitschen in Saxe-Altenburg, on the 4th Jan. 1720, and died in 1774. While a student of law at Leipsic he studied music under John Sebastian Bach. In 1741 he went to Berlin, where he placed himself under Quanz for instruction in musical composition. He was soon generally recognised as one of the most skilful organists of his time. In 1759, on the death of Graun, he was appointed kapellmeister to Frederick II. He composed several operas of great merit, as well as instrumental pieces and church music. His reputation chiefly rests, however, on his theoretical and critical writings on musical subjects

AGRICOLA (originally SCHNITTER or SCHNEIDER), JOHANNES, one of the foremost of the German reformers, was born on the 20th April 1492, at Eisleben, whence he is sometimes called *Magister Islebius.* He studied at Wittenberg, where he soon gained the friendship of Luther. In 1519 he accompanied Luther to the great assembly of German divines at Leipsic, and acted as recording secretary. After teaching for some time in Wittenberg, he went to Frankfort in 1525 to establish the worship according to the reformed religion. He had resided there only a month when he was induced to go to Eisleben, where he remained till 1526 as teacher in the school of St Andrew, and preacher in the Nicolai church, enjoying great popularity in the latter capacity. In 1536 he was recalled to Wittenberg to fill a professorial chair, and was welcomed by Luther. Almost immediately afterwards, however, a controversy, which had been begun ten years before and been temporarily silenced, broke out afresh with greater violence. Agricola was the first to teach the views which Luther was the first to stigmatise by the now well-known name *Antinomian.* He held that while the unregenerate were still under the law, Christians were entirely free from it, being under the gospel alone. He denied that Christians owed subjection to any part of the law, even the Decalogue, as a rule of life. Luther conducted the argument with his usual vehemence, and there was in the heat of controversy probably a good deal of misrepresentation on both sides. In 1540 Agricola left Wittenberg secretly for Berlin, where he published a letter addressed to the elector of Saxony, which was generally interpreted as a recantation of his obnoxious views. Luther, however, seems not to have so accepted it, and Agricola remained at Berlin. The elector Joachim II. of Brandenburg having taken him into his favour, appointed him court preacher and general superintendent. He held both offices until his death in 1566, and his career in Brandenburg was one of great activity and great influence. Along with the Catholic bishops Von Pflug and Michael Halding he prepared the Augsburg Interim of 1548. Agricola wrote a number of theological works which are now of little interest. He was the first to make a collection of German proverbs, which he illustrated with an appropriate commentary. The most complete edition is that published at Wittenberg in 1592.

AGRICOLA, RODOLPHUS (originally ROELOF HUYSMANN), a distinguished scholar, born at Bafflo, near Gröningen, in 1443. He was educated at Louvain, where he graduated as master of arts. After residing for some time in Paris, he went in 1476 to Ferrara in Italy, and attended the lectures of the celebrated Theodore Gaza on the Greek language. Having visited Pavia and Rome, he returned to his native country about 1479, and was soon afterwards appointed syndic of Gröningen. In 1482, on the invitation of Dalberg, bishop of Worms, whose friendship he had gained in Italy, he accepted a professorship at Heidelberg, and for three years delivered lectures in that university and at Worms on the literature of Greece and Rome. By his personal influence much more than by his writings he did a great deal for the promotion of learning in Germany. Hallam says that "no German wrote so pure a style, or possessed so large a portion of classical learning;" and the praises of Erasmus and other critics of the generation immediately succeeding Agricola's are unstinted. In his opposition to the scholastic philosophy he seems to have in some degree anticipated the coming of that great revolution in which many of his pupils were conspicuous actors. He died at Heidelberg in 1485. His principal work is the *De Inventione Dialectica*, in which he attempts to change the scholastic philosophy of the day. (See *Vita et Merita Rudolphi Agricolæ*, by T. F Tresling, Gröningen, 1830).

AGRICULTURE

CHAPTER I.

IT would be interesting to know how the nations of antiquity tilled, and sowed, and reaped; what crops they cultivated, and by what methods they converted them into food and raiment. But it is to be regretted, that the records which have come down to us are all but silent upon these homely topics.

Historical Summary.

In Mr Hoskyn's admirable treatise[1] we have an excellent specimen of what may yet be done to recover and construct an authentic history of the Agriculture of the ancients, from the casual allusions and accidental notices of rural affairs which lie thinly scattered through the body of general literature; and, more especially, from those mysterious records of the past, which are now being rescued from their long burial under the ruins of some of the most famous cities of antiquity. Although comparatively little has been found in such records bearing directly upon the subject, we must not despair of the learned industry and masterly skill of an advancing and searching criticism, gathering together these gleams of light, and making them happily converge upon the darkness which has hitherto interposed between us and a circumstantial knowledge of the methods and details of ancient husbandry.

Egypt

Every reader of the Bible is familiar with its frequent references to Egypt as a land so rich in corn, that it not only produced abundance for its own dense population, but yielded supplies for exportation to neighbouring countries. Profane history corroborates these statements. Diodorus Siculus bears explicit testimony to the skill of the farmers of ancient Egypt. He informs us that they were acquainted with the benefits of a rotation of crops, and were skilful in adapting these to the soil and to the seasons. The ordinary annual supply of corn furnished to Rome has been estimated at 20,000,000 bushels. From the same author we also learn that they fed their cattle with hay during the annual inundation, and at other times tethered them in the meadows on green clover. Their flocks were shorn twice annually (a practice common in several Asiatic countries), and their ewes yeaned twice a year. For religious as well as economical reasons, they were great rearers of poultry, and practised artificial hatching, as at the present day. The abundance or scarcity of the harvests in Egypt depended chiefly upon the height of the annual inundation. If too low, much of the land could not be sown, and scarcity or famine ensued. On the other hand, great calamities befell the country when the Nile rose much above the average level. Cattle were drowned, villages destroyed, and the crops necessarily much diminished, as in such cases many of the fields were still under water at the proper seed time. In 1818 a calamity of this kind took place, when the river rapidly attained a height of 3½ feet above the proper level.

It is from the paintings and inscriptions with which the ancient Egyptians decorated their tombs that we get the fullest insight into the state of agriculture amongst this remarkable people. Many of these paintings, after the lapse of two or three thousand years, retain the distinctness of outline and brilliancy of colour of recent productions. The acquaintance which these give us with their occupations, attainments, and habits is truly marvellous, and fills the reader of such works as Wilkinson's *Egypt* with perfect amazement. Every fresh detail seems to give confirmation to that ancient saying, "There is nothing new under the sun." The pictures referring to rural affairs disclose a state of advancement at that early date which may well lead us to speak modestly of our own attainments. An Egyptian villa comprised all the conveniences of a European one of the present day. Besides a mansion with numerous apartments, there were gardens, orchards, fish-ponds, and preserves for game. Attached to it was a farm-yard, with sheds for cattle and stables for carriage horses. A steward directed the tillage operations, superintended the labourers, and kept account of the produce and expenditure. The grain was stored in vaulted chambers furnished with an opening at the top, reached by steps, into which it was emptied from sacks, and with an aperture below for removing it when required. Hand-querns, similar to our own, were used for grinding corn; but they had also a larger kind worked by oxen. In one painting, in which the sowing of the grain is represented, a plough drawn by a pair of oxen goes first; next comes the sower scattering the seed from a basket; he is followed by another plough; whilst a roller, drawn by two horses yoked abreast, completes the operation. The steward stands by superintending the whole. Nothing, however, conveys to us so full an impression of the advanced state of civilisation amongst the ancient Egyptians as the value which they attached to land, and the formalities which they observed in the transfer of it. In the time of the Ptolemies, their written deeds of conveyance began with the mention of the reign in which they were executed, the name of the president of the court, and of the clerk who drew them. The name of the seller, with a description of his personal appearance, his parentage, profession, and residence, was engrossed. The nature of the land, its extent, situation, and boundaries; the name and appearance of the purchaser were also included. A clause of warrandice and an explicit acceptance by the purchaser followed, and finally the deed was attested by numerous witnesses (so many as sixteen occur to a trifling bargain), and by the president of the court.

Judea: Patriarchal Age.

The nomades of the patriarchal ages, like the Tartar, and perhaps some of the Moorish tribes of our own, whilst mainly dependent upon their flocks and herds, practised also agriculture proper. The vast tracts over which they roamed were in ordinary circumstances common to all shepherds alike. During the summer they frequented the mountainous districts and retired to the valleys to winter. Vast flocks of sheep and of goats constituted the chief wealth of the nomades, although they also possessed animals of the ox kind. When these last were possessed in abundance, it seems to be an indication that tillage was practised. We learn that Job, besides immense possessions in flocks and herds, had 500 yoke of oxen, which he employed in ploughing, and a "very great husbandry." Isaac, too, conjoined tillage with pastoral husbandry, and that with success, for we read that he sowed in the land Gerar, and reaped an hundred-fold —a return which, it would appear, in some favoured regions, occasionally rewarded the labour of the husbandman. In the parable of the sower, our Lord (grafting his instructions upon the habits, scenery, and productions of Palestine), mentions an increase of thirty, sixty, and an

[1] *Short Inquiry into the History of Agriculture*, by Chandos Wren Hoskyn, Esq.

hundred fold. Such increase, although far above the average rate, was sometimes even greatly exceeded, if we take the authority of Herodotus, Strabo, and Pliny.

Along with the Babylonians, Egyptians, and Romans, the Israelites are classed as one of the great agricultural nations of antiquity. The sojourn of the Israelites in Egypt trained them for the more purely agricultural life that awaited them on their return to take possession of Canaan. Nearly the whole population were virtually husbandmen, and personally engaged in its pursuits. Upon their entrance into Canaan, they found the country occupied by a dense population possessed of walled cities and innumerable villages, masters of great accumulated wealth, and subsisting on the produce of their highly cultivated soil, which abounded with vineyards and oliveyards. It was so rich in grain, that the invading army, numbering 601,730 able-bodied men, with their wives and children, and a mixed multitude of camp-followers, found "old corn" in the land sufficient to maintain them from the day that they passed the Jordan. The Mosaic Institute contained an agrarian law, based upon an equal division of the soil amongst the adult males, a census of whom was taken just before their entrance into Canaan. Provision was thus made for 600,000 yeomen, assigning (according to different calculations) from sixteen to twenty-five acres of land to each. This land, held in direct tenure from Jehovah, their sovereign, was strictly inalienable. The accumulation of debt upon it was prevented by the prohibition of interest, the release of debts every seventh year, and the reversion of the land to the proprietor, or his heirs, at each return of the year of jubilee. The owners of these small farms cultivated them with much care, and rendered them highly productive. They were favoured with a soil extremely fertile, and one which their skill and diligence kept in good condition. The stones were carefully cleared from the fields, which were also watered from canals and conduits, communicating with the brooks and streams with which the country "was well watered everywhere," and enriched by the application of manures. The seventh year's fallow prevented the exhaustion of the soil, which was further enriched by the burning of the weeds and spontaneous growth of the Sabbatical year. The crops chiefly cultivated were wheat, millet, barley, beans, and lentiles; to which it is supposed, on grounds not improbable, may be added rice and cotton. The ox and the ass were used for labour. The word "oxen," which occurs in our version of the Scriptures, as well as in the Septuagint and Vulgate, denotes the species, rather than the sex. As the Hebrews did not mutilate any of their animals, bulls were in common use. The quantity of land ploughed by a yoke of oxen in one day was called a yoke or acre. Towards the end of October, with which month the rainy season begins, seedtime commenced, and of course does so still. The seedtime, begun in October, extends, for wheat and some other white crops, through November and December; and barley continues to be sown until about the middle of February. The seed appears to have been sometimes ploughed in, and at other times to have been covered by harrowing. The cold winds which prevail in January and February frequently injured the crops in the more exposed and higher districts. The rainy season extends from October to April, during which time refreshing showers fall, chiefly during the night, and generally at intervals of a few days. The harvest was earlier or later as the rains towards the end of the season were more or less copious. It, however, generally commenced in April, and continued through May for the different crops in succession. In the south, and in the plains, the harvest, as might be expected, commenced some weeks earlier than in the northern and mountainous districts. The slopes of the hills were carefully terraced and irrigated wherever practicable, and on these slopes the vine and olive were cultivated with great success. At the same time the hill districts and neighbouring deserts afforded pasturage for numerous flocks and herds, and thus admitted of the benefits of a mixed husbandry. With such political and social arrangements, and under the peculiarly felicitous climate of Judea, the country as a whole, and at the more prosperous periods of the commonwealth, must have exhibited such an example of high cultivation, rich and varied produce, and wide-spread plenty and contentment, as the world has never yet elsewhere produced on an equally extensive scale. Not by a figure of speech but literally, every Israelite sat under the shadow of his own vine and fig-tree; whilst the country as a whole is described (2 Kings xviii. 32) as "a land of corn and wine, a land of bread and vineyards, a land of oil-olive and of honey." An interesting illustration of the advanced state of agriculture in these ancient times is afforded by the fact, that, making allowance for climatic differences, the numerous allusions to it with which the Scriptures abound seem natural and appropriate to the British farmer of the present day.

Greece. The unrivalled literature of Greece affords us little information regarding the practical details of her husbandry. The people who by what remains to us of their poetry, philosophy, history, and fine arts, still exert such an influence in guiding our intellectual efforts, in regulating taste, and in moulding our institutions, were originally the invaders and conquerors of the territory which they have rendered so famous. Having reduced the aboriginal tribes to bondage, they imposed upon them the labour of cultivating the soil, and hence both the occupation, and those engaged in it, were regarded contemptuously by the dominant race, who addicted themselves to what they regarded as nobler pursuits. With the exception of certain districts, such as Bœotia, the country was naturally unfavourable to agriculture. When we find, however, that valleys were freed from lakes and morasses by drainage, that rocky surfaces were sometimes covered with transported soil, and that they possessed excellent breeds of the domesticated animals, which were reared in vast numbers, we infer that agriculture was better understood, and more carefully practised, than the allusions to it in their literature would seem to warrant.

Rome. Amongst the ancient Romans agriculture was highly esteemed, and pursued with earnest love and devoted attention. "In all their foreign enterprises, even in earliest times," as Schlegel remarks, "they were exceedingly covetous of gain, or rather of land; for it was in land, and in the produce of the soil, that their principal and almost only wealth consisted. They were a thoroughly agricultural people, and it was only at a later period that commerce, trades, and arts, were introduced among them, and even then they occupied but a subordinate place."[1] Their passion for agriculture survived very long; and when at length their boundless conquests introduced an unheard-of luxury and corruption of morals, the noblest minds amongst them were strongly attracted towards the ancient virtue of the purer and simpler agricultural times. Several facts in Roman history afford convincing proof, if it were required, of the devotion of this ancient people to agriculture, in their best and happiest times. Whilst their arts and sciences, and general literature, were borrowed from the Greeks, they created an original literature of their own, of which rural affairs formed the substance and inspiration. Schlegel and Mr Hoskyn notice also the striking fact, that

---

[1] *The Philosophy of History*, by Frederick Von Schlegel. London, 1846, p. 253.

whilst among the Greeks the names of their illustrious families are borrowed from the heroes and gods of their mythology, the most famous houses amongst the ancient Romans, such as the Pisones, Fabii, Lentuli, &c., have taken their names from their favourite crops and vegetables. Perhaps it is not too much to assert, that many of those qualities which fitted them for conquering the world, and perfecting their so celebrated jurisprudence, were acquired, or at all events nourished and matured, by the skill, foresight, and persevering industry, so needful for the intelligent and successful cultivation of the soil. The words which Cicero puts into the mouth of Cato give a fine picture of the ancient Roman enthusiasm in agriculture. "I come now to the pleasures of husbandry, in which I vastly delight. They are not interrupted by old age, and they seem to me to be pursuits in which a wise man's life should be spent. The earth does not rebel against authority; it never gives back but with usury what it receives. The gains of husbandry are not what exclusively commend it. I am charmed with the nature and productive virtues of the soil. Can those old men be called unhappy who delight in the cultivation of the soil? In my opinion there can be no happier life, not only because the tillage of the earth is salutary to all, but from the pleasure it yields. The whole establishment of a good and assiduous husbandman is stored with wealth; it abounds in pigs, in kids, in lambs, in poultry, in milk, in cheese, in honey. Nothing can be more profitable, nothing more beautiful, than a well-cultivated farm."

In ancient Rome each citizen received, at first, an allotment of about two English acres. After the expulsion of the kings this allotment was increased to about six acres. These small inheritances must, of course, have been cultivated by hard labour. On the increase of the Roman territory the allotment was increased to fifty, and afterwards even to five hundred acres. Many glimpses into their methods of cultivation are found in those works of Roman authors which have survived the ravages of time. Cato speaks of irrigation, frequent tillage, and manuring, as means of fertilising the soil. Mr Hoskyn, from whose valuable contribution to the History of Agriculture we have drawn freely in this historic summary, quotes the following interesting passage from Pliny, commenting on Virgil:[1]— "Our poet is of opinion that alternate fallows should be made, and that the land should rest entirely every second year. And this is, indeed, both true and profitable, provided a man have land enough to give the soil this repose. But how, if his extent be not sufficient? Let him, in that case, help himself thus. Let him sow next year's wheat-crop on the field where he has just gathered his beans, vetches, or lupines, or such other crop as enriches the ground. For, indeed, it is worth notice that some crops are sown for no other purpose but as food for others, a poor practice in my estimation." In another place he tells us, "Wheat, the later it is reaped, the better it casts; but the sooner it is reaped, the fairer the sample. The best rule is to cut it down before the grain is got hard, when the ear begins to have a reddish-brown appearance. 'Better two days too soon than as many too late,' is a good old maxim, and might pass for an oracle." The following quotation from the same author is excellent:—"Cato would have this point especially to be considered, that the soil of a farm be good and fertile; also, that near it there be plenty of labourers, and that it be not far from a large town: moreover, that it have sufficient means for transporting its produce, either by water or land. Also, that *the house be well built*, and the land about it as well managed. But I observe a great error and self-deception which many men commit, who hold opinion that the negligence and ill-husbandry of the former owner is good for his successor or after-purchaser. Now, I say, there is nothing more dangerous and disadvantageous to the buyer than land so left waste and out of heart; and therefore Cato counsels well to purchase land of one who has managed it well, and not rashly and hand-over-head to despise and make light of the skill and knowledge of another. He says, too, that as well land as men, which are of great charge and expense, how gainful soever they may seem to be, yield little profit in the end, when all reckonings are made. The same Cato being asked, what was the most assured profit rising out of land? made this answer,—'To feed stock well.' Being asked again, 'What was the next?' he answered, 'To feed *with moderation*.' By which answer he would seem to conclude that the most certain and sure revenue was *a low cost of production*. To the same point is to be referred another speech of his, 'That a good husbandman ought to be a seller rather than a buyer;' also, 'that a man should stock his ground early and well, but take long time and leisure before he be a builder;' for it is the best thing in the world, according to the proverb, 'to make use, and derive profit, from other men's follies.' Still when there is a good and convenient house on the farm, the master will be the closer occupier, and take the more pleasure in it; and truly it is a good saying, that 'the master's eye is better than his heel.'"

"It is curious," says Mr Hoskyn, "to read such passages as these, and to find the very same subjects still handled, week after week, in fresh and eager controversy in the agricultural writings and periodicals of the present day, eighteen centuries after those opinions were written."

In the later ages of the empire agriculture was neglected, and those engaged in it regarded with contempt. Many fair regions once carefully cultivated, and highly productive, were abandoned to nature, and became a scene of desolation, the supplies of overgrown Rome being drawn from Egypt, Sicily, and other provinces, which became notable as the granaries of the empire.

Under the Goths, Vandals, and other barbarian conquerors, agriculture in Europe, during the middle ages, seems to have sunk into the lowest condition of neglect and contempt. We owe its revival, like that of other arts and sciences, to the Saracens of Spain, who devoted themselves to the cultivation of that conquered territory, with hereditary love for the occupation, and with the skilful application of the experience which they had gathered in other lands in which they had established their power. By them, and their successors, the Moors, agriculture was carried in Spain to a height which perhaps has not yet been surpassed in Europe. It is said, that so early as the tenth century the revenue of Saracenic Spain alone amounted to £6,000,000 sterling,—probably as much as that of all the rest of Europe at that time. The ruins of their noble works for the irrigation of the soil still attest their skill and industry, and put to shame the ignorance and indolence of their successors. The same remark applies to the Spanish dominions in South America. In the ancient empire of Peru agriculture seems to have reached a high degree of perfection. The ruins of basins and canals, frequently carried through tunnels, prove their industry and skill in irrigation. One of their aqueducts is said by Mr Prescott[2] to have been traced by its ruins for nearly 500 miles. They cultivated the sides of mountains, by means of terraces, which retained forced soil, and were skilled in the application of manure. That on which they chiefly depended was guano, and their Incas protected the penguins, by which it was deposited, by strict laws, which made it

Middle Ages.

Spain.

[1] *Short Inquiry into the History of Agriculture*, pp. 49–51, by Chandos Wren Hoskyn, Esq.

[2] *History of the Conquest of Mexico.*

Middle ages highly penal to kill one of these birds, or to set foot on the islands at breeding time. The Spaniards thus obtained possession of two good patrimonies, and have wasted them both.

The influence of the crusades upon the agriculture of this period is not to be overlooked. The dreadful oppression of the feudal system received at that time a shock most favourable to the liberties of man, and, with increasing liberty, more enlightened ideas began to be entertained, and greater attention to be paid to the cultivation of the soil.

Condition of labour. But, during this long interval, the population of Europe was divided into two great classes, of which by far the larger one was composed of bondmen, without property, or the power of acquiring it, and small tenants, very little superior to bondmen; and the other class, consisting chiefly of the great barons and their retainers, was more frequently employed in laying waste the fields of their rivals than in improving their own. The superstition of the times, which destined a large portion of the land to the support of the church, and which, in some measure, secured it from predatory incursions, was the principal source of what little skill and industry were then displayed in the cultivation of the soil. "If we consider the ancient state of Europe," says Mr Hume,[1] "we shall find that the far greater part of society were everywhere bereaved of their personal liberty, and lived entirely at the will of their masters. Every one that was not noble was a slave; the peasants were not in a better condition; even the gentry themselves were subjected to a long train of subordination under the greater barons, or chief vassals of the crown, who, though seemingly placed in a high state of splendour, yet, having but a slender protection from law, were exposed to every tempest of the state, and by the precarious condition on which they lived, paid dearly for the power of oppressing and tyrannising over their inferiors."—"The villains were entirely occupied in the cultivation of their master's land, and paid their rents either in corn or cattle, and other produce of the farm, or in servile offices, which they performed about the baron's family, and upon farms which he retained in his own possession. In proportion as agriculture improved and money increased, it was found that these services, though extremely burdensome to the villain, were of little advantage to the master; and that the produce of a large estate could be much more conveniently disposed of by the peasants themselves who raised it, than by the landlord or his bailiff, who were formerly accustomed to receive it. A commutation was therefore made of rents for services, and of money-rents for those in kind; and as men in a subsequent age discovered that farms were better cultivated where the farmer enjoyed security in his possession, the practice of granting leases to the peasant began to prevail, which entirely broke the bonds of servitude, already much relaxed from the former practices. The latest laws which we find in England for enforcing or regulating this species of servitude were enacted in the reign of Henry VII. And though the ancient statutes on this subject remain still unrepealed by Parliament, it appears that before the end of Elizabeth the distinction between villain and freeman was totally, though insensibly, abolished, and that no person remained in the state to whom the former laws could be applied."

But long before the 15th century, it is certain that there was a class of tenants holding on leases for lives, or for a term of years, and paying a rent in land produce, in services, or in money. Whether they gradually sprung up from the class of bondmen, according to Lord Kames,[2] or existed from the earliest period of the feudal constitution, according to other writers,[3] their number cannot be supposed to have been considerable during the middle ages. The stock which these tenants employed in cultivation commonly belonged to the proprietor, who received a proportion of the produce as rent,—a system which still exists in France and in other parts of the Continent, where such tenants are called *metayers*, and some vestiges of which may yet be traced in the *steel-bow* of the law of Scotland. Leases of the 13th century still remain,[4] and both the laws and chartularies[5] clearly prove the existence in Scotland of a class of cultivators distinct from the *serfs* or bondmen. Yet the condition of these tenants seems to have been very different from that of the tenants of the present day; and the lease approached nearer in its form to a feu-charter than to the mutual agreement now in use. It was of the nature of a beneficiary grant by the proprietor, under certain conditions, and for a limited period; the consent of the tenant seems never to have been doubted. In the common expression "granting a lease," we have retained an idea of the original character of the deed, even to the present time.

The corn crops cultivated during this period seem to have been of the same species, though all of them probably much inferior in quality to what they are in the present day. Wheat, the most valuable grain, must have borne a small proportion, at least in Britain, to that of other crops; the remarkable fluctuation of price, its extreme scarcity, indicated by the extravagant rate at which it was sometimes sold, as well as the preparatory cultivation required, may convince us that its consumption was confined to the higher orders, and that its growth was by no means extensive. Rye and oats furnished the bread and drink of the great body of the people of Europe. Cultivated herbage and roots were then unknown in the agriculture of Britain. It was not till the end of the reign of Henry VIII. that any salads, carrots, or other edible roots were produced in England. The little of these vegetables that was used was formerly imported from Holland and Flanders. Queen Catherine, when she wanted a salad, was obliged to despatch a messenger thither on purpose.[6] Crops.

The ignorance and insecurity of those ages, which necessarily confined the cultivation of corn to a comparatively small portion of country, left all the rest of it in a state of nature, to be depastured by the inferior animals, then only occasionally subjected to the care and control of man. Cultivators were crowded together in miserable hamlets; the ground contiguous was kept continually under tillage; and beyond this, wastes and woodlands of a much greater extent were appropriated to the maintenance of their flocks and herds, which pastured indiscriminately, with little attention from their owners.

The low price of butcher-meat, though it was then the food of the common people, when compared with the price of corn, has been justly noticed by several writers as a decisive proof of the small progress of civilisation and industry.

One of the earliest and greatest agricultural grievances was the levying of Purveyance. This originally comprehended the necessary provisions, carriages, &c., which the nearest farmers were obliged to furnish at the current prices to the king's armies, houses, and castles, in time of war. It was called the *great purveyance*, and the officers who collected those necessaries were called purveyors. The smaller purveyance included the necessary provisions for the household of the king when travelling through the Purveyance.

[1] *History of England*, chap. xxiii.
[2] Kames's *Law Tracts*.
[3] Bell's *Treatise on Leases*.
[4] Sir John Cullum's *History and Antiquities of Hawsted (Suffolk)*.
[5] Chalmers' *Caledonia*, book iv. c. 6.
[6] Hume's *History of England*, chap. xxiii.

kingdom, and these the tenants on the king's demesne lands were obliged to furnish gratis, a practice that came to be adopted by the barons and great men in every tour which they thought proper to make in the country. These exactions were so grievous, and levied in so high-handed a manner, that the farmers, when they heard of the court's approach, often deserted their houses, as if the country had been invaded by an enemy. "Purveyance," says Dirom,[1] "was perhaps for many centuries the chief obstruction to the agriculture and improvement of Great Britain. Many laws were made for the reformation and regulation of purveyance, but without effect; and the practice continued down to so late a period as the reign of James the First."

By statute 1449, the tenant was for the first time secured in possession, during the term of his lease, against a purchaser of the land; and in 1469 he was protected from having his property carried off for the landlord's debts, beyond the amount of rent actually due; an enactment which proves his miserable condition before that time.

Soon after the beginning of the 16th century agriculture partook of the general improvement which followed the invention of printing, the revival of learning, and the more settled authority of government; and instead of the occasional notices of historians, we can now refer to regular treatises, written by men who engaged eagerly in this neglected and hitherto degraded occupation. We shall therefore give a short account of the principal works, as well as of the laws and general policy of Britain, in regard to agriculture, from the early part of the 16th century to the Revolution in 1688, when a new era commenced in the legislation of corn, and soon after in the practice of the cultivator.[2]

Early Works on Agriculture.

Book of Husbandry. 1534.

The first and by far the best of our early works is the *Book of Husbandry*, printed in 1534, commonly ascribed to Fitzherbert, a judge of the Common Pleas in the reign of Henry VIII. This was followed, in 1539, by the *Book of Surveying and Improvements*, by the same author. In the former treatise we have a clear and minute description of the rural practices of that period, and from the latter may be learned a good deal of the economy of the feudal system in its decline. The *Book of Husbandry* has scarcely been excelled by any later production, in as far as concerns the subjects of which it treats; for at that time cultivated herbage and edible roots were still unknown in England. The author writes from his own experience of more than forty years; and, with the exception of passages denoting his belief in the superstition of the Roman writers, there is very little of this valuable work, in so far as regards the culture of corn, that should be omitted, and not a great deal that need be added, even in a manual of husbandry adapted to the present time. Fitzherbert touches on almost every department of the art, and in about a hundred octavo pages has contrived to condense more practical information than will be found scattered through as many volumes of later times; and yet he is minute even to the extreme on points of real utility. There is no reason to say, with Mr Harte, that he had revived the husbandry of the Romans; he merely describes the practices of the age in which he lived; and from his commentary on the old statute *extenta manerii*, in his *Book of Surveying*, in which he does not allude to any recent improvements, it is probable that the management which he details had been long established. But it may surprise some of the agriculturists of the present day to be told, that, after the lapse of almost three centuries, Fitzherbert's practice, in some material particulars, has not been improved upon; and that in several districts abuses until recently existed, which were as clearly pointed out by him at that early period as by any writer of the present age

The *Book of Husbandry* begins with the plough and other instruments, which are concisely and yet minutely described; and then about a third part of it is occupied with the several operations as they succeed one another throughout the year. Among other things in this part of the work, the following deserve notice :—

"Somme (ploughs) wyll tourn the shald bredith at every landsende, and plowe all one way;" the same kind of plough that is now found so useful on hilly grounds. Of wheel-ploughs he observes, that "they be good on even grounde that lyetl lyghte;" and on such lands they are still most commonly employed. Cart-wheels were sometimes bound with iron, of which he greatly approves. On the much agitated question about the employment of horses or oxen in labour, the most important arguments are distinctly stated.

"In some places," he says, "a horse plough is better," and in others an oxen plough, to which, upon the whole, he gives the preference, and to this, considering the practices of that period, they were probably entitled. Beans and peas seem to have been common crops. He mentions the different kinds of wheat, barley, and oats; and after describing the method of harrowing "all maner of cornnes," we find the roller employed. "They used to role their barley grounde after a showr of rayne, to make the grounde even to mowe." Under the article "To falowe," he observes, "the greater clottes (clods) the better wheate, for the clottes kepe the wheat warme all wynter; and at March they will melte and breake and fal in manye small peces, the whiche is a new dongynge and refreshynge of the corne." This is agreeable to the present practice, founded on the very same reasons. "In May, the shepe folde is to be set out;" but Fitzherbert does not much approve of folding, and points out its disadvantages in a very judicious manner. "In the latter end of May and the begynnynge of June, is tyme to wede the corne;" and then we have an accurate description of the different weeds, and the instruments and mode of weeding. Next comes a second ploughing of the fallow; and afterwards, in the latter end of June, the mowing of the meadows begins. Of this operation, and of the forks and rakes, and the haymaking, there is a very good account. The corn harvest naturally follows: rye and wheat were usually *shorn*, and barley and oats cut with the scythe. This intelligent writer does not approve of the practice, which still prevails in some places, of cutting wheat high, and then mowing the stubbles. "In Somersetshire," he says, "they do shere theyr wheat very lowe; and the wheate strawe that they purpose to make *thacke* of, they do not threshe it, but cut off the ears, and bynd it in sheves, and call it *rede*, and therewith they thacke theyr houses." He recommends the practice of setting up corn in shocks, with two sheaves to cover eight, instead of ten sheaves as at present; probably owing to the straw being then shorter. The corn was commonly housed; but if there be a want of room, he advises that the ricks be built on a scaffold, and not upon the ground. Cornstacks are now beginning to be built on pillars and frames. The fallow received a third ploughing in September, and was sown about Michaelmas. "Wheat is moost commonlye sowne under the forowe, that is to say, cast it uppon the falowe, and then plowe it under;" and this branch of his subject is concluded with directions about threshing, winnowing, and other kinds of barn-work.

Fitzherbert next proceeds to live stock. "An housbande," he says, "can not well thryue by his corne without he have other cattell, nor by his cattell without corne. And bycause that shepe, in myne opynyon, is the mooste profytablest cattell that any man can haue, therefore I pourpose to speake fyrst of shepe." His remarks on this subject are so accurate, that one might imagine they came from a storemaster of the present day; and the minutiæ which he details are exactly what the writer of this article has seen practised in the hilly parts of this country. In some places at present, "they neuer seuer their lambes from their dammes;" "and the poore of the peeke (high) countreye, and such other places, where, as they vse to mylke theyr ewes, they vse to wayne theyr lambes at 12 weekes olde, and to mylke their ewes fiue or syxe weekes;" but that, he observes, "is greate hurte to the ewes, and wyll cause them that they wyll not take the ramme at the tyme of the yere for pouertye, but goo barreyne." "In June is tyme to shere shepe; and ere they be shorne, they must be verye well washen, the which shall be to the owner greate profyte in the sale of his wool, and also to the clothe-maker." It appears that *hand washing* was then a common practice; and yet in the west and north of Scotland its introduction is of comparatively recent date. His remarks on horses, cattle, &c., are not less interesting; and there is a very good account of the diseases of each species, and some just observations on the advantage of mixing different kinds on the same pasture. Swine and bees conclude this branch of the work.

[1] *Inquiry into the Corn Laws*, &c., p. 9.

[2] The account of the Writers on Agriculture taken from Mr Cleghorn's Treatise in the former edition of the *Encyclopædia Britannica*.

Early Works.

The author then points out the great advantages of inclosure; recommends "quyckesettynge, dychynge, and hedgeyng;" and gives particular directions about *settes*, and the method of training a hedge, as well as concerning the planting and management of trees. We have then a short information "for a yonge gentylman that intendeth to thryue," and "a prolouge for the wiues occupation," in some instances rather too homely for the present time. Among other things, she is to "make her husband and herself somme clothes;" and "she maye haue the lockes of the shepe eyther to make blankettes and courlettes, or bothe." This is not so much amiss; but what follows will bring the learned judge into disrepute even with our most industrious housewives. "It is a wynes occupation," he says, "to wynowe all maner of cornes, to make malte, to washe and wrynge, to make heye, shere corne, and, in time of nede, to helpe her husbande to fyll the mucke wayne or dounge carte, dryue the ploughe, to loode heye, corne, and suche other; and to go or ride to the market to sel butter, chese, mylke, egges, chekyns, capons, hennes, pygges, gese, and all maner of cornes." The rest of the book contains some useful advices about diligence and economy; and concludes, after the manner of the age, with many pious exhortations.

Such is Fitzherbert's *Book of Husbandry*, and such was the state of agriculture in England in the early part of the 16th century, and probably for a long time before; for he nowhere speaks of the practices which he describes or recommends as of recent introduction.

Book of Surveying.

The *Book of Surveying* adds considerably to our knowledge of the rural economy of that age. "Four maner of commens" are described; several kinds of mills for corn and other purposes, and also "quernes that goo with hand;" different orders of tenants, down to the "boundmen," who "in some places contynue as yet;" "and many tymes, by colour thereof, there be many freemen taken as boundmen, and their lands and goods is taken from them." Lime and marl are mentioned as common manures; and the former was sometimes spread on the surface to destroy heath. Both draining and irrigation are noticed, though the latter but slightly. And the work concludes with an inquiry "how to make a township that is worth XX. marke a yere, worth XX. li. a year;" from which we shall give a specimen of the author's manner, as well as of the economy of the age.

"It is undoubted, that to every townshyppe that standeth in tyllage in the playne countrey, there be errable landes to plowe and sowe, and leyse to tye or tedder theyr horses and mares upon, and common pasture to kepe and pasture their catell, beestes, and shepe upon; and also they have medowe groundes to get theyr hey upon. Than to let it be known how many acres of errable lande euery man hath in tyllage, and of the same acres in euery felde to chaunge with his neyghbours, and to leye them togyther, and to make hym one seuerall close in euery felde for his errable lands; and his leyse in euery felde to leve them togyther in one felde, and to make one seuerall close for them all. And also another seuerall close for his portion of his common pasture, and also his porcion of his medowe in a seuerall close by itselfe, and al kept in seuerall both in wynter and somer; and euery cottage shall haue his portion assigned hym accordynge to his rent, and than shall nat the ryche man ouerpresse the poore man with his cattell; and euery man may eate his oun close at his pleasure. And vndoubted, that hay and strawe that will find one beest in the house wyll finde two beestes in the close, and better they shall lyke. For those beestis in the house have short heare and thynne, and towards March they will pylle and be bare; and therefore they may nat abyde in the fylde before the heerdmen in winter tyme for colde. And those that lye in a close under a hedge haue longe heare and thyck, and they will neuer pylle nor be bare; and by this reason the husbands maye kepe twyse so many catell as he did before.

"This is the cause of this approwment. Nowe euery husbande hath sixe seuerall closes, whereof iii. be for corne, the fourthe for his leyse, the fyfte for his commen pastures, and the sixte for his haye; and in wynter time there is but one occupied with corne, and than hath the husbande other fyue to occupy tyll lente come, and that he hath his falowe felde, his ley felde, and his pasture felde al sommer. And when he hath mowen his medowe, then he hath his medowe grounde, soo that if he hath any weyke catell that wold be amended, or dyvers maner of catell, he may put them in any close he wyll, the which is a great advantage; and if all shulde lye commen, than wolde the edyche of the corne feldes and the aftermath of all the medowes be eaten in X. or XII. dayes. And the rych men that hath moche catell wold have the advantage, and the poore man can have no helpe ner relefe in wynter when he hath moste nede; and if an acre of lande be worthe sixe pens, or it be enclosed, it will be worth VIII. pens, when it is enclosed by reason of the compostying and dongyng of the catell that shall go and lye upon it both day and nighte; and if any of his thre closes that he hath for his corne be worne or ware bare, than he may breke and plowe up his close that he hadde for his layse, or the close that he hadde for his commen pasture, or bothe, and sowe them with corne, and let the other lye for a time, and so shall he have alway reist grounde, the which will bear moche corne with lytel donge; and also he shall have a great profyte of the wod in the hedges whan it is growen; and not only these profytes and advantages beforesaid, but he shall save moche more than al these, for by reason of these closes he shall save meate, drinke, and wages of a shepherde, the wages of the heerdmen, and the wages of the swine herde, the which may fortune to be as chargeable as al his holle rent; and also his corne shall be better saved from eatinge or destroyeng with catel. For dout ye nat but heerdemen with their catell, shepeherdes with their shepe, and tieng of horses and mares, destroyeth moch corne, the which the hedges wold save. Paraduenture some men would say, that this shuld be against the common weale, bicause the shepeherdes, heerdmen, and swyneherdes, shuld than be put out of wages. To that it may be answered, though these occupations be not used, there be as many newe occupations that were not used before; as getting of quicke settes, diching, hedging, and plashing, the which the same men may use and occupye."

Tusser, 1562.

The next author who writes professedly on agriculture is Tusser, whose *Five Hundred Points of Husbandry*, published in 1562, was formerly in such high repute as to be recommended by Lord Molesworth to be taught in schools.[1] The edition of 1604 is the one we make use of here. In it the book of husbandry consists of 118 pages, and then follows the *Points of Housewifrie*, occupying 42 pages more. It is written in verse. Amidst a vast heap of rubbish, there are some useful notices concerning the state of agriculture at the time in different parts of England. Hops, which had been introduced in the early part of the 16th century, and on the culture of which a treatise was published in 1574 by Reynolde Scott, are mentioned as a well-known crop. Buckwheat was sown after barley. Hemp and flax are mentioned as common crops. Inclosures must have been numerous in several counties; and there is a very good comparison between "champion (open fields) country, and several," which Blythe afterwards transcribed into his *Improver Improved*. Carrots, cabbages, turnips, and rape, are mentioned among the herbs and roots for the kitchen. There is nothing to be found in Tusser about serfs or bondmen, as in Fitzherbert's works. This author's division of the crop is rather curious, though probably quite inaccurate, if he means that the whole rent might be paid by a tenth of the corn.

"One part cast forth for rent due out of hand.
One other part for seed to sow thy land.
Another part leave parson for his tith.
Another part for harvest, sickle and sith.
One part for ploughwrite, cartwrite, knacker, and smith.
One part to uphold thy teemes that draw therewith.
Another part for servant and workman's wages laie.
One part likewise for filbellie daie by daie.
One part thy wife for needful things doth crave.
Thyself and thy child the last part would have."

Googe, 1578.

The next writer is Barnaby Googe, whose *Whole Art of Husbandry* was printed in 1578, and again by Markham in 1614. The first edition is merely a translation of a German work; and very little is said of English husbandry in the second, though Markham made some trifling interpolations, in order, as it is alleged, to adapt the German husbandry to the English climate. It is for the most part made up of gleanings from the ancient writers of Greece and Rome, whose errors are faithfully retained, with here and there some description of the practices of the age, in which there is little of novelty or importance. Googe mentions a number of English writers who lived about the time of Fitzherbert, whose works have not been preserved.

[1] *Some Considerations for the promoting of Agriculture and employing the Poor*. Dublin, 1723.

For more than fifty years after this, or till near the middle of the 17th century, there are no systematic works on husbandry, though several treatises on particular departments of it. From these it is evident that all the different operations of the farmer were performed with more care and correctness than formerly; that the fallows were better worked, the fields kept freer from weeds, and much more attention paid to manures of every kind. A few of the writers of this period deserve to be shortly noticed.

Plat, 1594. Sir Hugh Plat, in his *Jewel House of Art and Nature*, printed in 1594 (which Weston in his catalogue erroneously ascribes to Gabriel Plattes), makes some useful observations on manures, but chiefly collected from other writers. His censure of the practice of leaving farm dung lying scattered about is among the most valuable.

Norden, 1618. Sir John Norden's *Surveyor's Dialogue*, printed in 1607, and reprinted with additions in 1618, is a work of considerable merit. The first three books of it relate to the rights of the lord of the manor and the various tenures by which landed property was then held, with the obligations which they imposed. Among others, we find the singular custom, so humorously described in the *Spectator*, of the incontinent widow riding upon a ram. In the fifth book there are a good many judicious observations on the "different natures of grounds, how they may be employed, how they may be bettered, reformed, and amended." The famous meadows near Salisbury are mentioned; and when cattle have fed their fill, hogs, it is pretended, "are made fat with the remnant—namely, with the knots and sappe of the grasse." "Clouer grasse, or the grasse honey suckle" (white clover), is directed to be sown with other hay seeds. "Carrot rootes" were then raised in several parts of England, and sometimes by farmers. London street and stable dung was carried to a distance by water, though it appears from later writers to have been got for the trouble of removing. And leases of 21 years are recommended for persons of small capital, as better than employing it in purchasing land,—an opinion that prevails very generally among our present farmers.

Butler on Bees, 1609. Bees seem to have been great favourites with these early writers; and among others, there is a treatise by Butler, a gentleman of Oxford, called the *Feminine Monarchie, or the History of Bees*, printed in 1609, full of all manner of quaintness and pedantry.

We shall pass over Markham, Mascall, Gabriel Plattes, and several other authors of this period, the best part of their writings being preserved by Blythe and Hartlib, of whom we shall say a little immediately. In Sir Richard Weston's *Discourse on the Husbandry of Brabant and Flanders*, published by Hartlib in 1645, we may mark the dawn of the vast improvements which have since been effected in Britain. This gentleman was ambassador from England to the elector palatine and king of Bohemia in 1619, and had the merit of being the first who introduced the *great clover*, as it was then called, into English agriculture, about 1645, and probably turnips also. His directions for the cultivation of clover are better than was to be expected. It thrives best, he says, when you sow it on the worst and barrenest ground, such as our worst heath ground is in England. The ground is to be pared and burnt, and unslacked lime must be added to the ashes. It is next to be well ploughed and harrowed; and about ten pounds of clover seed must be sown on an acre in April or the end of March. If you intend to preserve seed, then the second crop must be let stand till it come to a full and dead ripeness, and you shall have at the least five bushels per acre. Being once sown, it will last five years; and then being ploughed, it will yield, three or four years together, rich crops of wheat, and after that a crop of oats, with which clover seed is to be sown again. It is in itself an excellent manure, Sir Richard adds; and so it should be, to enable land to bear this treatment. In less than ten years after its introduction, that is, before 1655, the culture of clover, exactly according to the present method seems to have been well known in England, and it had also made its way to Ireland.

Weston, 1645

Early Works.

Blythe, 1649. A great many works on agriculture appeared during the time of the Commonwealth, of which Blythe's *Improver Improved* and Hartlib's *Legacy* are the most valuable. The first edition of the former was published in 1649, and of the latter in 1650; and both of them were enlarged in subsequent editions. In the first edition of the *Improver Improved*, no mention is made of clover, nor in the second of turnips, but in the third, published in 1662, clover is treated of at some length, and turnips are recommended as an excellent cattle crop, the culture of which should be extended from the kitchen garden to the field. Sir Richard Weston must have cultivated turnips before this; for Blythe says, that Sir Richard affirmed to himself he did feed his swine with them. They were first given boiled, but afterwards the swine came to eat them raw, and would run after the carts, and pull them forth as they gathered them,—an expression which conveys an idea of their being cultivated in the fields.

Blythe's book is the first systematic work in which there are some traces of the alternate husbandry so beneficially established since, by interposing clover and turnip between culmiferous crops. He is a great enemy to commons and common fields, and to retaining land in old pasture, unless it be of the best quality. His description of the different kinds of ploughs is interesting; and he justly recommends such as were drawn by two horses (some even by one horse), in preference to the weighty and clumsy machines which required four or more horses or oxen. Almost all the manures now used seem to have been then well known, and he brought lime himself from a distance of 20 miles. He speaks of an instrument which ploughed, sowed, and harrowed at the same time; and the *setting of corn* was then a subject of much discussion. "It was not many years," says Blythe, "since the famous city of London petitioned the Parliament of England against two anusancies or offensive commodities, which were likely to come into great use and esteem; and that was Newcastle coal, in regard of their stench, &c., and hops, in regard they would spoyle the taste of drink, and endanger the people."

Hartlib, 1650. Hartlib's *Legacy* is a very heterogeneous performance, containing, among some very judicious directions, a great deal of rash speculation. Several of the deficiencies which the writer complains of in English agriculture must be placed to the account of our climate, and never have been or can be supplied. Some of his recommendations are quite unsuitable to the state of the country, and display more of general knowledge and good intention than of either the theory or practice of agriculture. Among the subjects deserving notice may be mentioned the practice of steeping and liming seed corn as a preventive of smut; changing every year the *species* of grain, and bringing seed corn from a distance; ploughing down green crops as manure; and feeding horses with broken oats and chaff. This writer seems to differ a good deal from Blythe about the advantage of interchanging tillage and pasture. "It were no losse to this island," he says, "if that we should not plough at all, if so be that we could certainly have corn at a reasonable rate, and likewise vent for all our manufactures of wool;" and one reason for this is, that pasture employeth more hands than tillage, instead of depopulating the country, as was commonly imagined. The *grout*, which he mentions "as coming over to us in Holland ships," about which he desires information, was probably the same with our present shelled barley; and mills

for manufacturing it were introduced into Scotland from Holland towards the beginning of the last century.

To the third edition, published in 1655, are subjoined Dr Beatie's *Annotations* with the writer of the *Legacy's* answers, both of them ingenious, and sometimes instructive. But this cannot be said of Gabriel Plattes's *Mercurius Lætificans*, also added to this edition, which is a most extravagant production. There are also several communications from Hartlib's different correspondents, of which the most interesting are those on the early cultivation and great value of clover. Hartlib himself does not appear much in this collection; but he seems to have been a very useful person in editing the works of others, and as a collector of miscellaneous information on rural subjects. It is strange that neither Blythe nor Hartlib, nor any of Hartlib's correspondents, seem ever to have heard of Fitzherbert's works.

Ray and Evelyn. Among the other writers previous to the Revolution, we shall only mention Ray the botanist, and Evelyn, both men of great talent and research, whose works are still in high estimation. A new edition of Evelyn's *Silva and Terra* was published in 1777 by Dr Hunter, with large notes and elegant engravings, and reprinted in 1812.

The preceding review commences with a period of feudal anarchy and despotism, and comes down to the time when the exertions of individual interest were protected and encouraged by the firm administration of equal laws; when the prosperity of Great Britain was no longer retarded by internal commotions, nor endangered by hostile invasion.

Laws.

The laws of this period, in so far as they relate to agriculture and rural economy, display a similar progress in improvement.

Tillage, 1488. From the beginning of the reign of Henry VII. to the end of Elizabeth's, a number of statutes were made for the encouragement of tillage, though probably to little purpose. The great grievance of those days was the practice of laying arable land to pasture, and suffering the farm-houses to fall to ruin. "Where in some towns," says the statute 4th Henry VII. (1488), "two hundred persons were occupied and lived of their lawful labours, now there are occupied two or three herdsmen, and the residue fall into idleness;" therefore it is ordained, that houses which within three years have been let for farms, with twenty acres of land lying in tillage or husbandry, shall be upheld, under the penalty of half the profits, to be forfeited to the king or the lord of the fee. Almost half a century afterwards, the practice had become still more alarming; and in 1534 a new Act was tried, apparently with as little success. "Some have 24,000 sheep, some 20,000 sheep, some 10,000, some 6000, some 4000, and some more and some less;" and yet it is alleged the price of wool had nearly doubled, "sheep being come to a few persons' hands." A penalty was therefore imposed on all who kept above 2000 sheep; and no person was to take in farm more than two tenements of husbandry. By the 39th Elizabeth (1597), arable land made pasture since the 1st Elizabeth shall be again converted into tillage, and what is arable shall not be converted into pasture.

Vagabonds. Many laws were enacted during this period against vagabonds, as they were called; and persons who could not find employment seem to have been sometimes confounded with those who really preferred idleness and plunder. The dissolution of the feudal system, and the suppression of the monasteries, deprived a great part of the rural population of the means of support. They could not be employed in cultivating the soil, for there was no middle class of farmers possessed of capital to be vested in improvements; and what little disposable capital was in the hands of great proprietors could not, in those rude times, be so advantageously embarked in the expensive and precarious labours of growing corn, as in pasturage, which required much less skill and superintendence. Besides, there was a constant demand for wool on the Continent; while the corn market was not only confined by laws against exportation, but fettered by restrictions on the internal trade. The laws regarding the wages of labour and the price of provisions are a further proof of the ignorance of the age in regard to the proper subject of legislation.

Forestalling, 1552. By the statute 1552 it is declared, that any person that shall buy merchandise, victual, &c., coming to market, or make any bargain for buying the same, before they shall be in the market ready to be sold, or shall make any motion for enhancing the price, or dissuade any person from coming to market, or forbear to bring any of the things to market, &c., shall be deemed a *forestaller*. Any person who buys and sells again in the same market, or within four miles thereof, shall be reputed a *regrater*. Any person buying corn growing in the fields, or any other corn, with intent to sell again, shall be reputed an unlawful *ingrosser*. It was also declared, that no person shall sell cattle within five weeks after he had bought them. Licenses, indeed, were to be granted in certain cases, and particularly when the price of wheat was at or under 6s. 8d. a quarter, and other kinds of grain in that proportion.

Corn Trade. The laws regarding the exportation and importation of corn during this period could have had little effect in encouraging agriculture, though towards the latter part of it they gradually approached that system which was finally established at and soon after the Revolution. From the time of the above-mentioned statute against forestallers, which effectually prevented exportation, as well as the freedom of the home trade, when corn was above the price therein specified, down to 1688, there are at least twelve statutes on this subject; and some of them are so nearly the same, that it is probable they were not very carefully observed. The price at which wheat was allowed to be exported was raised from 6s. 8d. a quarter, the price fixed by the 1st and 2d of Philip and Mary (1553), to 10s. in 1562; to 20s. in 1593; to 26s. 8d. in 1604; to 32s. in 1623; to 40s. in 1660; to 48s. in 1663; and at last, in 1670, exportation was virtually permitted without limitation. Certain duties, however, were payable, which in some cases seem to have amounted to a prohibition; and until 1660 importation was not restrained even in years of plenty and cheapness. In permitting exportation, the object appears to have been revenue rather than the encouragement of production.

Tolls, 1662. The first statute for levying tolls at turnpikes, to make or repair roads in England, passed in 1662.

Scotland, 16th and 17th Centuries. Of the state of agriculture in Scotland in the 16th and the greater part of the 17th century very little is known; no professed treatise on the subject appeared till after the Revolution. The south-eastern counties were the earliest improved, and yet in 1660 their condition seems to have been very wretched. Ray, who made a tour along the eastern coast in that year, says, "We observed little or *no fallow ground* in Scotland; some ley ground we saw, which they manured with sea wreck. The men seemed to be very lazy, and may be frequently observed to plough in their cloaks. It is the fashion of them to wear cloaks when they go abroad, but especially on Sundays. They have neither good bread, cheese, nor drink. They cannot make them, nor will they learn. Their butter is very indifferent, and one would wonder how they could contrive to make it so bad. They use much pottage made of coalwort, which they call *kail*, sometimes broth of decorticated barley. The ordinary country-houses are pitiful cots, built of stone and covered with turfs, having in them but one

room, many of them no chimneys, the windows very small holes, and not glazed. The ground in the valleys and plains bears very good corn, but especially bears barley or bigge, and oats, but rarely wheat and rye."[1]

It is probable that no great change had taken place in Scotland from the end of the 15th century, except that tenants gradually became possessed of a little stock of their own, instead of having their farm stocked by the landlord. "The minority of James V., the reign of Mary Stuart, the infancy of her son, and the civil wars of her grandson Charles I., were all periods of lasting waste. The very laws which were made during successive reigns for protecting the tillers of the soil from spoil, are the best proofs of the deplorable state of the husbandman."[2]

Yet in the 17th century were those laws made which paved the way for the present improved system of agriculture in Scotland. By statute 1633, landholders were enabled to have their tithes valued, and to buy them either at nine or six years' purchase, according to the nature of the property. The statute 1685, conferring on landlords a power to entail their estates, was indeed of a very different tendency in regard to its effects on agriculture. But the two Acts in 1695, for the division of commons, and separation of intermixed properties, have facilitated in an eminent degree the progress of improvement.

Progress of Agriculture from 1688 to 1760.

From the Revolution to the accession of George III. the progress of agriculture was by no means so considerable as we should be led to imagine from the great exportation of corn. It is the opinion of well-informed writers,[3] that very little improvement had taken place, either in the cultivation of the soil or in the management of live stock, from the Restoration down to the middle of last century. Even clover and turnips, the great support of the present improved system of agriculture, were confined to a few districts, and at the latter period were scarcely cultivated at all by common farmers in the northern part of the island. Of the writers of this period, therefore, we shall notice only such as describe some improvement in the modes of culture, or some extension of the practices that were formerly little known.

Houghton, 1681. In Houghton's *Collections on Husbandry and Trade*, a periodical work begun in 1681, we have the first notice of turnips being eaten by sheep :—"Some in Essex have their fallow after turnips, which feed their sheep in winter, by which means the turnips are scooped, and so made capable to hold dews and rain water, which, by corrupting, imbibes the nitre of the air, and when the shell breaks it runs about and fertilises. By feeding the sheep, the land is dunged as if it had been folded; and those turnips, though few or none be carried off for human use, are a very excellent improvement, nay, some reckon it so though they only plough the turnips in without feeding."[4] This was written in February 1694; but ten years before, Worlidge, one of his correspondents, observes, "Sheep fatten very well on turnips, which prove an excellent nourishment for them in hard winters when fodder is scarce; for they will not only eat the greens, but feed on the roots in the ground, and scoop them hollow even to the very skin. Ten acres (he adds) sown with clover, turnips, &c., will feed as many sheep as one hundred acres thereof would before have done."[5]

At this time potatoes were beginning to attract notice.

"The potato," says Houghton, "is a *bacciferous* herb, with *esculent* roots, bearing winged leaves and a bell flower.

"This, I have been informed, was brought first out of Virginia by Sir Walter Raleigh; and he stopping at Ireland, some was planted there, where it thrived very well, and to good purpose; for in their succeeding wars, when all the corn above the ground was destroyed, this supported them; for the soldiers, unless they had dug up all the ground where they grew, and almost sifted it, could not extirpate them; from whence they were brought to Lancashire, where they are very numerous, and now they begin to spread all the kingdom over. They are a pleasant food boiled or roasted, and eaten with butter and sugar. There is a sort brought from Spain, that are of a longer form, and are more luscious than ours; they are much set by, and sold for sixpence or eightpence the pound."[6]

The next writer is Mortimer, whose *Whole Art of Husbandry* was published in 1706, and has since run through several editions. It is a regular, systematic work, of considerable merit; and will even now repay perusal by the practical agriculturist. From the third edition of Hartlib's *Legacy*, we learn that clover was cut green, and given to cattle; and it appears that this practice of *soiling*, as it is now called, had become very common about the beginning of last century, wherever clover was cultivated. Rye-grass was now sown along with it. Turnips were hand-hoed, and extensively employed in feeding sheep and cattle, in the same manner as at present. Mortimer, 1706.

The first considerable improvement in the practice of that period was introduced by Jethro Tull, a gentleman of Berkshire, who began to drill wheat and other crops about the year 1701, and whose *Horse-hoeing Husbandry*, published in 1731, exhibits the first decided step in advance upon the principles and practices of his predecessors. Not contented with a careful attention to details, Tull set himself, with admirable skill and perseverance, to investigate the growth of plants, and thus to arrive at a knowledge of the principles by which the cultivation of field-crops should be regulated. Having arrived at the conclusion that the food of plants consists of minute particles of earth taken up by their rootlets, it followed, that the more thoroughly the soil in which they grew was disintegrated, the more abundant would be the "pasture" (as he called it), to which their fibres would have access. He was thus led to adopt that system of sowing his crops in rows or drills, so wide apart as to admit of tillage of the intervals, both by ploughing and hoeing, being continued until they had well-nigh arrived at maturity. Tull, 1731.

As the distance between his rows appeared much greater than was necessary for the range of the roots of the plants, he begins by showing that these roots extend much farther than is commonly believed, and then proceeds to inquire into the nature of their food. After examining several hypotheses, he decides this to be fine particles of earth. The chief, and almost the only use of dung, he thinks, is to divide the earth, to dissolve "this terrestrial matter, which affords nutriment to the mouths of vegetable roots;" and this can be done more completely by tillage. It is therefore necessary not only to pulverise the soil by repeated ploughings before it be seeded, but, as it becomes gradually more and more compressed afterwards, recourse must be had to tillage while the plants are growing; and this is *hoeing*, which also destroys the weeds that would deprive the plants of their nourishment.

The leading features of Tull's husbandry are his practice of laying the land into narrow ridges of five or six feet, and upon the middle of these drilling one, two, or three rows, distant from one another about seven inches when there were three, and ten when only two. The distance of the

[1] *Select Remains of John Ray*. Lond. 1760.
[2] Chalmers's *Caledonia*, vol. ii. p. 732.
[3] *Annals of Agriculture*, No. 270. Harte's *Essays*. Comber *on National Subsistence*, p. 161.
[4] Houghton's *Collections on Husbandry and Trade*, vol. i. p. 213, edit. 1728.
[5] *Ibid*. vol. iv. pp. 142–144.
[6] Houghton's *Collections on Husbandry and Trade*, vol. ii. p. 468.

Tull, continued.

plants on one ridge from those on the contiguous one he called an *interval;* the distance between the rows on the same ridge, a *space* or *partition;* the former was stirred repeatedly by the horse-hoe, the latter by the hand-hoe.

The extraordinary attention this ingenious person gave to his mode of culture is perhaps without a parallel:—

"I formerly was at much pains," he says, "and at some charge in improving my drills for planting the rows at very near distances, and had brought them to such perfection, that one horse would draw a drill with eleven shares, making the rows at three inches and a half distance from one another; and at the same time sow in them three very different sorts of seeds, which did not mix; and these, too, at different depths. As the barley-rows were seven inches asunder, the barley lay four inches deep. A little more than three inches above that, in the same channels, was clover; betwixt every two of these rows was a row of St Foin, covered half an inch deep.

"I had a good crop of barley the first year; the next year two crops of broad clover, where that was sown; and where hop-clover was sown, a mixed crop of that and St Foin; but I am since, by experience, so fully convinced of the folly of these, or any other mixed crops, and more especially of narrow spaces, that I have demolished these instruments, in their full perfection, as a vain curiosity, the drift and use of them being contrary to the true principles and practice of horse-hoeing."[1]

In the culture of wheat, he began with ridges six feet broad, or eleven on a breadth of 66 feet; but on this he afterwards had fourteen ridges. After trying different numbers of rows on a ridge, he at last preferred two, with an intervening space of about 10 inches. He allowed only three pecks of seed for an acre. The first hoeing was performed by turning a furrow from the row, as soon as the plant had put forth four or five leaves; so that it was done before or at the beginning of winter. The next hoeing was in spring, by which the earth was returned to the plants. The subsequent operations depended upon the circumstances and condition of the land and the state of the weather. The next year's crop of wheat was sown upon the intervals which had been unoccupied the former year; but this he does not seem to think was a matter of much consequence.

"My field," he observes, "whereon is now the thirteenth crop of wheat, has shown that the rows may successfully stand upon any part of the ground. The ridges of this field were, for the twelfth crop, changed from six feet to four feet six inches. In order for this alteration the ridges were ploughed down, and then the next ridges were laid out the same way as the former, but one foot six inches narrower, and the double rows drilled on their tops; whereby, of consequence, there must be some rows standing on every part of the ground, both on the former partitions and on every part of the intervals. Notwithstanding this, there was no manner of difference in the goodness of the rows; and the whole field was in every part of it equal, and the best, I believe, that ever grew on it. It is now the thirteenth crop, likely to be good, though the land was not ploughed crossways."[2]

It follows, from this singular management, that Tull thought a succession of crops of different species altogether unnecessary; and he labours hard to prove against Dr Woodward, that the advantages of such a change under his plan of tillage were quite chimerical, though he seems to admit the benefit of a change of the seed itself.

In cultivating turnips he made the ridges of the same breadth as for wheat, but only one row was drilled on each. His management, while the crop was growing, differs very little from the present practice. When drilled on the level, it is impossible, he observes, to hoe-plough them so well as when they are planted upon ridges. But the seed was deposited at different depths, the half about four inches deep, and the other half exactly over that, at the depth of half an inch.

"Thus planted, let the weather be never so dry, the deepest seed will come up, but if it raineth immediately after planting, the shallow will come up first. We also make it come up at four times, by mixing our seed half new and half old, the new coming up a day quicker than the old. These four comings up give it so many chances for escaping the fly; it being often seen that the seed sown over night will be destroyed by the fly, when that sown the next morning will escape, and *vice versa:* or you may hoe-plough them when the fly is like to devour them; this will bury the greatest part of these enemies: or else you may drill in another row without new-ploughing the land."

Drilling and horse and hand hoeing seem to have been in use before the publication of Tull's book. "Hoeing," he says, "may be divided into deep, which is our horse-hoeing; and shallow, which is the English hand-hoeing; and also the shallow horse-hoeing used in some places betwixt rows, where the intervals are very narrow, as 16 or 18 inches. This is but an imitation of the hand-hoe, or a succedaneum to it, and can neither supply the use of dung nor fallow, and may be properly called scratch-hoeing." But in his mode of forming ridges his practice seems to have been original; his implements display much ingenuity; and his claim to the title of father of the present horse-hoeing husbandry of Great Britain seems indisputable. A translation of Tull's book was undertaken at one and the same time in France, by three different persons of consideration, without the privity of each other. Two of them afterwards put their papers into the hands of the third, M. du Hamel du Monceau, of the Royal Academy of Sciences at Paris, who published a treatise on husbandry, on the principles of Mr Tull, a few years after. But Tull seems to have had very few followers in England for more than thirty years. The present method of drilling and horse-hoeing turnips was not introduced into Northumberland till about the year 1780;[3] and it was then borrowed from Scotland, the farmers of which had the merit of first adopting Tull's management in the culture of this root about 1760. From Scotland it made its way, but slowly, into the southern parts of the island.

Tull's doctrines and practices being quite in advance of his own times, were, as is usual in such cases, vehemently opposed by his contemporaries. He was, in consequence, involved in frequent controversy, in conducting which he occasionally showed an asperity of temper which excites our regret, but which is not to be wondered at, when we consider the trials of patience which he encountered from the unreasonable opposition of the agricultural community to his improvements; the thwarting of his experiments by his own labourers, who, in their ignorant zeal against innovations, wilfully broke his machines, and disregarded his orders; and from acute and protracted bodily disease. The soundness of his views and practice, as regards turnip culture, came by-and-by to be acknowledged, and have since been generally adopted. But it was only some twenty-five years ago that his full merit began to be understood. The Rev. Mr Smith, in his *Word in Season,* about that time recalled attention to Tull's peculiar system of wheat culture in a way that startled the whole community; while Professor Way, in a series of eloquent lectures delivered before the Royal Agricultural Society, showed that his science was true in the main, and even more strikingly ahead of his times than his practice.

Among the English writers of this period may be mentioned Bradley, Lawrence, Hales, Miller, Ellis, Smith, Hill, Hitt, Lisle, and Home. Most of their works went through several editions in a few years,—at once a proof of the estimation in which they were held, and of the direction of the public mind towards investigating the principles and practice of agriculture.

Scotland: Progress.

Of the progress of the art in Scotland, till towards the end of the 17th century, we are almost entirely ignorant. The first work, written by Donaldson, was printed in 1697, under the title of *Husbandry Anatomized; or, an Inquiry into the Present Manner of Teiling and Manuring the*

[1] *Horse-hoeing Husbandry,* p. 62. Lond. 1762. [2] *Ibid.* p. 424.

[3] *Northumberland Survey,* p. 106.

Ground in Scotland. It appears from this treatise, that the state of the art was not more advanced at that time in North Britain than it had been in England in the time of Fitzherbert. Farms were divided into infield and outfield; corn crops followed one another without the intervention of fallow, cultivated herbage, or turnips, though something is said about fallowing the outfield; inclosures were very rare; the tenantry had not begun to emerge from a state of great poverty and depression; and the wages of labour, compared with the price of corn, were much lower than at present; though that price, at least in ordinary years, must appear extremely moderate in our times. Leases for a term of years, however, were not uncommon; but the want of capital rendered it impossible for the tenantry to attempt any spirited improvements.

Donaldson, 1697.

Donaldson first points out the common management of that period, which he shows to have been very unproductive, and afterwards recommends what he thinks would be a more profitable course.

"Of the dale ground," he says, "that is, such lands as are partly hills and partly valleys, of which sorts may be comprehended the greatest part of arable ground in this kingdom, I shall suppose a farmer to have a lease or tack of three score acres, at three hundred merks of rent per annum (£16, 13s. 4d. sterling). Perhaps some who are not acquainted with rural affairs may think this cheap; but those who are the possessors thereof think otherwise, and find difficulty enough to get the same paid, according to their present way of manuring thereof. But that I may proceed to the comparison, I shall show how commonly this farm-room is managed. It is commonly divided into two parts, viz., one-third croft, and two-thirds outfield, as it is termed. The croft is usually divided into three parts: to wit, one-third barley, which is always dunged that year barley is sown thereon; another third oats; and the last third peas. The outside field is divided into two parts, to wit, the one half oats, and the other half grass, two years successively. The product which may be supposed to be on each acre of croft, four bolls (three Winchester quarters), and that of the outfield, three (2¼ quarters); the quota is seven score bolls, which we shall also reckon at five pounds (8s. 4d.) per boll, cheap year and dear year one with another. This, in all, is worth £700 (£58, 6s. 8d. sterling).

"Then let us see what profit he can make of his cattle. According to the division of his lands there is 20 acres of grass, which cannot be expected to be very good, because it gets not leave to lie above two years, and therefore cannot be well swarded. However, usually, besides four horses, which are kept for ploughing the said land, ten or twelve nolt are also kept upon a farm-room of the above-mentioned bounds; but, in respect of the badness of the grass, as said is, little profit is had of them. Perhaps two or three stone of butter is the most that can be made of the milk of his kine the whole summer, and not above two heffers brought up each year. As to what profit may be made by bringing up young horses, I shall say nothing, supposing he keeps his stock good, by those of his own upbringing. The whole product, then, of his cattle cannot be reckoned above fifty merks (£2, 15s. 6d.) For, in respect his beasts are in a manner half-starved, they are generally small; so that scarce may a heffer be sold at above twelve pounds (£1 sterling). The whole product of his farm-room, therefore, exceeds not the value of £733 (£61, 1s. 8d. sterling), or thereabout."

The labourers employed on this farm were two men and one woman, besides a herd in summer, and other servants in harvest.

Donaldson then proceeds to point out a different mode of management, which he calculates to be more profitable; but no notice is taken of either clover or turnips as crops to be raised in his new course, though they are incidentally noticed in other parts of the work.

"I also recommend potatoes as a very profitable root for husbandmen and others that have numerous families. And because there is a peculiar way of planting this root, not commonly known in this country, I shall here show what way it is ordinary planted or set. The ground must be dry; and so much the better it is if it have a good soard of grass. The beds or riggs are made about eight foot broad, good store of dung being laid upon your ground; horse or sheep dung is the proper manure for them. Throw each potatoe or sett (for they were sometimes cut into setts) into a knot of dung, and afterwards dig earth out of the furrows, and cover them all over, about some three or four inches deep; the furrows left between your riggs must be about two foot broad, and little less will they be in depth before your potatoes be covered. You need not plant this root in your garden; they are commonly set in the fields, and wildest of ground, for enriching of it." As to their consumption, they were sometimes "boiled and broken, and stirred with butter and new milk; also roasted, and eaten with butter; yea, some make bread of them, by mixing them with oat or barley meal; others parboil them and bake with them apples, after the manner of tarts."

There is a good deal in this little treatise about sheep, and other branches of husbandry; and, if the writer was well informed, as in most instances he appears to have been, his account of prices, of wages, and generally of the practices of that period, is very interesting.

Belhaven, 1723.

The next work on the husbandry of Scotland is, *The Countryman's Rudiments, or an advice to the Farmers in East Lothian, how to labour and improve their grounds*, said to have been written by Lord Belhaven about the time of the Union, and reprinted in 1723. In this we have a deplorable picture of the state of agriculture in what is now the most highly improved county in Scotland. His lordship begins with a very high encomium on his own performance. "I dare be bold to say, there was never such a good easy method of husbandry as this, so succinct, extensive, and methodical in all its parts, published before." And he bespeaks the favour of those to whom he addresses himself, by adding, "neither shall I affright you with hedging, ditching, marling, chalking, paring, and burning, draining, watering, and such like, which are all very good improvements indeed, and very agreeable with the soil and situation of East Lothian; but I know ye cannot bear as yet a crowd of improvements, this being only intended to initiate you in the true method and principles of husbandry." The farm-rooms in East Lothian, as in other districts, were divided into infield and outfield.

"The infield (where wheat is sown) is generally divided by the tenant into four divisions or breaks, as they call them, viz, one of wheat, one of barley, one of pease, and one of oats, so that the wheat is sowd after the pease, the barley after the wheat, and the oats after the barley. The outfield land is ordinarily made use of promiscuously for feeding of their cows, horse, sheep, and oxen; 'tis also dunged by their sheep who lay in earthen folds; and sometimes, when they have much of it, they fauch or fallow a part of it yearly."

Under this management the produce seems to have been three times the seed; and yet, says his lordship, "if in East Lothian they did not leave a higher stubble than in other places of the kingdom, their grounds would be in a much worse condition than at present they are, though bad enough."—"A good crop of corn makes a good stubble, and a good stubble is the equalest mucking that is." Among the advantages of inclosures, he observes, "you will gain much more labour from your servants, a great part of whose time was taken up in gathering thistles and other garbage for their horses to feed upon in their stables; and thereby the great trampling and pulling up, and other destruction of the corns, while they are yet tender, will be prevented." Potatoes and turnips are recommended to be sown in the yard (kitchen-garden). Clover does not seem to have been in use. Rents were paid in corn; and, for the largest farm, which he thinks should employ no more than two ploughs, the rent was about six chalders of victual "when the ground is very good, and four in that which is not so good. But I am most fully convinced they should take long leases or tacks, that they may not be straitened with time in the improvement of their rooms; and this is profitable both for master and tenant."

Society of Improvers.

Such was the state of the husbandry of Scotland in the early part of last century. The first attempts at improvement cannot be traced farther back than 1723, when a number of land-holders formed themselves into a society, under the title of the *Society of Improvers in the Knowledge of Agriculture*

in Scotland. The Earl of Stair, one of their most active members, is said to have been the first who cultivated turnips in that country. The *Select Transactions* of this society were collected and published in 1743 by Mr Maxwell, who took a large part in its proceedings. It is evident from this book that the society had exerted itself in a very laudable manner, and apparently with considerable success, in introducing cultivated herbage and turnips, as well as in improving the former methods of culture. But there is reason to believe that the influence of the example of its numerous members did not extend to the common tenantry, who are always unwilling to adopt the practices of those who are placed in a higher rank, and supposed to cultivate land for pleasure rather than profit. Though this society, the earliest probably in the United Kingdom, soon counted upwards of 300 members, it existed little more than 20 years. Maxwell delivered lectures on agriculture for one or two sessions at Edinburgh, which, from the specimen he has left, ought to have been encouraged.

Maxwell, 1743.

In the introductory paper in Maxwell's collection, we are told, that—

> "The practice of draining, inclosing, summer fallowing, sowing flax, hemp, rape, turnip and grass seeds, planting cabbages after, and potatoes with, the plough, in fields of great extent, is introduced; and that, according to the general opinion, more corn grows now yearly where it was never known to grow before, these twenty years last past, than perhaps a sixth of all that the kingdom was in use to produce at any time before."

First Threshing-Machine

In this work we find the first notice of a threshing-machine: it was invented by Mr Michael Menzies, advocate, who obtained a patent for it. Upon a representation made to the society that it was to be seen working in several places, they appointed two of their number to inspect it; and in their report they say, that one man would be sufficient to manage a machine which would do the work of six. One of the machines was "moved by a great water-wheel and triddles," and another "by a little wheel of three feet diameter, moved by a small quantity of water." This machine the society recommended to all gentlemen and farmers.

The next work is by the same Mr Maxwell, printed in 1757, and entitled the *Practical Husbandman; being a collection of miscellaneous papers on Husbandry*, &c. In this book the greater part of the *Select Transactions* is republished, with a number of new papers, among which, an *Essay on the Husbandry of Scotland*, with a proposal for the improvement of it, is the most valuable. In this he lays it down as a rule, that it is bad husbandry to take two crops of grain successively, which marks a considerable progress in the knowledge of modern husbandry; though he adds, that in Scotland the best husbandmen after a fallow take a crop of wheat; after the wheat, peas; then barley, and then oats; and after that they fallow again. The want of inclosures was still a matter of complaint. The ground continued to be cropped so long as it produced two seeds; the best farmers were contented with four seeds, which was more than the general produce.

The first Act of Parliament for collecting tolls on the highway in Scotland was passed in 1750, for repairing the road from Dunglass bridge to Haddington. In ten years after, several Acts followed for the counties of Edinburgh and Lanark, and for making the roads between Edinburgh and Glasgow. The benefit which agriculture has derived from good roads it would not be easy to estimate. The want of them was one great cause of the slow progress of the art in former times.

The Revolution in 1688 was the epoch of that system of corn laws to which very great influence has been ascribed, both on the practice of agriculture and the general prosperity of the country. But for an account of these and later statutes on the subject, we must refer to the article CORN LAWS.

The exportation of wool was prohibited in 1647, in 1660, and in 1688; and the prohibition strictly enforced by subsequent statutes. The effect of this on its price, and the state of the wool trade, from the earliest period to the middle of last century, are distinctly exhibited by the learned and laborious author of *Memoirs on Wool*, printed in 1747.

CHAPTER II.

RECENT BRITISH AGRICULTURE.

Section 1.—Progress during the Eighteenth Century.

Before entering upon a description of the agriculture of Great Britain at the present day, it may help to set matters in a clearer light if we take just so much of a retrospect as will serve as a back-ground to our picture.

At the beginning of the 18th century the agriculture of our country was still of the rudest kind. With the exception of certain parts of England, the land was still for the most part unenclosed, the live stock of each township grazing together, and the arable land being occupied in common field or run-rig. The practice of fallowing annually a portion of the arable land, and of interposing a crop of peas betwixt the cereal crops, was becoming a common practice, and was a great improvement upon the previous and yet common usage of growing successive crops of white-corn until the land was utterly exhausted, when it was left to recruit itself by resting in a state of nature, while other portions were undergoing the same process. Clover and turnips had been introduced before this date, and were coming gradually into cultivation as field crops in the more advanced parts of England. Potatoes were commonly grown in gardens, but had not yet found their way to the fields.

The gradual advance in the price of farm produce soon after the year 1760, occasioned by the increase of population and of wealth derived from manufactures and commerce, gave a powerful stimulus to rural industry, augmented agricultural capital, and called forth a more skilful and enterprising race of farmers. The arable lands of the country, which, under the operation of the feudal system, had been split up into minute portions, cultivated by the tenants and their families without hired labour, began now to be consolidated into larger holdings, and let to those tenants who possessed most energy and substance. This enlargement of farms, and in Scotland the letting of them under leases for a considerable term of years, continued to be a marked feature in the agricultural progress of the country until the end of the century, and is to be regarded both as a cause and a consequence of that progress. The passing of more than 3000 inclosure bills during the reign of Geo. III., before which the whole number was but 244, shows how rapidly the cultivation of new land now proceeded. The disastrous American war for a time interfered with the national prosperity; but with the return of peace in 1783, the cultivation of the country made more rapid progress. The quarter of a century immediately following 1760, is memorable in our agricultural annals for the introduction of various important improvements. It was during this period that the genius of Bakewell produced such an extraordinary change in the character of our more important breeds of live stock; but especially by the perfecting of a new race of sheep—the well-known Leicesters—which have ever since proved such a boon to the country, and have added so much to its wealth. Bakewell's fame as a breeder was for a time enhanced by the improvement which he effected on the long-horned cattle, then the

prevailing breed of the midland counties of England. These, however, were ere long rivalled, and have now been entirely superseded by the shorthorn or Durham breed, which the brothers Colling obtained from the useful race of cattle that had long existed in the valley of the Tees, by applying to them the principle of breeding which Bakewell had already established. A more rational system of cropping now began very generally to supersede the thriftless and barbarous practice just referred to of sowing successive crops of corn until the land was utterly exhausted, and then leaving it foul with weeds, to recover its power by an indefinite period of rest. Green crops, such as turnips, clover, and ryegrass, began to be alternated with grain crops, and hence the name *alternate husbandry*, by which this improved system is generally known. The land was now also generally rendered clean and mellow by a summer fallow before being sown with clover or grasses.

Hitherto the husbandry of England had been very superior in every respect to that of Scotland. Improvements now, however, made rapid progress in the latter. Mr Dawson, at Frogden, in Roxburghshire, is believed to have been the first who grew turnips as a field crop to any extent. This enterprising farmer having heard of the success with which this crop was cultivated in certain parts of England, took the precaution of seeing for himself the most approved mode of doing so before attempting to introduce it on his own farm. He accordingly went to Leicestershire, and presenting himself to the celebrated Bakewell in the garb of a Scotch ploughman, hired himself to him for six months in that capacity. Having in this thoroughly practical way acquired the knowledge he was in quest of, he told his employer (who would fain have retained him longer) that it was full time for him to be home to his own large farm. The season was too advanced to admit of his doing more that year than sow a few experimental drills, but the very next year he is said to have sown 70 acres. We have been unable to ascertain the exact date of this occurrence, but it is on record that as early as 1764 Mr Dawson had 100 acres of drilled turnips on his farm in one year.

Culley.

A few years after this the Messrs Culley—one of them also a pupil of Bakewell—left their paternal property on the banks of the Tees, and settled on the Northumbrian side of the Tweed, bringing with them the valuable breeds of live stock and improved husbandry of their native district. The improvements introduced by these energetic and skilful farmers spread rapidly, and exerted a most beneficial influence upon the border counties. An Act passed in 1770, which relaxed the rigour of strict entails, and afforded power to landlords to grant leases and otherwise improve their estates, had a beneficial effect on Scottish agriculture. From 1784 to 1795 improvements advanced with steady steps. This period was distinguished for the general adoption and industrious working out of ascertained improvements. Small's swing plough, and Meikle's thrashing-machine, although invented some years before this, were now perfected and brought into general use, to the great furtherance of agriculture. Two important additions were about this time made to the field crops, viz., the Swedish turnip and potato oat. The latter was accidentally discovered in 1788, and both soon came into general cultivation. in the same year Merino sheep were introduced by his Majesty, George III., who was a zealous farmer. For a time this breed attracted much attention, and sanguine expectations were entertained that it would prove of national importance. Its unfitness for the production of mutton, and increasing supplies of fine clothing wool from other countries, soon led to its total rejection.

In Scotland, the opening up of the country by the construction of practicable roads, and the enclosing and subdividing of farms by hedge and ditch, was now in active progress. The former admitted of the general use of wheel-carriages, of the ready conveyance of produce to markets, and in particular, of the extended use of lime, the application of which was immediately followed by a great increase of produce. The latter, besides its more obvious advantages, speedily freed large tracts of country from stagnant water, and their inhabitants from ague, and prepared the way for the under-ground draining which soon after began to be practised.

Section 2.—Remarkable progress from 1795 *to* 1815.

The agriculture of the country was thus steadily improving, when suddenly the whole of Europe became involved in the wars of the French Revolution. In 1795, under the joint operation of a deficient harvest, and the cutting off of foreign supplies of grain by the policy of Napoleon, the price of wheat, which, for the twenty preceding years, had been under 50s. a quarter, suddenly rose to 81s. 6d., and in the following year reached to 96s. In 1797 the fear of foreign invasion led to a panic and run upon the banks, in which emergency the Bank Restriction Act, suspending cash payment, was passed, and ushered in a system of unlimited credit transactions. Under the unnatural stimulus of these extraordinary events, every branch of industry extended with unexampled rapidity. But in nothing was this so apparent as in agriculture; the high prices of produce holding out a great inducement to improve lands then arable, to reclaim others that had previously lain waste, and to bring much pasture-land under the plough. Nor did this increased tillage interfere with the increase of live stock, as the green crops of the alternate husbandry more than compensated for the diminished pasturage. This extraordinary state of matters lasted from 1795 to 1814; the prices of produce even increasing towards the close of that period. The average price of wheat for the whole period was 89s. 7d. per quarter; but for the last five years it was 107s., and in 1812 it reached to 126s. 6d. The agriculture of Great Britain, as a whole, advanced with rapid strides during this period; but nowhere was the change so great as in Scotland. Indeed, its progress there, during these twenty years, is probably without parallel in the history of any other country. This is accounted for by a concurrence of circumstances. Previous to this period, the husbandry of Scotland was still in a backward state as compared with the best districts of England, where many practices, only of recent introduction in the north, had been in general use for generations. This disparity made the subsequent contrast the more striking. The land in Scotland was now, with trifling exceptions, let on leases for terms varying from twenty to thirty years, and in farms of sufficient size to employ at the least two or three ploughs. The unlimited issues of Government paper, and the security afforded by these leases, induced the Scotch banks to afford every facility to landlords and tenants to embark capital in the improvement of the land. The substantial education supplied by the parish schools, of which nearly the whole population could then avail themselves, had diffused through all ranks such a measure of intelligence as enabled them promptly to discern, and skilfully and energetically to take advantage of this spring-tide of prosperity, and to profit by the agricultural information now plentifully furnished by means of the Bath and West of England Society, established in 1777, the Highland Society, instituted in 1784, and the National Board of Agriculture, in 1793—of which, however, more anon. As one proof of the astonishing progress of Scottish husbandry during this period, we may mention that the rental of land, which in 1795 amounted to £2,000,000, had in 1815 risen to

£5,278,685, or considerably more than double in twenty years.

But of the causes which have influenced the agriculture of the period under review, none have been so powerful as the extraordinary increase of our population, which, in round numbers, has twice doubled during the past seventy years. Not only are there four times as many people requiring to be fed and clad now as there were then, but from the increased wealth and altered habits of the people, the individual rate of consumption is greater now than formerly. This is particularly apparent in the case of butcher-meat, the consumption of which has increased out of all proportion to that of bread-corn. To meet this demand, there behoved to be more green crops and more live stock; and from that has resulted more wool, more manure, and more corn. While this ever-growing demand for farm-produce has stimulated agricultural improvement, it has also operated in another way. The productiveness of the soil has been greatly increased, and will no doubt be still more so in future; but the area of the country cannot be increased. Land—the raw material from which food is produced—being thus limited in amount and in increasing demand, has necessarily risen in price. So much is this the case, that whereas the average price of wheat for the five years preceding 1872 was £2, 15s. per quarter, or £2, 7s. 6d. less than during the five years preceding 1815, the rent of land is much higher now than it was then. The raw material of the food-grower having thus risen in price, his only resource has been to fall upon plans for lowering the cost of producing his crops and for increasing their amount. To such an extent has he succeeded, that the produce market has been kept full, and prices have decreased. The business of farming has in the main been a less prosperous one than most other branches of national industry, and yet agriculture, as an art and as a science, has made steady progress. We believe it is only in this way that the contemporaneous existence of two things apparently so incompatible as a steady rise in the rent of land, and a steady decrease in the price of its produce, can be satisfactorily accounted for.

PROGRESS SINCE 1815

Section 3.—Laws affecting Agriculture.

The abundant crop of 1813, and restored communication with the continent of Europe in the same year, gave the first check to these unnaturally exorbitant prices and rents. The restoration of peace to Europe, and the re-enactment of the Corn Laws in 1815, mark the commencement of another era in the history of our national agriculture. It was ushered in with a time of severe depression and suffering to the agricultural community. The immense fall in the price of farm-produce which then took place was aggravated, first, by the unpropitious weather and deficient harvest of the years 1816, 1817; and still more by the passing in 1819 of the Bill restoring cash payments, which, coming into operation in 1821, caused serious embarrassment to all persons who had entered into engagements at a depreciated currency, which had now to be met with the lower prices of an enhanced one. The much-debated Corn Laws, after undergoing various modifications, and proving the fruitful source of business uncertainty, social discontent, and angry partizanship, were finally abolished in 1846, although the Act was not consummated until three years later. Several other Acts of the Legislature, passed during this period, have exerted an important influence on agriculture. Of these, the first in date and importance is the Tithe Commutation Act of 1836. All writers on agriculture had long concurred in pointing out the injurious effects on agriculture of the tithe system as it then stood. The results of the change have amply verified the anticipations of those who were instrumental in procuring it. Since the removal of this formidable hindrance, improvement has been stimulated by those Acts under which the Government has been empowered to advance money on certain conditions for the draining of estates. An important feature in these advances is, that the $6\frac{1}{2}$ per cent. of interest charged upon them provides a sinking fund by which the debt is extinguished in twenty-two years. Additional facilities have also been granted by the Act passed in 1848 for disentailing estates, and for burdening such as are entailed with a share of the cost of certain specified improvements.

Section 4.—Cattle Murrain and Potato Disease.

Another class of outward events, which has had an important influence upon agriculture, requires our notice. We refer to those mysterious diseases affecting both the animal and vegetable kingdoms, the causes and remedies for which have alike baffled discovery. The murrain, or "vesicular epizootic," appeared first in 1841, having been introduced, as is supposed, by foreign cattle. It spread rapidly over the country, affecting all our domesticated animals, except horses, and causing everywhere great alarm and loss, although seldom attended by fatal results. It has prevailed ever since, in a greater or less degree, and has been more widely diffused as well as more virulent in 1871 and 1872 than ever before. It was soon followed by the more terrible lung-disease, or pleuro-pneumonia, which continues to cause serious mortality among our herds. In 1865 the rinderpest, or steppe murrain, originating amongst the vast herds of the Russian steppes, where it would appear to be never altogether wanting, had spread westward over Europe, until it was brought to London by foreign cattle. Several weeks elapsed before the true character of the disease was known, and in this brief space it had already been carried by animals purchased in Smithfield market to all parts of the country. After causing the most frightful losses, it was at last stamped out by the resolute slaughter of all affected animals and of all that had been in contact with them. In the autumn of 1872 this cattle plague was again detected in several cargoes of foreign cattle brought to our ports. Happily the stringent provisions of the Contagious Diseases (Animals) Act had the effect of preventing its entrance, except in the case of one cargo brought to Hull, from which the plague was conveyed to several herds in the adjacent parts of Yorkshire, and caused considerable losses before it was again stamped out. Severe as have been the losses in our flocks and herds from these imported diseases, they have been as nothing in comparison with the effects of the mysterious potato blight, which, first appearing in 1845, has since pervaded the whole of Europe, and in Ireland especially proved the sad precursor of famine and pestilence. This seemingly insignificant blight for a time well-nigh withdrew from cultivation one of our most esteemed field crops; it influences the business of farming in a way that baffles the shrewdest calculators, and is producing social changes of which no man can predict the issue.

Section 5.—Leading Improvements.

We can here do little more than enumerate some of the more prominent improvements in practical agriculture which have taken place during the period under review. Before the close of the past century, and during the first quarter of the present one, a good deal had been done in the way of draining the land, either by open ditches, or by Elkington's system of deep covered drains. This system has now been superseded by one altogether superior to it both in principle and practice. In 1835, James Smith of Deanston (honour to his memory!) promulgated his now well-known

system of thorough draining and deep ploughing. It has been carried out already to such an extent as to alter the very appearance and character of whole districts of our country, and has prepared the way for all other improvements. The words "Portable Manures" indicate at once another prominent feature in the agriculture of the times. Early in the present century, ground bones began to be used as a manure for turnips in the eastern counties of England, whence the practice spread, at first slowly, and then very rapidly, over the whole country. It was about 1825 that bones began to be generally used in Scotland. In 1841 the still more potent guano was introduced into Great Britain; and about the same time, bones, under the new form of superphosphate of lime. By means of these invaluable fertilisers, a stimulus has been given to agriculture which can scarcely be over-rated.

The labour of agriculture has been greatly lightened, and its cost curtailed, by means of improved implements and machines. The steam-engine has taken the place of the jaded horses as a thrashing power. This was first done in East Lothian by Mr Aitchison of Drumore, who about 1803 had his thrashing-machinery, at his distillery and farm of Clement's Wells, attached to a steam-engine, which was erected for him a few years previously by Bolton and Watt, for the works of the distillery. About 1818–20 several steam-engines on the condensing principle were erected in East Lothian, solely for the propelling of thrashing-machinery. One of these, put up by Mr Reid of Drem, at a cost of £600, is still doing its work there, and, strange to say, after the lapse of fifty-five years, looks as well and is as efficient as when first erected. It would be tedious to particularise other instances in this department, as it will be treated of fully in its proper place. It is especially in this department that the influence of the ever-memorable Exhibition of the Industry of all Nations in 1851 has told upon agriculture. Reaping by machinery may virtually be regarded as one of the fruits of that great gathering.

The railways, by which the country is now intersected in all directions, have proved of great service to farmers, by conveying their bulky produce to distant markets cheaply and quickly, and by making lime and other manures available to the occupiers of many inland and remote districts. In nothing has this benefit been more apparent than in the case of fatted live stock, which is now invariably transported by this means, with manifest economy to all concerned.

During the whole of this period there has been going on great improvement in all our breeds of domesticated animals. This has been manifested not so much in the production of individual specimens of high merit—in which respect the Leicesters of Bakewell, or the short-horns of Colling, have perhaps not yet been excelled—as in the diffusion of these and other good breeds over the country, and in the improved quality of our live stock as a whole. The fattening of animals is now conducted on more scientific principles. Increased attention has also been successfully bestowed on the improvement of our field crops. Improved varieties, obtained by cross-impregnation, either naturally or artificially brought about, have been carefully propagated, and generally adopted. Increased attention is now bestowed on the cultivation of the natural grasses. The most important additions to our list of field crops during this period have been Italian rye-grass, winter beans, white Belgian carrot, sugar beet, and alsike clover.

Section 6.—Increase and Diffusion of Agricultural Knowledge.

Let us look now at the means by which, during this period, agricultural knowledge has at once been increased and diffused. Notice has already been taken of the institution of the Highland Society and the National Board of Agriculture. These patriotic societies were the means of collecting a vast amount of statistical and general information connected with agriculture, and by their publications and premiums made known the practices of the best-farmed districts of the country, and encouraged their adoption elsewhere. These national associations were soon aided in their important labours by numerous local societies which sprang up in all parts of the kingdom. After a highly useful career, under the zealous presidency of Sir John Sinclair, the Board of Agriculture was dissolved, but has left in its Statistical Account, county surveys, and other documents, much interesting and valuable information regarding the agriculture of that period. In 1800 the original *Farmers' Magazine* entered upon its useful career under the editorship of Robert Brown of Markle, the author of the well-known treatise on *Rural Affairs*. The Highland Society having early extended its operations to the whole of Scotland, by-and-by made a corresponding addition to its title, and as the Highland and Agricultural Society of Scotland continues to occupy its important sphere with a steadily increasing membership, popularity, and usefulness. As its revenue and experience increased, it gradually extended its operations. In 1828, shortly after the discontinuance of the *Farmers' Magazine*, its *Prize Essays and Transactions* began to be issued statedly in connection with the *Quarterly Journal of Agriculture*, a periodical which until recently occupied a prominent place in our professional literature. This society early began to hold a great annual show of live stock, implements, &c., the popularity of which continues unabated. In 1842, Mr John Finnie at Swanstone, near Edinburgh, having suggested to some of his neighbours the desirableness of obtaining the aid of chemistry to guide farmers in many departments of their business, the hint was promptly acted upon, and these Mid-Lothian tenant-farmers had the merit of originating an Agricultural Chemistry Association (the first of its kind), by which funds were raised, and an eminent chemist engaged, for the express purpose of conducting such investigations as the title of the society implies. After a successful trial of a few years this association was dissolved, transferring its functions to the Highland and Agricultural Society, which has ever since devoted much of its attention to this subject. The nature and importance of the services which labourers in this department of science have rendered to agriculture may be gathered from the society's Transactions, and numerous other publications of a similar kind. The Highland Society has of late years established itself on a broader basis, and imparted new energy to its operations by lowering its admission-fee in behalf of tenant-farmers, who have in consequence joined it in great numbers, and now take an important part in the conduct of its business. The practice adopted by it, about the same time, of holding periodical meetings for the discussion of important practical questions, by means of essays, prepared by carefully selected writers, did good service, too, to the cause of agricultural progress.

The adoption by Government of a proposal made by this society, to collect the agricultural statistics of Scotland, showed at once how thoroughly it enjoyed the confidence of the tenantry, and how easily, and by what simple and inexpensive machinery, this most important and interesting inquiry could be conducted. Through an unfortunate misunderstanding between the Government and the society on a mere technical point, this most useful inquiry came to an abrupt termination, after having been conducted for five years. This brief experiment had, however, proved so conclusively the value of such statistics, and the ease with which they could be collected, that the Government soon

after took the matter in hand, and has ever since, through the agency of the officers of Inland Revenue, obtained annual returns of cropping and live stock for the whole of Great Britain.

The obvious success of this National Scottish Society has led to the formation of similar ones in England and in Ireland. The former, instituted in 1838, and shortly afterwards incorporated by royal charter, at once entered upon a career of usefulness, the extent of which cannot well be over-rated. Its membership—comprising the most influential persons in the kingdom—and its revenues are now so large as to enable it to conduct its proceedings on a scale befitting its position and objects. These are of a varied character, but its efforts are concentrated upon its journal and annual show. The former, published twice a-year, is chiefly composed of the essays and reports to which the liberal prizes of the society have been awarded, and undoubtedly stands at the head of our present agricultural periodicals. At the annual shows of the society, a prominent place is assigned to implements and machines. Such as admit of it, are subjected to comparative trials, which are conducted with such skill and pains that the awards command the entire confidence of exhibitors and their customers. The extent and rapidity of the improvement in agricultural machinery which the society has been mainly instrumental in effecting are altogether extraordinary.

There are few market towns of any importance that have not their organised club or occasional gathering of the farmers in their neighbourhood, for the discussion of professional topics. We have now also a goodly list of agricultural periodicals, both weekly and monthly, most of them ably conducted, which are extensively read, and are the means of collecting and diffusing much valuable knowledge, which, but for them, would often, as in former times, perish with its authors, or be confined to corners. The facilities now afforded by railways for cheap and expeditious travelling, induce most farmers to take an occasional peep at what is going on beyond their own neighbourhood. This, more than anything, deals death-blows to prejudices, and extends good husbandry.

Literature. The literature of agriculture has been enriched by the contributions of many able writers. Some deserve to be particularly mentioned. The volumes of the late David Low, Esq., on *Practical Agriculture*, *Landed Property and Economy of Landed Estates*, and *Domesticated Animals*, must ever be of standard authority on their respective subjects. Mr Henry Stephens' *Book of the Farm*, and Mr J. C. Morton's *Cyclopædia of Agriculture*, are invaluable to the agricultural student for their fulness, and for the minuteness of their details. Mr Caird's *English Agriculture* supplies the means for a most interesting comparison with the descriptions left to us by Arthur Young. Mr Hoskyn's *History of Agriculture* and *Chronicles of a Clay Farm* are the very gems of our professional literature. In a series of essays on our *Farm Crops* by Professor John Wilson of Edinburgh, the scientific and the practical are most happily combined. Among the more recent publications of value may be mentioned Loudon's *Encyclopædia; How Crops Grow*, by Mr Johnson; M'Combie's *Cattle and Cattle-Breeders;* Mechi's *How to Farm Profitably;* Hozier's *Practical Remarks on Agricultural Drainage;* Todd's *American Wheat Culturist*, &c. Johnston, Anderson, Way, and Voelcker, have done admirable service in expounding the chemistry of agriculture; Youatt, Spooner, and Vasey, its zoology; and Smith, Parkes, Webster, Bailey, Denton, Scott Burn, and Starforth, its engineering, mechanics, and architecture.

In reviewing the history of our national agriculture for the past sixty years, it is pleasing to note the growing intelligence displayed by our agriculturists in the prosecution of their calling. It is curious, also, to observe the analogy between the order of that progress, and that which is usually observed in individual minds. For a long time we see agricultural societies and writers occupying themselves chiefly about the practical details and statistics of husbandry, and attaching much importance to empirical rules. Gradually, however, we observe, along with a zealous collecting of facts, a growing disposition to investigate the *causes* of things, and desire to know the *reason* why one practice is preferable to another. When, therefore, the Royal Agricultural Society adopted as its motto, "Practice with Science," it expressed not more the objects to be aimed at in its own proceedings, than the characteristic feature of our present stage of agricultural progress.

CHAPTER III.

PRACTICE OF BRITISH AGRICULTURE.

We shall now endeavour to present a picture of British agriculture in its present state. In doing this, we shall take much the same course which we should pursue, if we were asked to conduct a visitor over our own farm, and to give him a detailed account of its cultivation and management. In the case supposed, we should, first of all, explain to him that the farm comprises a great diversity of *soils;* that its fields are very variously circumstanced as regards *climate*, altitude, exposure, and distance from the homestead; and that in its *tillage*, cropping, and general management, regard must be had to these diversities, whether natural or artificial. We should then conduct him through the homestead, pointing out the position and uses of the various *farm buildings* and of the *machinery* and *implements* contained in them. From thence we should proceed to the fields to examine their *fences* and the *tillage operations*. With some observations about the *succession of crops*, and the *manures* applied to them, there would follow an examination of the *cultivated crops*, *pastures*, and *meadows*, of the *live stock* of the farm, and of the measures adopted in reclaiming certain *waste lands* belonging to it. This survey being completed, there would naturally follow some discussion about the *tenure* of land, the *capital* required for its profitable cultivation, the condition of *farm labourers*, the necessity for devoting more attention to the *education* of the agricultural community, and the duty of the Legislature to remove certain *obstructions* to agricultural improvement.

Section 1.—*Soils.*

The soil constituting the subject-matter on which the husbandman operates, its character necessarily regulates to a large extent the nature of his proceedings. The soil or surface covering of the earth in which plants are produced is exceedingly varied in its qualities. Being derived from the disintegration and decomposition of the rocks which constitute the solid crust of the globe, with a mixture of vegetable and animal remains, soils take their character from that of the rocks from which they have chiefly been derived. There is thus a generally prevailing resemblance between the soils of a district and the rocks over which they lie, so that a knowledge of the composition of the one affords a key to the character of the other. But this connection is modified by so many circumstances, that it is altogether impossible by the mere study of geology to acquire an easy and certain rule for determining the agricultural character of the soil of any particular district or field, as it has been the fashion with some writers of late years to assert. "When, indeed, we regard a considerable tract of land, we can for the most part trace a connection between the subjacent deposits and the subsoil, and consequently the soil. Thus, in a country of

sandstone and arenaceous beds, we shall find the soil sandy; in one of limestone, more or less calcareous; in one of schistose rocks, more or less clayey. But even in tracts of the same geological formation, there exist great differences in the upper stratum, arising from the prevalence of one or other member of the series, or from the greater or less inclination of the strata, by which the debris of the different beds are more or less mixed together on the surface. The action of water, too, in denuding the surface at one part, and carrying the debris in greater or smaller quantity to another, exercises everywhere an important influence on the character of soils. Thus the fertility of a soil on the higher ground, from which the earthy particles are washed, is found to be very different from that of the valley to which these particles are carried. It is seen accordingly, that within the limits of the same geological formation, soils are greatly varied, and that the mere knowledge of the formation will not enable us to predicate the character of the soil of any given tract, either with respect to its texture, its composition, or its productiveness."[1] Even a very limited acquaintance with the geology of Great Britain serves, however, to account for the exceedingly diversified character of its soils. The popular definitions of soils—and to these it is safest for practical farmers to adhere—have respect to their most obvious qualities. Thus they are designated from their composition, as *clays, loams, sands, gravels, chalks,* or *peats;* or from their texture, in which respect those in which clay predominates are called *heavy, stiff,* or *impervious;* and the others *light, friable,* or *porous.* From the tendency of the former to retain moisture they are often spoken of as *wet* and *cold,* and the latter, for the opposite reason, as *dry* and *warm.* According to their measure of fertility, they are also described as *rich* or *poor.* The particular crops for the production of which they are respectively considered to be best adapted have also led to clays being spoken of as *wheat* or *bean soils,* and the friable ones as *barley* and *turnip soils.* This latter mode of discriminating soils is, however, becoming every day less appropriate; as those of the lighter class, when sufficiently enriched by suitable manuring, are found the most suitable of all for the growth of wheat; while the efforts of agriculturists are now successfully directed to the production of root crops on soils so strong as heretofore to have been reckoned unfit for the purpose. But still, such extreme diversities as we everywhere meet with in our soils must necessarily lead to a corresponding diversity in their agricultural treatment, and hence the necessity for keeping this fact prominently in view in every reference to British agriculture as a whole.

Section 2.—Influence of Climate.

But if diversity of soil necessarily modifies the practice of the husbandman, that of climate does so far more powerfully. The soils of the different parts of the globe do not very materially differ from each other, and yet their vegetable products vary in the extreme. This is chiefly owing to difference of temperature, which decreases more or less regularly as we recede from the equator, or ascend from the sea-level. Places in the same latitude and at the same elevation are found, however, to vary exceedingly in temperature, according to their aspect, the prevailing winds to which they are exposed, their proximity to seas or mountains, and the condition of their surface. The different parts of Great Britain are accordingly found to possess very different climates. In passing from south to north, its mean temperature may be taken to decrease one degree Fahrenheit for every 80 miles of latitude, and the same for every 300 feet of elevation. The temperature of the west side of our island also differs materially from that of the east, being more equal throughout the year. This is owing to the prevalence of mild westerly winds charged with moisture, which, while they equalise the temperature, cause the average fall of rain on the west side of Britain to be in many cases double, and in some nearly three times that on the opposite side. In the central parts of England cultivation is carried on at 1000 feet of elevation, but 800 may be taken as the ordinary limit. In Scotland the various crops are usually from two to three weeks later in coming to maturity than in England. In both divisions of the island the western counties, owing to their mild and humid climate, are chiefly devoted to pasturage, and the eastern, or dry ones, to tillage. As compared with the continent of Europe, our summers are neither so hot, our winters so cold, nor our weather so steady. We want, therefore, many of its rich products, but, on the other hand, our milder winter and moister climate are eminently favourable to the production of pasturage and other cattle crops, and admit of agricultural operations being carried on more regularly throughout the year. Indeed, looking to the immense varieties of the products of our soil, there is probably no other country so favourably circumstanced for a varied and successful agriculture.

Section 3.—Influence of Population, &c.

Besides those variations in the agricultural practice of this country which arise from diversities of soil and climate, there are others which are due to the distribution of the population. The proximity of cities and towns, or of populous villages, inhabited by a manufacturing or mining population, implies a demand for dairy produce and vegetables, as well as for provender and litter, and at the same time affords an ample supply of manure to aid in their reproduction. Such commodities, from their bulk or perishable nature, do not admit of long carriage. The supplies of these must therefore be drawn from comparatively limited areas, and the character of the husbandry pursued there is determined apart from those general influences previously referred to. From these and other causes there is a diversity in the practice of British agriculture which increases the difficulty of describing it accurately. Indeed, it is so well known that there are peculiarities of character attaching to almost every individual field and farm, and still more to every different district or county, which demand corresponding modifications of treatment in order to their successful cultivation, that a prudent man, if required to take the management of a farm in some district greatly inferior in its general system of farming to that which he may have left, will yet be very cautious in innovating upon specific practices of the natives.

To such peculiarities it is obviously impracticable to refer in such a treatise as the present. They are referred to now because they suggest an explanation of some of those discrepancies in the practice and opinions of farmers, equally successful in their respective localities, which we constantly meet with; and because, in proceeding to delineate the practice of Berwickshire, where our personal experience has been gained by upwards of forty years of actual farming, we would deprecate the idea of claiming for its modes a superiority over those of other districts. Its geographical position, and the mixed husbandry pursued in it, would justify, in some measure, its being referred to as a fair sample of the national agriculture. But it is on the specific ground that it is best to speak from actual experience as far as that will serve, that we vindicate this selection.

[1] Low's *Practical Agriculture*, p. 42.

CHAPTER IV.

FARM-BUILDINGS.

Section 1.—*General Requisites.*

In pursuance of the plan already indicated, let us now refer for a little to *Farm-Buildings*. We have spoken of the soil as the raw material upon which the farmer operates: his homestead may, in like manner, be regarded as his manufactory. That it may serve this purpose in any good measure, it is indispensable that the accommodation afforded by it be adequate to the extent of the farm, and adapted to the kind of husbandry pursued upon it. It should be placed upon a dry, sunny, sheltered site, have a good supply of water, and be as near as possible to the centre of the farm. The buildings should be so arranged as to economise labour to the utmost. It should be constructed of substantial materials, so as to be easily kept in repair, and to diminish, to the utmost, risk from fire.

The most cursory examination of existing homesteads will suffice to show that in their construction these obvious conditions have been sadly neglected. For one farm really well equipped in this respect, hundreds are to be met with in all parts of the kingdom, and more especially in England, most wretchedly deficient. Wherever this is the case, it is impossible that the farmer, however skilful or industrious, can make the most of his materials, or compete on equal terms with his better furnished neighbours. As the agricultural community becomes more generally alive to the importance of economising labour by a judicious arrangement of buildings, and of reducing the cost of the production of beef (and adding to the amount and fertilising power of the home-made manure) by the manner in which the live stock is housed, we may hope that improvement in this department will make rapid progress. Tenants will refuse to embark their capital, and waste their skill and labour, on farms unprovided with suitable apparatus for cultivating them to the best advantage. Landlords and their agents will by-and-by find that until this is done, they must put up with an inferior tenantry, an antiquated husbandry, and with lower and worse-paid rents.

Section 2.—*Plans.*

In erecting new homesteads, or in making considerable additions to or alterations upon existing ones, it is of much importance to call in the aid of an architect of ascertained experience in this department of his art, and then to have the work performed by contracts founded upon the plans and specifications which he has furnished. A reasonable sum thus expended will be amply returned in the cost, trouble, and disappointment, which it usually saves to both landlord and tenant. It is to be hoped that in future a greater number of thoroughly qualified architects will devote themselves to this department of their profession, and that they will meet with adequate encouragement. It is not, therefore, with the view of superseding their services, but simply to illustrate our references to existing practices, that we subjoin a plan of farm-buildings.

While protesting against the utter rudeness and inadequacy of the great majority of homesteads, we must also deprecate the hurtful expenditure sometimes lavished in erecting buildings of an extent and style altogether disproportionate to the size of the farm, and out of keeping with its homely purposes. When royalty or nobility, with equal benefit to themselves and their country, make agriculture their recreation, it is altogether befitting that in such cases the farm-yard should be of such a style as to adorn the park in which it is situated. And even those intended for plain everyday farming need not be unsightly; for ugliness is sometimes more costly than elegance. Let utility, economy, and comfort, first be secured, and, along with these, as much as possible of that pleasing effect which arises from just proportions, harmonious arrangement, and manifest adaptation to the use the buildings are designed for.

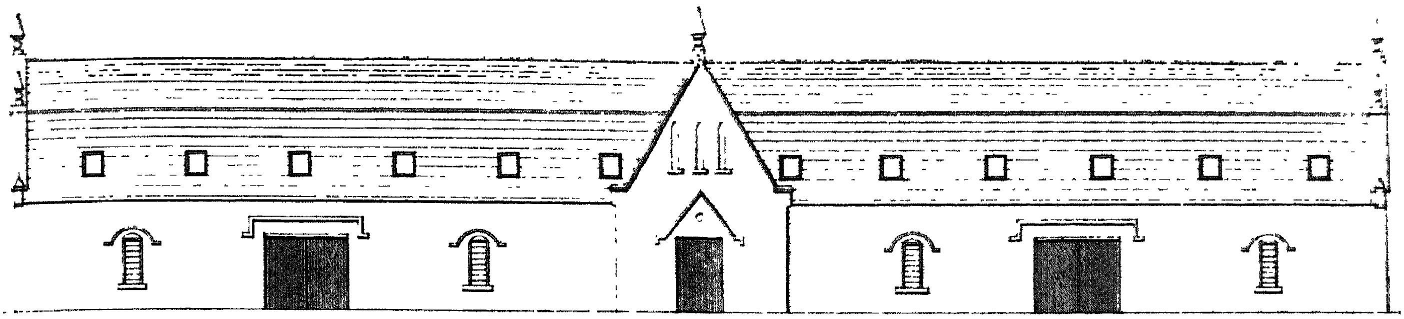
Section 3.—*Principles of Arrangement.*

The barn, with its thrashing-machinery, and other appurtenances, naturally forms the nucleus of the homestead, and regulates the distribution of the other buildings. The command of water-power will often determine the exact site of the barn, and indeed of the whole buildings. The cheapness and safety of this motive-power render it well worth while to make considerable sacrifices to secure it, when a really sufficient and regular supply of it can be had. But the difficulty of securing this when the adjoining lands are thoroughly drained, and the great efficiency and facility of application of steam-power, are good reasons why precarious supplies of water-power should now be rated very differently than they were when a horse-wheel or windmill were the only alternatives. A very usual and suitable arrangement is to have the whole buildings, forming a lengthened parallelogram, facing south or south-east; the barn being placed in the centre of the north range, with the engine-house behind it, and the straw-house at right angles in front, with doors on both sides for the ready conveyance of litter and fodder to the yards, &c. It is always advantageous to have the barn of sufficient height to afford ample accommodation to the thrashing and winnowing machinery. When the disposition of the ground admits, it is a great convenience to have the stackyard on a level with the upper barn, so that the unthrashed corn may be wheeled into it on barrows, or on a low-wheeled truck drawn by a horse. Failing this, the sheaves are usually pitched in at a wide opening from a framed cart. The space on which the cart stands while this is going on is usually paved, that loose ears and scattered grain may be gathered up without being soiled; and it is a further improvement to have it covered by some simple roof, to protect the sheaves from sudden rain.

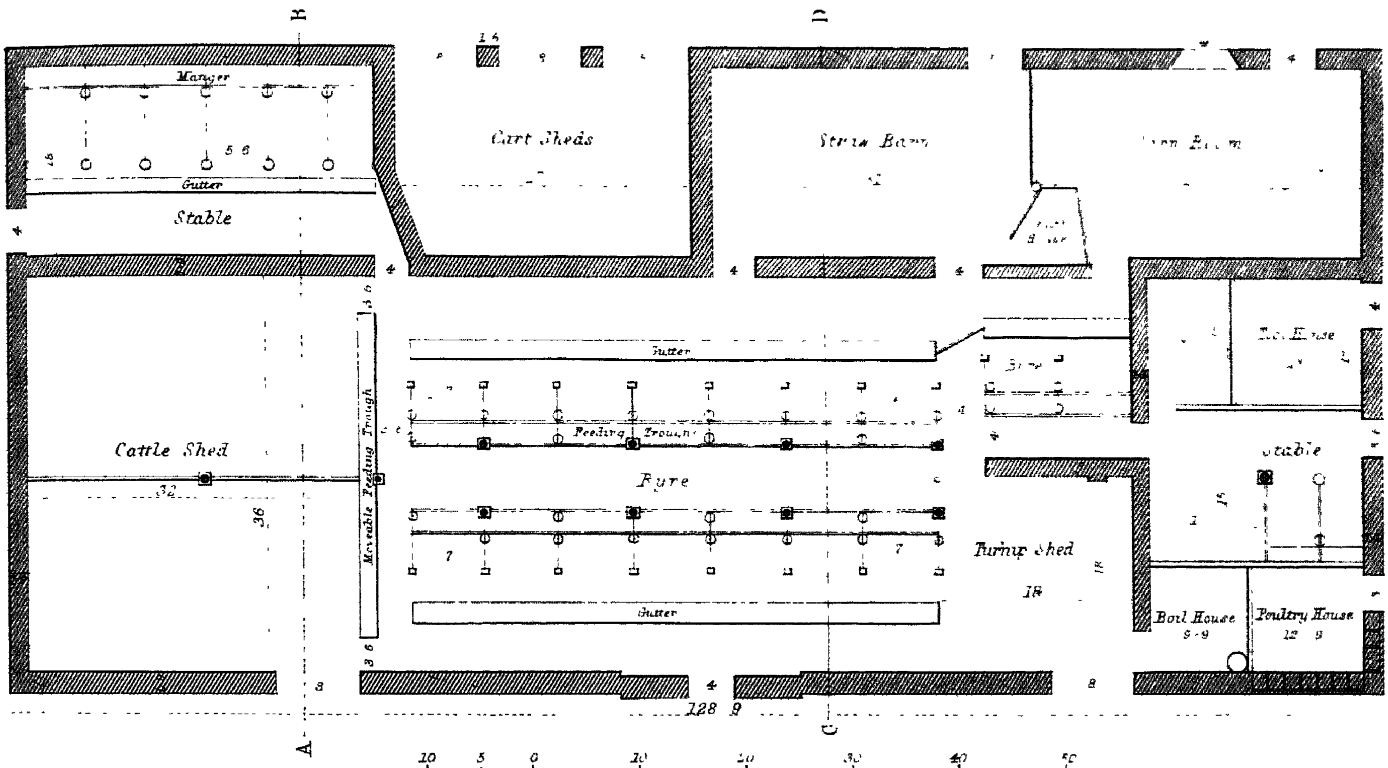
It is a good arrangement to have the straw-barn fitted up with a loft, on the level of the opening at which the straw is discharged from the thrashing-mill, so as to admit of fodder being stored above and litter below. A sparred trap-door in front of the shaker retains the straw above, or lets it fall to the ground as required. This upper floor of the straw-barn is the most convenient place for fixing a chaff-cutter to be driven by the thrashing-power. The granary should communicate with the upper barn, that the dressed grain may be raised to it by machinery.

A loft over the engine-room, communicating with the upper barn and granary, forms a suitable place for fixing a grinding-mill, bruising rollers, and cake-breakers, as it affords opportunity for having these machines easily connected with the steam-power. It suits well to have the house in which cattle food is cooked attached to and under the same roof as the engine-house. One coal store and chimney thus serves for both. Over this cooking-house, and communicating with the grinding-loft, may advantageously be placed a kiln, to be heated by the waste steam from the engine. An open shed outside the barn, for the accommodation of a circular saw, is also a desideratum. By the aid of the latter machine and a handy labourer, the timber required for ordinary repairs on the farm may be cut out at trifling expense.

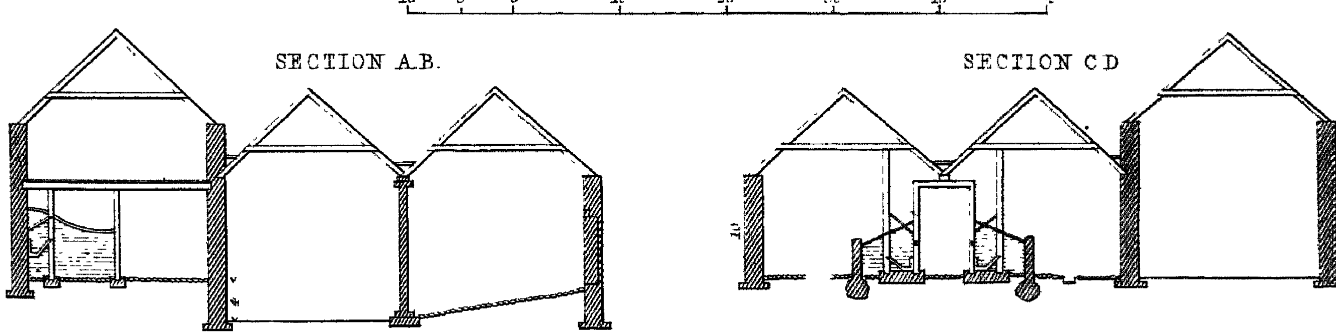
The cattle-housing, of whatever description, where there are the largest and most frequent demands for straw, is placed nearest to the straw-house, and in communication with the turnip-stores, and the house (if any) in which food is cooked or otherwise prepared. Where cattle are bred, the cow-house and calf-house are kept together. A roomy



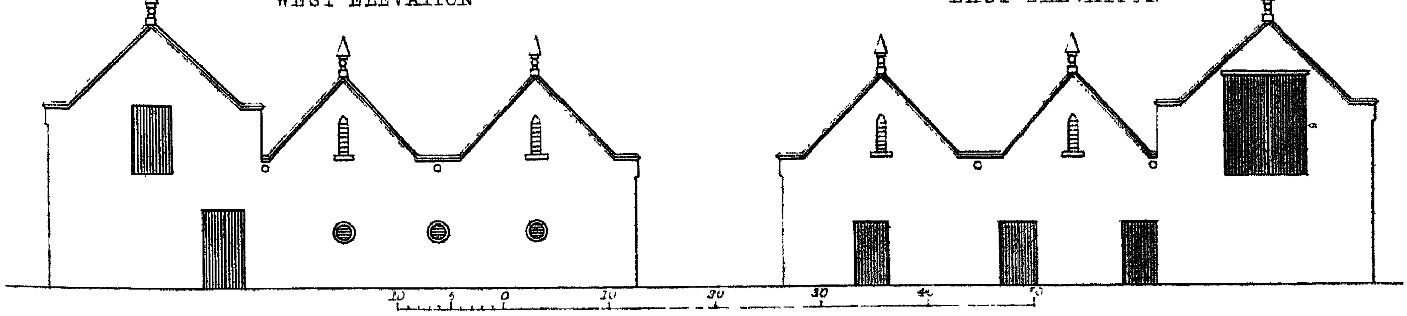
FRONT ELEVATION



SECTION A.B. SECTION C D



WEST ELEVATION EAST ELEVATION

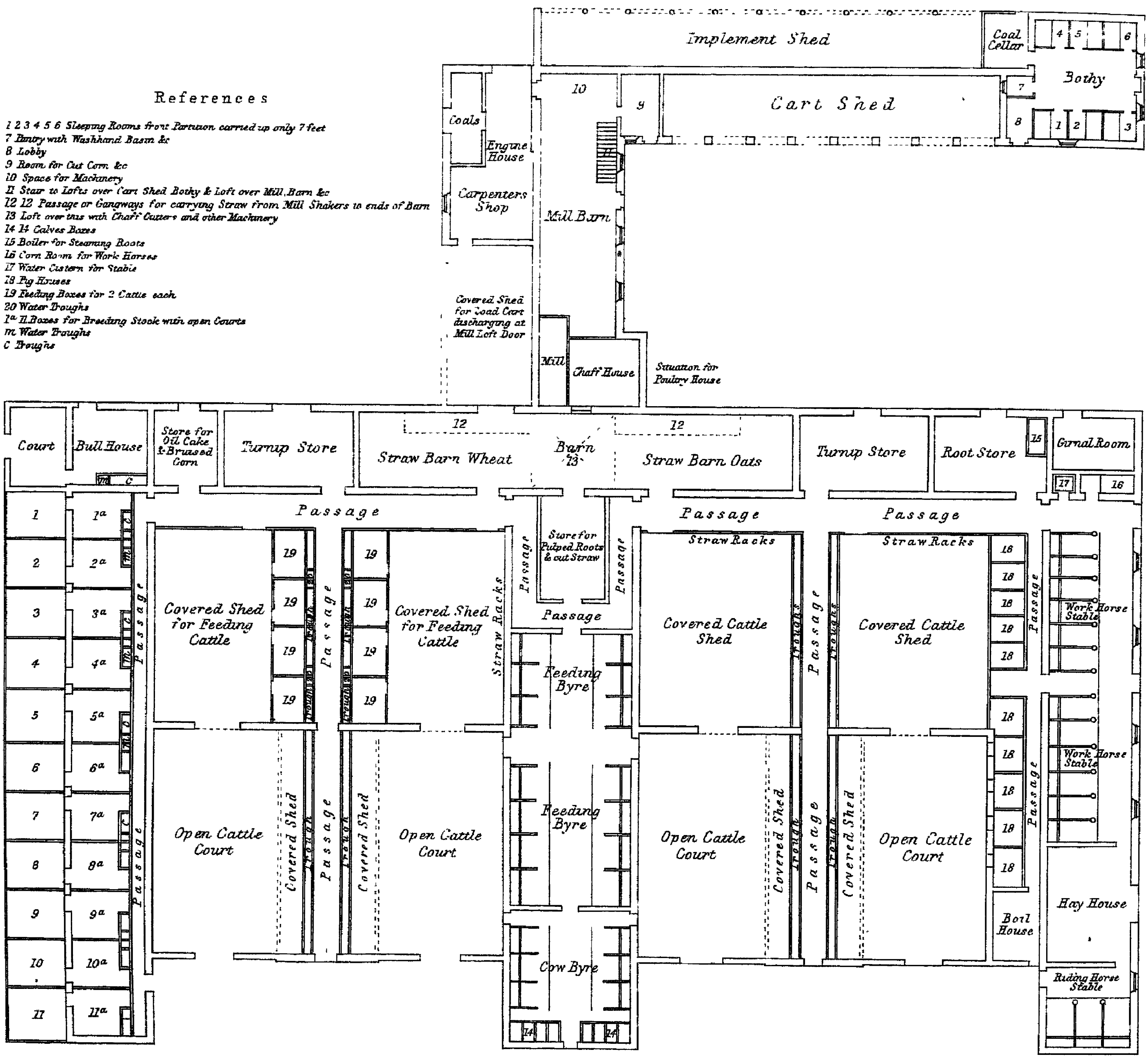


Page 308 see also p 410

W. & A. K. Johnston

PLAN OF HOMESTEAD FOR A FARM OF 500 ACRES BY CHARLES LYALL ESQ.

ARCHITECT. WILLIAM, FETTES, BRECHIN



Scale of Feet

10 5 0 10 20 30 40 50 60 70 80 90 100

Page 308 see also p 410

W & A.K Johnston

working court is always a great convenience, and it suits well to have the stable opening to it, and the cart-shed and tool-house occupying another side. Costly machines, such as corn-drills and reaping machines, require to be kept in a locked place, to preserve them from the collisions, and the loss or derangement of their minute parts, to which they are exposed in an open cart-shed.

Water.

An abundant supply of good water is a most important matter. The best source is from springs, at such an elevation as to admit of its being brought in a pipe, with a continuous flow. Failing this a well and pump is the usual alternative, although it is sometimes necessary to collect the rain-water from the roofs, and preserve it in a capacious and carefully-made tank. In every case it is desirable to have a regulating cistern, from which it is distributed by pipe to every part of the homestead where it is required. It is, in every case, of importance to have the eaves of the whole buildings spouted, and the rain-water carried where it can do no mischief. Where fattening cattle are kept in open yards with sheds, by spouting the eaves, and slightly hollowing the yards towards their centres, the urine to a large extent is absorbed by the litter, and retained in the manure. The effectual way, however, is to have the whole of the yards roofed over. The waste of food and litter, and the damage sustained alike by cattle and manure, from the excessive rainfall of winter 1872–3, has probably done more than any amount of argument could do to convince farmers of this. If stall feeding is practised, a pit is required, into which the solid dung is wheeled and the liquid conveyed by drains. Liquid manure tanks are at present in universal repute, but we shall endeavour to show, when treating of manures, that they are not such an indispensable appendage to a farm-yard as is generally asserted. In Scotland it is customary to carry the dung from the byres into a yard in which young cattle are kept, where it is daily spread about and subjected to further treading, along with such quantities of fresh litter as are deemed necessary. That from the stables is carried into the adjoining feeding-yard, and it is usually remarked that the cattle occupying it make more rapid progress than their neighbours.

Cottages.

An important part of the buildings of a farm are the cottages for its labourers. It is in all cases expedient to have the people required for the ordinary working of a farm resident upon it; and it is always much better to have families, each in its own cottage, than a number of young people boarded in the farm-kitchen, or with the farm-overseer. These cottages are usually a little removed from the other farm-buildings, and it is, on various accounts, better to have them so. There is, however, an advantage in having the cottages of the farm-steward and cattleman either within the courtyard, or close to its entrance, that these responsible functionaries may at all times be near their charge, and especially that they may be at hand when any of the live stock require night attendance. As there are manifold advantages in having but one main entrance to the homestead, and that closed by a gate which can be locked at night, it will be obviously necessary to have the keeper of the key close at hand to open the gate by night if required. Much more attention than formerly is now paid to the construction of cottages. The apartments are better floored, higher in the roof, and so arranged as to secure comfort and decency. Besides a small garden, each cottage is usually provided with a pig-sty and ash-pit, and in some cases with a coal-place and privy besides.

Farm-house.

The position and style of the farmer's dwelling also claims a remark here. The approved mode used to be, to place it either directly in front or rear of the farm-yard, on the ground that the farmer would thus have his premises and cattle under his eye even when in his parlour or bed-room. As has been well remarked, "The advantages of this parlour-farming are not very apparent, the attendant evils glaringly so. If the condition of ready communication be obtained, the farm-house should be placed where the amenities of a country residence can be best enjoyed."[1] On all hands we now hear it urged, that it is only by men possessed of capital and intelligence that the business of farming can be rendered remunerative. Those who desire to have such men for tenants will be more likely to succeed by providing a commodious and comfortable farmery, pleasantly placed among trees and shrubs, than by setting it down in the precincts of the dung-heap.

CHAPTER V.

FENCES.

Section 1.—*Benefit of Fences.*

The fences by which farms are generally enclosed and subdivided form another part of what may be termed their fixtures, and may therefore be suitably noticed here. When lands are let to a tenant, the buildings and fences are usually put into sufficient repair, and he is taken bound to keep and leave them so at the issue of his occupancy. Although there are some persons who advocate the total removal of subdivision fences, it is admitted on all hands that the farm as a whole, and the sides of public thoroughfares which may intersect it, should be guarded by sufficient fences of some kind. The general belief has hitherto been, that there is a farther advantage in having the land subdivided by permanent fences into enclosures of moderate size. The use of such partition fences is not only to confine the live stock to particular fields, or restrain them from trespassing on the other crops, but to afford shelter from cutting winds. It is now frequently urged, that the heavier cattle should never be turned to pasture at all, but kept on roots and green forage the whole year round, and that sheep can be managed satisfactorily by means of movable hurdles. It is highly probable that the practice of soiling will become more general, as it undoubtedly deserves to do. Still, this does not necessarily call for the total removal of subdivision fences, which we cannot but regard as an imprudent proceeding. It is probable that those who have adopted it have done so very much owing to the prevalence of the opposite extreme. There are large portions of the finest land in England so encumbered with hedges and hedgerow trees, as to be utterly incapable of profitable cultivation. In many cases the fields are so small and the trees so large that their roots actually meet from the opposite sides, and pervade the entire surface soil of the area enclosed by them. When manure is applied to such fields, it is monopolised by these freebooters from the hedges, and the crops of grain or hay, such as they are, are so screened from the sun and wind that there is great risk of their being spoiled in the harvesting. If drains are made in such fields, they are speedily filled up by the rootlets, and thus rendered useless. It has been computed that not less than one and a quarter million acres are occupied by hedgerows in England and Wales, and that if the land overshaded and plundered by roots be included, the amount is three millions. In Devonshire one-fourth of the enclosures in many parishes are under *two* acres; more than one-third under *three* acres; and nearly two-thirds under *four* acres. Two millions, at least, of these acres might be redeemed, and what a margin is here available for increased production! The land thus wasted would probably yield a sum equal to county and poor rates, and perhaps malt-tax

[1] For further information on Farm Buildings, see also *Morton's Cyclopædia of Agriculture*, article "Farm Buildings," and *The Book of Farm Buildings*, by Henry Stephens and R. Scott Burn, Edinburgh, 1861.

too.[1] In such circumstances, it is no wonder that zealous agricultural improvers should look upon hedgerows much as American settlers do upon their forests, and, like them, be sometimes indiscriminate in their clearings. We believe that there is an advantage in having land, whether for pasture or tillage, subdivided into parallel-sided fields of from ten to forty acres each, according to the size of the farm, by means of permanent fences of a kind adapted to the locality.

Section 2.—Varieties of Fences.

Thorn. When the soil and climate are favourable to the growth of the common *white thorn*, hedges formed of it combine efficiency, economy, and ornament, in a greater degree than any other fence. But to have a really efficient thorn hedge, much attention must be paid to its planting, rearing, and after management. In proceeding to *run* a new line of thorn hedge, care must be taken that the soil is clean and in good heart, and that the subsoil is porous and dry. When these conditions do not obtain, they must be secured by fallowing, manuring, draining, and trenching. The young quicks should be stout and well rooted; not taken indiscriminately as they stand in the nurserymen's beds, but of uniform stoutness. Such selected plants are always to be had for a small additional price, which will be found to be well repaid in the superior progress of such plants, when contrasted with that of others taken as they chance to come to hand. The embryo fence must be kept free of weeds, and secured from the encroachments of cattle by a line of rails on both sides. Some persons advise that the young hedge should from the first be trimmed into line by using the pruning-hook after each year's growth. It is certainly better not to touch it with the knife, or, at least, only to restrain an occasional shoot that unduly overtops its neighbours, until the centre stems are at least a couple of inches in diameter. If the plants are then headed over fence-high, and the lateral shoots pruned to a straight line, a close fence with a substantial backbone in it is secured; whereas by pruning annually from the first, a fence is obtained that pleases the eye, but which, consisting only of a mass of spray, presents no effectual barrier to cattle. When a thorn hedge has reached the stage just referred to, the protecting rails may be removed, and the hedge kept in a neat and efficient state by annual pruning. On good, deep soil, thorns will stand this constant removal of the annual growth of spray for many years without injury, especially if the pruning is delayed until the leaf has fallen. In less favourable circumstances, it is found necessary from time to time to withhold the pruning-knife for a few years together. When the hedge has been reinvigorated by such periods of unrestrained growth, it can again be cut back to the centre stems, and subjected anew to a course of annual pruning. To insure a close fence, the bottom of the hedge must at all times be kept clear of tall weeds. The constant use of the weeding-iron is, however, objectionable; for, besides being expensive, it injures the bark of the thorns and thereby impairs their health. It is quite sufficient to cut the weeds close to the surface twice a year by means of a reaping-hook or short scythe.

In arable lands, by this plan of keeping hedges about four feet high, and cutting down the weeds as required, an efficient and ornamental fence is maintained at comparatively small cost, and with little injury to the adjoining crops from shading, or the harbouring of weeds and vermin.

Although the white thorn forms a better hedge than any shrub yet tried for the purpose in this country, there are many upland situations where the beech and hornbeam grow more freely, and are to be preferred either alone or in mixture with it. These plants, and also crab or sloe, are sometimes useful in filling a gap occasioned by the removal of a hedgerow tree or the death of a portion of thorn hedge.

Stone. In exposed situations, where thorns do not thrive, *drystone walls* are the most usual substitute. When carefully constructed, of stones suitable for the purpose, they last a long time, and form an excellent fence. Their durability is much enhanced by having the cope-stones set in lime-mortar. A layer along the centre of the wall, and an external pointing, of lime-mortar will also repay the additional first cost thus incurred. A wall of this kind four feet high, exclusive of the cope, while quite sufficient to restrain cattle and the heavier kinds of sheep, is no barrier to the mountain breeds, which can easily clear a six-foot wall.

Wire. A simple and very effective fence has, however, come much into use of late years. It is composed of iron wire (No. 8 being the size most commonly used), which is attached by small staples to common stakes, such as are used for wooden railings, driven firmly into the ground about five feet apart. The wire is drawn out of the coil, and the ends of the various lengths or *threads* are neatly joined by first heating them, and then twisting the one into the other, until the quantity required for the stretch of fence is run out. It is then attached to every third or fourth stake by a staple, which must not be driven home. The other lines of wire are then treated in the same manner, each being attached to the stakes at such width apart as has been determined upon, and marked upon the stakes. A ready way of doing this is by stretching along the stakes a common gardener's line which has been previously rubbed with chalk, or a charred stick, and striking it against the stakes at the required heights, in the way that sawyers mark a plank. When the requisite number of wires has thus been loosely attached, they are pulled as tight as possible by the hands of the workmen, after which a screw or lever is applied to each in turn until it is made perfectly tight. As the efficiency of this kind of fence is wholly dependent on perfect tightness being obtained, a stout straining-post must be fixed securely in the ground at the end of each line of fence. This serves the double purpose of furnishing a fulcrum for the stretching instrument, and a secure attachment for the ends of the wires. When the straining is accomplished, each wire is stapled to each stake. The gates are usually hung upon these straining-posts. Although wooden straining-posts are commonly used, some persons prefer iron ones, fixed into large blocks of stone. Five wires thus stretched, at an average width of six inches, form an effectual fence for the wildest sheep. They could, indeed, easily clear it so far as height is concerned, but they are afraid to leap at an object which they cannot see until they are close upon it. They may be seen at first walking along the line anxiously looking for an opening, and if one more bold than the others makes a run at it, he is sure to catch such a fall as effectually deters him from repeating the attempt. With these cheap and portable materials, which any labourer of ordinary intelligence can easily put together, a fence admirably adapted for enclosing or subdividing mountain pastures is now quite attainable by every sheep-farmer, and will well repay its cost. It is equally available for protecting young thorn hedges, and generally for all purposes for which wooden railing is used. As a fence for cattle or horses, it is advisable to add a single rail of wood nailed *flat* along the top of the stakes, which must be sawn off evenly for this purpose. As compared with wooden railing, wire is much cheaper and more durable, and more easily kept in repair. It is cheaper also than stone walls, available in many situations where they are not, and a more certain barrier to agile sheep; but it is less durable, and affords no shelter.

The latter defect can in some situations be remedied by

[1] See *Farmer's Magazine* for March 1852, p. 253.

raising a low mound of turf, running the wire-fence along the top of this mound, and sowing on it the seeds of the common whin.

We have already noticed that the fences of a farm are usually erected by the landlord and kept in repair by the tenant. The latter is at least usually taken bound in his lease to keep and leave them in good order; but as this obligation is often very indifferently performed, and much damage and vexation occasioned in consequence, it is always expedient that a person should be appointed by the landlord to attend to the fences, and the half of his wages charged against the tenant. By such a course, dilapidation and disputes are effectually guarded against, and the eyesore of defective, ill-kept fences is wholly removed.

CHAPTER VI.

MACHINES AND IMPLEMENTS OF HUSBANDRY.

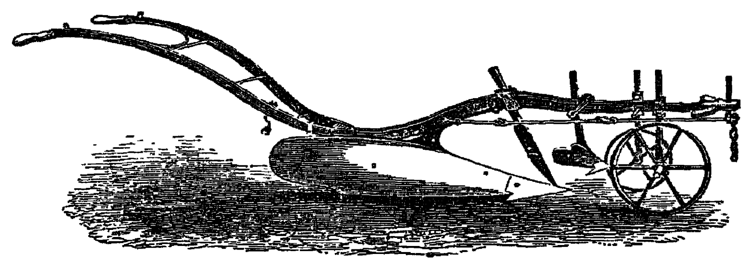
Section 1.—*Recent Improvements.*

That the cultivation of the soil may be carried on to the best advantage, it is necessary that the farmer be provided with a sufficient stock of machines and implements of the best construction. Very great improvement has of late years taken place in this department of mechanics. The great agricultural societies of the kingdom have devoted much of their attention to it; and under their auspices, and stimulated by their premiums, exhibitions, and competitive trials, manufacturers of skill and capital have embarked largely in the business. In many instances the quality of the article has been improved and its cost reduced. There has hitherto been a tendency to produce implements needlessly cumbrous and elaborate, and to introduce variations in form which are not improvements. The inventors of several valuable implements, the exclusive manufacture of which they have secured to themselves by patent, appear to have retarded their sale, and marred their own profits by the exorbitant prices which they have put upon them. Some, however, have become alive to the advantages of looking rather to large sales with a moderate profit on each article, and of lowering prices to secure this. A most salutary practice has now become common of inventors of implements of ascertained usefulness granting licence to other parties to use their patent-right on reasonable terms, and thus removing the temptation to evade it by introducing some alteration which is trumpeted as an improvement, although really the reverse.

The extended use of iron and steel in the construction of agricultural implements is materially adding to their durability, and generally to their efficiency, and is thus a source of considerable saving. While great improvement has taken place in this department, it too commonly happens that the village mechanics, by whom a large portion of this class of implements is made and repaired, are exceedingly unskilled, and lamentably ignorant of the principles of their art. They usually furnish good materials and substantial workmanship, but by their unconscious violation of mechanical laws, enormous waste of motive power is continually incurred, and poor results are attained. This can probably be remedied only by the construction of the more costly and complex machines being carried on in extensive factories, where, under the combined operation of scientific superintendence, ample capital, and skilled labour, aided by steam-power, the work can be so performed as to combine the maximum of excellence with the minimum of cost.

Section 2.—*Ploughs.*

We begin our brief notice of the implements of the farm with those used for the tillage of the soil. Of these the first place is unquestionably due to the plough. A history of this implement, tracing its gradual progress from the ancient *Sarcle* to its most improved form at the present day, is necessarily a history of agriculture. So much is this the case, that a tolerably correct estimate of the progress of the art in any country, whether in ancient or modern times, may be formed by ascertaining the structure of the plough. Much attention has been paid to its construction in Britain for the last hundred years, and never more than at the present day. After all that has been done, it is still, however, an unsettled point which is the best plough for different soils and kinds of work; and accordingly, many varying forms of it are in use in those parts of the kingdom which have the reputation of being most skilfully cultivated. Ever since the introduction of Small's improved *swing-plough*, the universal belief in Scotland, and to a considerable extent in England, has been that this is the best form of the implement. Wheel-ploughs have accordingly been spoken of by Scottish agriculturists in the most depreciatory terms, and yet it turns out that this has been nothing better than an unfounded prejudice; for when subjected to careful comparative trial, as has been frequently done of late, the



Howard's Champion Plough.

balance of excellence is undoubtedly in favour of the plough with wheels. Its advantages are, that it is easier of draught; that the quality of its work is better and greatly more uniform than can be produced by a swing plough; that in land rendered hard by drought, or other causes, it will enter and turn over even furrows where its rival either cannot work at all, or at best with great irregularity and severe exertion to the ploughman; and, lastly, that its efficiency is independent of skill in the ploughman. This last quality has indeed been usually urged as an objection to wheel-ploughs, as their tendency is said to be to produce an inferior class of workmen. Those who know the difficulty of getting a field ploughed uniformly, and especially of getting the depth of furrow specified by the master adhered to over a field, and by all the ploughmen, can best appreciate the value of an implement that, when once properly adjusted, will cut every furrow of an equal width and depth, and lay them all over at exactly the same angle. The diversity in the quality of the work at those ploughing competitions, to which only the picked men of a neighbourhood are sent, and where each may be supposed to do his very best, shows conclusively how much greater it must be on individual farms, even under the most vigilant superintendence. In every other art the effect of improved machinery is to supersede manual dexterity; and it does seem absurd to count that an objection in agriculture which is an advantage in everything else. There is more force in the objection that wheel-ploughs are inferior to swing ones in ploughing cloddy ground, or in crossing steep ridges, and that they cannot be used for forming drills for turnip or other crops. This objection vanishes when it is known that in the most improved wheel-ploughs, the wheels can be laid aside at pleasure, and that they can then be used in all respects as swing-ploughs. A mould-board, somewhat higher and wider behind than that best adapted for ordinary work, is required for forming turnip-drills. This, however, is easily managed by having two distinct mould-boards for each plough, or, better still, by using only the double mould-board

or bulking plough for drilling. An important feature in the English ploughs is, that they are fitted with cast-iron shares, which, being case-hardened on their under surface, wear unequally, and so preserve a sharp edge. The necessity for daily recourse to the smithy is thus removed, and along with it that irregularity in the quality of the work and draught of the plough, which so often arises from witting or unwitting alterations being made in the *set* of the share in the course of its unceasing journeys thither. These cast-iron shares are slightly more brittle than those made of malleable iron with steel points; but it is of importance in determining their comparative merits to bear in mind that the prime cost of the former—10d. to 1s. each—is so small as to render them at the year's end the least expensive of the two. When it is desired to turn a very deep furrow, a plough is used differing from the common one only in being somewhat larger and stronger in all its parts, with four horses to draw it.

Ploughs which break and stir the subsoil, without bringing it to the surface, by following in the wake of the common plough, are now much used. The first of the kind—the invention of the late Mr Smith of Deanston—is a ponderous implement, requiring at least four good horses to draw it. It is well adapted for displacing and aiding in the removal of earth-fast stones. The inventor has happily described its operation by terming it a "horse pick." Read's subsoil-plough is a much lighter implement, which can usually be drawn by two horses. Since the introduction of thorough draining, it is found beneficial to loosen the soil to a much greater depth than was formerly practicable, and this class of implements is well fitted for the work. It is always advisable to use this implement, and to mark and dig out the large stones encountered by it, before introducing steam cultivation.

Broadshare or paring-ploughs are much used in various parts of England in the autumn cleaning of stubble. A broad-cutting edge is made to penetrate the soil to the depth of three or four inches, so as to cut up the root-weeds which at that season lie for the most part near the surface. These, as well as the stubble, being thus detached from the firm soil, are removed by harrowing and raking; after which the land is worked by the common plough. An implement of this kind is frequently used in carrying out the operation of paring and burning. Bentall's Broadshare has the reputation of being the best of its class; but we can confidently recommend the common plough, stripped of its mould-board and fitted with a share twelve inches broad, as not only the cheapest, but decidedly the most efficient scarifier that has yet been used.

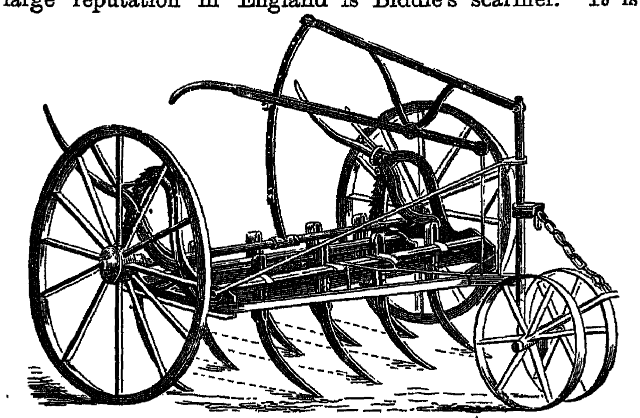
An ingenious Aberdeenshire mechanic, Mr Pirie of Kinmundy, has recently invented a double-furrow plough, on an entirely new principle, which has met with general approval, and has already been adopted by all the great plough makers. By carrying the plough on three wheels, one on the land and two bevelled ones in the angle of the furrow, Mr Pirie dispenses with both soles and side plates, and thereby lessens the friction, and avoids that hurtful glazing and hardening of the bottom of the furrow which attends the use of other ploughs. So much is the draught lessened by this improvement, that *three* horses and one man with this double-plough can perform as much work in a day as *four* horses and two men with two ordinary ploughs. For a seed-furrow or level field of free soil, *two* horses are quite able to work the double-plough.

Various implements of the plough type, so modified as to adapt them for particular processes, have from time to time been offered to public notice, but have failed to meet with general favour. We limit our notice to those of ascertained utility, and refer the reader who desires fuller information to *Ransome's Implements of Agriculture*,[1] and the more recent work by Messrs Stephens and Scott Burn, where he will find descriptions of the most interesting of them.

Section 3.—Grubbers, &c.

Next in importance to the plough is the class of implements variously called grubbers, cultivators, drags, or scarifiers. To prepare the soil for the crops of the husbandman, it is necessary to pulverise it to a sufficient depth, and to rid it of weeds. The appropriate function of the plough is to penetrate, break up, and reverse the firm surface of the field. This, however, is only the first step in the process, and does but prepare for the more thorough disintegration which has usually been accomplished by harrowing, rolling, and repeated ploughings. Now, however excellent in its own place, the plough is a cumbrous and tedious pulveriser, besides needlessly exposing a fresh surface at each operation, and cutting the weeds into minute portions, which renders their removal more difficult. These defects were long felt, and suggested the desirableness of having some implement of intermediate character betwixt the plough and harrow, which should stir the soil deeply and expeditiously without reversing it, and bring the weeds unbroken to the surface. The whole tribe of grubbers, &c., has arisen to meet this demand, and we shall now consider the comparative merits of the more prominent of the group. The first notice is due to Finlayson's harrow, which, as improved by Scoular, was, until recently, the best implement of its kind. Its faults—and they attach equally to Kirkwood's and Wilkie's—are, that it is severe work for two horses, is liable to choke in turfy or foul ground, and that it consolidates the bottom of the furrow, while producing a fine tilth on the surface. Finlayson's grubber, in its improved form, weighs about five cwt., and costs as many pounds.

Another useful implement of this class which enjoys a large reputation in England is Biddle's scarifier. It is



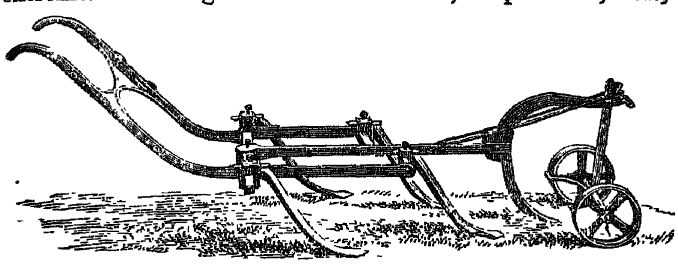
Biddle's Scarifier, as made by Ransome & Co.

mounted on four wheels—two small ones in front and two much larger behind. The frame and tines are of cast-iron, and can be raised and depressed at pleasure by means of two levers which regulate the depth to which the tines shall penetrate. The tines are prepared to receive case-hardened cast-iron points of different widths, or steel hoes of nine inches width, so that the implement can be used for breaking up and paring the surface, or for grubbing out weeds and pulverising the soil, as may be required. An important feature in this scarifier is, that it keeps its hold of a hard surface much better than a plough. It weighs half a ton, is drawn by four or six horses, and costs about £18.

[1] *The Implements of Agriculture*, by J. Allen Ransome, Lond. 1843. *The Book of Farm Implements and Machines*, by Henry Stephens and R. Scott Burn, Edin.

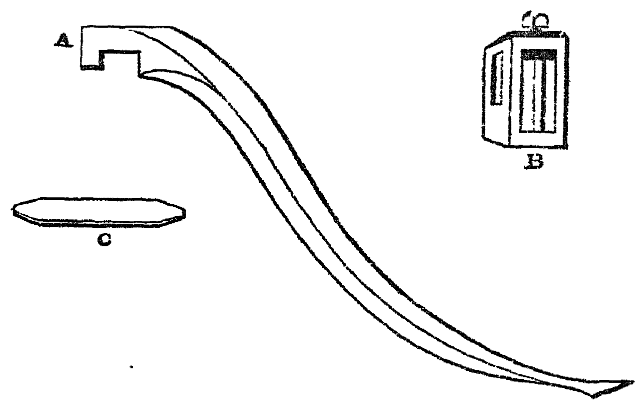
The *Ducie* or Uley cultivator has many features in common with Biddle's, and although brought forward as an improvement upon it, has not established its title to be so regarded. The great weight, high price, and amount of horse-power required to work them, are serious objections to all these implements.

Of more recent notoriety than these, and contrasting with them favourably in these respects, is an implement invented by the late Mr John Tennant, at Shields, near Ayr, and now popularly known as Tennant's grubber. Its construction, as the annexed cut will show, is simple in the extreme. Its weight is about two cwt., its price £4, 10s.,



Tennant's Grubber, as improved by T. Brown, Edington.

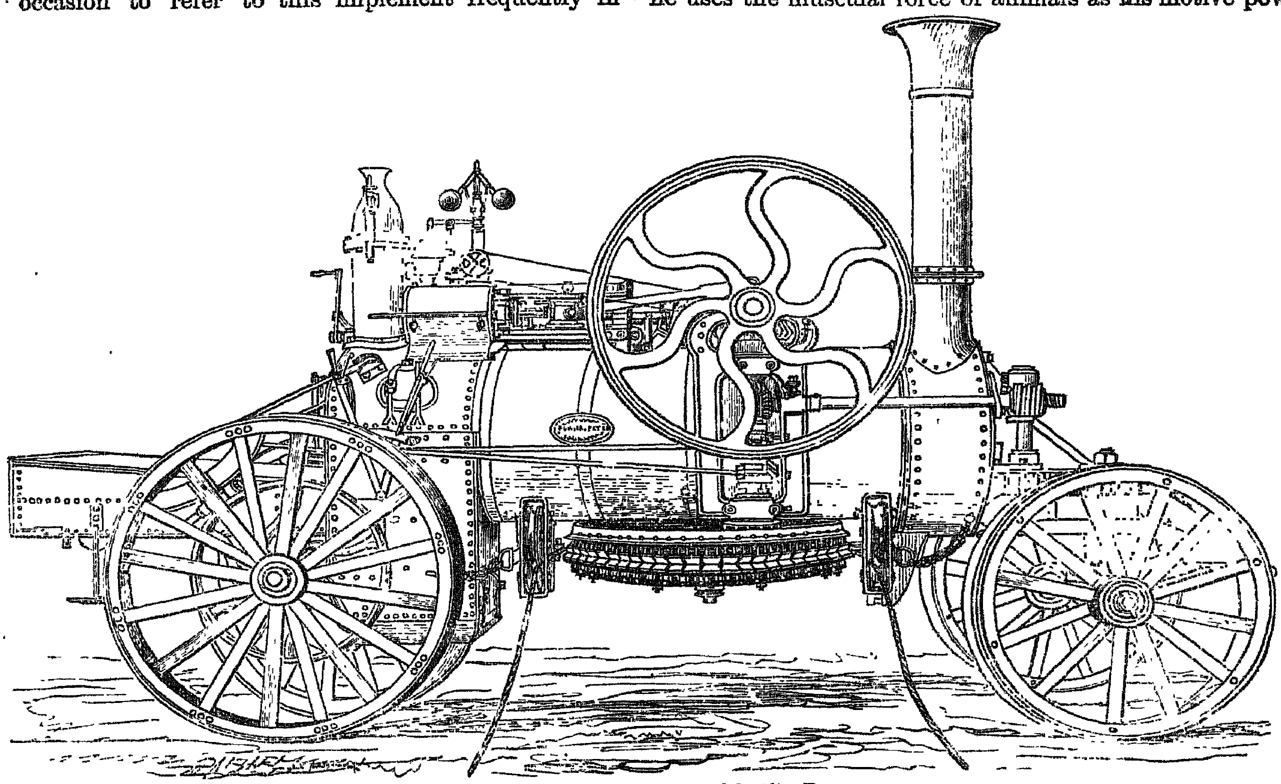
and its draught easily overcome by two horses. The depth at which it works is regulated by raising or lowering the shank which supports its wheels in front. Its tines can be easily moved on their supporting bars, and it may be worked with five or seven as desired. By substituting a shorter hind bar, and setting the tines more closely together, it makes a most efficient drill-grubber. We shall have occasion to refer to this implement frequently in treating of tillage operations. The improvement which Mr T. Brown has made on Tennant's grubber consists mainly in the mode of attaching the tines to the bars. This attachment, which the cut explains, has the merit of being at once very simple and very effectual. The tines when thus fixed are as rigid as if welded to the bars, and yet, by merely slackening the screws and driving out the wedges, they can with ease and rapidity be either adjusted at varying widths apart, or detached for repair.



A, Tine; B, Keeper; C, Wedge. ⅛ Actual Size.

Section 4.—Steam-Power Tillage Implements.

Such are the most important of those implements by which the tilling of the soil has hitherto been accomplished, and upon which the farmer must continue to rely so long as he uses the muscular force of animals as his motive power.



Fowler's Locomotive Engine, with Clip Drum.

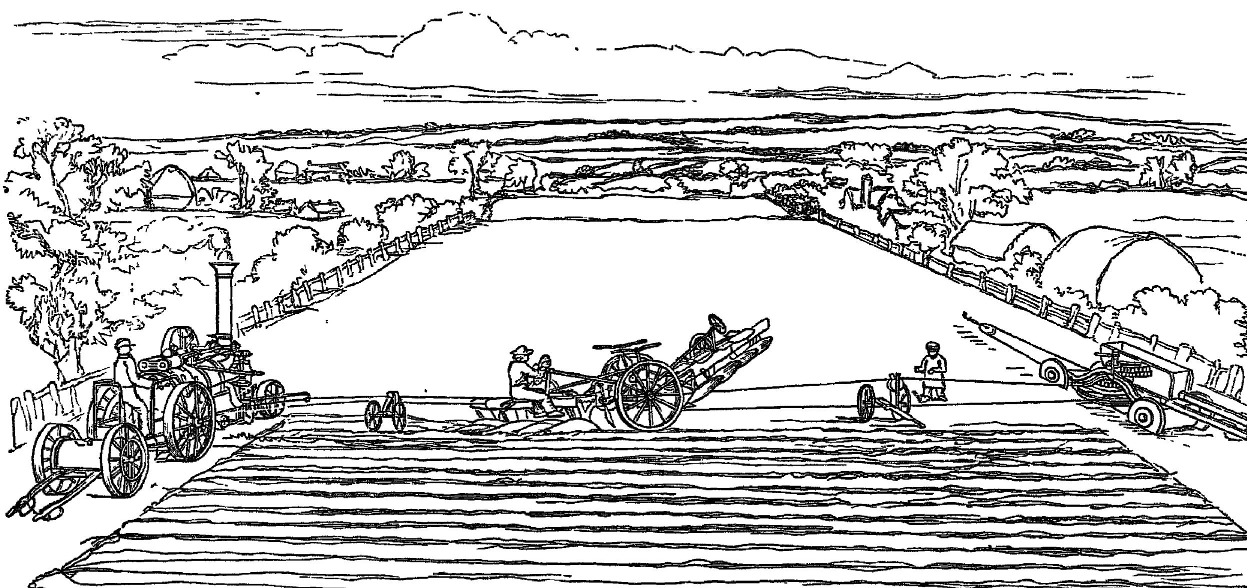
But the progress of invention has at last made the steam-engine practically available for this purpose, and accordingly we here introduce some notice of what has now been accomplished, in applying steam power to the cultivation of the soil.

After many abortive attempts to do this by moving the engine itself over the land to be operated upon, it is now admitted on all hands that the only available method is to communicate the power from the engine to the implements by means of steel wire-ropes and windlasses. This is done in a variety of ways, some of the most prominent of which we shall now describe. The systems actually in operation fall under two general classes, which are known severally as the "Direct" and the "Roundabout." The first of these is the system introduced by Messrs John Fowler & Co. of Cornhill, London, and now so well known in connection with

their name. The late Mr John Fowler's first efforts were directed to the production of a draining apparatus, and it was after succeeding in this apparently more arduous effort that he adapted his tackle to the hauling of tillage implements. After various tentative changes, Mr Fowler settled on the form which is still in extensive use. It consists of a single locomotive engine, usually of 12 or 14 horse-power, with a windlass attached to it under the boiler. Around this windlass an endless steel wire-rope passes with a single turn in a groove, which, by means of hinged clips, lays hold of nearly the entire circumference of the rope, and that with a force proportioned to the strain upon the rope, which thus obtains sufficient grip to convey the necessary hauling power without risk of slipping upon the drum. This wire-rope, which requires to be just twice as long as the field to be tilled is wide, passes round a sheave upon a self-acting anchor placed at the farther side of the field opposite to the engine. This anchor is a prominent feature in Mr Fowler's apparatus. It consists of a low truck on four wheels, with sharp disk edges, which cut deeply into the soil, and thus obtain a hold sufficient to resist the strain of the wire-rope. A box, loaded with stones, is fixed on the outer side of this truck to hinder it from canting over. The sheave mounted upon this truck, besides serving its primary use, gives motion when required to a drum, which winds up a rope, the other end of which is fixed well ahead in the direction in which the truck is required to move. Thus the apparatus warps itself along the headland as the ploughing progresses, and is kept always *vis-à-vis* to the engine, which moves itself forward by its own locomotive power at every bout of the ploughs, and keeps abreast of them. That the rope may not drag upon the ground, friction rollers or rope-porters, as they are called, are placed at suitable intervals. These being mounted on wheels and strung upon the rope, are now in a good measure self-acting, as the tautness of the rope keeps them in its own line. The ploughs are fixed to a balance frame carried on two wheels, and are in duplicate, pointing to each other, so that when the set at one end of the frame is in work, the opposite set is carried aloft in the air. The plough frame is thus hauled to and fro across the field, between the engine and movable anchor, by reversing the action of the windlass; and it is adapted for taking from two to eight furrows at once, according to the power of the engine employed, or the nature of the soil that is operated upon.

Messrs Fowler have made this form of their apparatus more generally available by adapting it for attachment to the ordinary 8-horse power thrashing engine. When thus used the clip-drum is mounted on a separate frame and connected with the engine, which being stationed in a corner of the field to be ploughed, the rope is carried to two self-acting anchors, one at each side of the field, and thus encloses a triangle. The plough is drawn to and fro betwixt these anchors, and as it gradually approaches the engine at each successive bout, the gearing on the plough-frame tightens up the rope and accommodates it to the diminishing length required.

To work Fowler's apparatus there are required one engine-driver, one ploughman, a stout lad to attend to the anchor, two boys to shift the rope-porters, and a horse and boy to supply the engine with water and fuel.



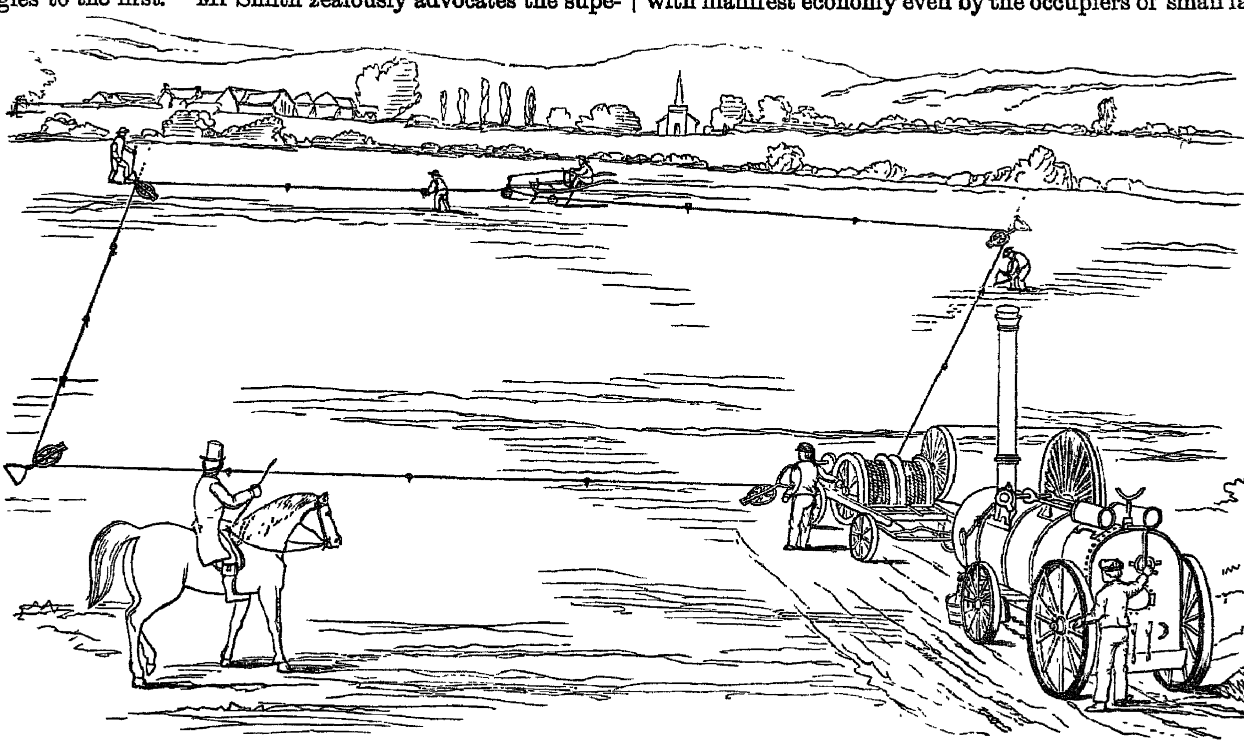
Fowler's Steam-Plough as at work.

About 1865 Messrs Fowler made an important addition to their apparatus by substituting a second engine for their movable anchor. In this arrangement, now well known as the "Double Engine system," a pair of locomotive engines, each having a plain winding drum instead of the clip-drum, are placed opposite to each other at the ends of the field to be operated upon; the rope of each of the engines is attached to the plough, or other tillage implement, which is drawn to and fro betwixt them by each working in turn. While the engine in gear is coiling in its rope and drawing the plough towards itself, the rope of the other engine is paid out with merely so much drag on it as to keep it from kinking or getting ravelled on the drum. The advantages claimed for this system are, economy of power from the direct pull of the engines on the implement; the facility and rapidity with which the engines move themselves and the whole apparatus from field to field, or farm to farm, and take up their positions and get to work without the aid of horses; and the few hands required to work it. Its drawbacks are the large first cost, and corresponding charge for wear and tear, depreciation, and interest; its unsuitableness for working in small and irregularly shaped fields; and the injury done to headlands in wet weather. Its special adaptation is for large farms, and for working for hire; and for these it is undoubtedly without a rival.

Mr William Smith of Woolston, Bedfordshire, may fairly be regarded as the pioneer of cultivation by steam power. At the meeting of the Royal Agricultural Society of England at Carlisle in 1855, he witnessed the performance of the late John Fowler's steam draining-plough, and then contracted

with him to construct for him a windlass and other tilling apparatus, with which he got to work on his own farm in the autumn of that year. These two leaders in steam-cultivation did not long work together. They had decided and diverse opinions as to the best road to success, and accordingly each for the future took his own course. Mr Smith's merit is not largely that of an original inventor of machinery, but rather that of a zealous, persevering, and successful applier of the inventions of others. But by his own example and his vigorous writings, he has contributed very largely indeed to the success of steam cultivation. He makes use of the ordinary portable engine, such as is employed as a thrashing power, which gives motion to a detached windlass with two drums, from which a wire-rope is carried round the area to be operated upon, and hence the name "Roundabout" applied to this system. This rope being attached by a turning bow to a powerful grubber, the implement is drawn to and fro across the field by reversing as required the action of the windlass, the slack half of the rope being uncoiled from the one drum as the part in work is wound up upon the other. His mode of working is to break up the ground by using a three-tined grubber, and then to go over it again with a seven-tined one, working at right angles to the first. Mr Smith zealously advocates the superiority of grubbing to ploughing, being of opinion that if the soil is thoroughly broken up to a sufficient depth, it is better not to reverse the surface, as weeds are thus kept on the top, and the removal of them thereby greatly facilitated.

Mr Smith soon made an important addition to his system of tillage by means of an implement which he calls a *Ridger and Subsoiler*. By means of it the soil, after being thoroughly smashed up by the steam-grubber, is thrown into 36-inch ridges, the tine at the same time penetrating and loosening the subsoil in each furrow several inches deeper. His clay soil treated thus immediately after harvest is put into the best possible condition for benefiting by the alternations of wintry weather, for allowing rain-water to pass readily and beneficially to the drains, and for yielding a friable seed-bed in spring. It has enabled him altogether to dispense with dead fallows; to grow abundant crops of wheat and beans alternately for a number of successive years, at an average annual cost of 8s. 6d. per acre for tillage; and to keep his land perfectly clean under this constant cropping. He has the high merit not only of being the first man who successfully used steam power for the cultivation of a farm, but of demonstrating that this can be done with manifest economy even by the occupiers of small farms,



Smith's Steam Cultivator as at work.

seeing that his own farm extends to but 180 acres of arable land. After the lapse of eighteen years there is probably no one who yet practises steam cultivation with as great success and economy. At the end of this period he reports that his engine and tackle are in excellent condition.

Mr Smith's apparatus was for a time manufactured by the well-known firm of J. & F. Howard of Bedford, and more recently by Barford & Perkins of Peterborough. Since 1860 the Messrs Howard have sent out a tackle of their own, in which the main features of Smith's system are retained, but to these they have themselves added from time to time various improvements. By means of a self-acting windlass and self-moving anchors, their tackle can now be worked by one engineman (who also attends to the windlass), one ploughman, and two porter-boys.

Although the earliest in date of invention, the most recent in actual operation is the tackle of Messrs Fisken, which has features peculiar to itself. A single traction engine is stationed at any convenient point on the margin of or near to the field to be operated upon, the preference always being given to a site where there is water, whence it can supply itself either by pumping or by the patent injector. The other parts of the apparatus are *two* self-moving anchor windlasses, which are placed opposite to each other on two sides of the field, occupying the place and doing the work of the *two* engines in the double-engine system. These windlasses are mounted on four disc wheels, and have also a spud which cuts into the soil to give the necessary resistance to the side pull. They each carry a winding-drum with the necessary length of wire-rope, and these windlass-drums wind up and pay out alternately in precisely the same way as in Fowler's double engines. They also have each a winding-forward drum with wire-rope and anchor fixed a-head, by means of

which they warp themselves forward and keep abreast as the work progresses. Power is communicated from the engine to these windlasses by means of a light hemp rope, travelling at the speed of the fly-wheel, which is carried all round the field, and takes a double turn round a grooved pulley on each windlass. A set of anchor pulleys on wheels carry this rope round the corners of the field; another set of pulleys, on stakes driven into the ground at suitable points, carry it off the ground; and a tension anchor mounted on four wheels, and having, like the windlasses, an apparatus by which it warps itself forward, and keeps the hemp-rope taut as the length out varies with the progress of the work. The windlasses have each a self-acting clutch, which stops the implement when any obstruction is encountered, and by which the attendants stop it at the turnings, or when otherwise necessary, without in any case requiring to stop the engine. By these arrangements the engine-driver does not require to have the implement in sight, his duty being merely to drive his engine at a uniform speed, as neither stopping nor reversing are required. The advantages claimed for Fisken's tackle are those which it has in common with the other Roundabout systems, and, in addition, the use of a light hemp rope to convey power from engine to implement with less friction and cost than in other systems; great adaptability to fields of any size, or shape, or inequality of surface; and a capacity in certain circumstances of being worked by a fixed steam-engine or water power.

The Royal Agricultural Society of England has from the first devoted much attention and large funds to the promotion of steam cultivation, by the prizes offered at its annual shows, and by the reports published in its *Journal* from year to year. In the prolonged trial of steam-ploughs which took place at Leeds in July 1861 under its auspices, the competition was mainly betwixt Fowler's and the modification, by Howard, of what is popularly known as Smith's system. The award of the judges was as follows:—"The £100 prize offered for the most economical application of steam power to the cultivation of the soil, was awarded to Mr Fowler for his 12-horse power engine, moving anchorage, and plough; and of the £100 offered for the most economical application of the ordinary thrashing-engine of the farm to steam cultivation, £75 was given to Mr Fowler, and £25 to Mr Howard. Besides these a silver medal is given to Mr Hayes, for his clever windlass for the same purpose; and the same to Mr Roby for his combined engine and windlass."

During the summer and autumn of 1861, Mr J. C. Morton, editor of the *Agricultural Gazette*, personally inspected the farms of many of these parties, and published from time to time in that paper detailed accounts of his own observations and of the information supplied to him in regard to each case. In his *New Farmer's Almanac* for 1862, he condensed these reports, and from it we give the following extracts:—

"Little Woodcote Farm lies—a tract of open country and light calcareous soil of various depth—upon the chalk, about a mile from the Carshalton station on the London and Epsom railway. Mr Arnot has had Fowler's 10-horse power steam-engine and ploughing apparatus since the harvest of 1859. His apparatus, rope, and engine cost £700. He works a three-furrow plough. The work done each year by the steam-plough on his 400 acre farm has thus been 393 acres in 1859-60, and 389 acres in 1860-61. It has been done at the rate of six or seven acres a day for ordinary ploughing, and three acres a day (one acre per furrow) when at the 10 and 12-inch deep work. It may average on the whole five acres a day, including all stoppages and removals, and has thus taken close upon eighty days for its accomplishment. Besides this however, 150 acres have been ploughed during the time for neighbours at a charge, including everything, of 12s. an acre. The engine is also used for thrashing purposes, and 220 acres at home and 250 acres elsewhere are thus thrashed out for hire.

"The cost of repairs has been uncommonly small—including a new cog-wheel, repacking cylinders, and a thorough overhaul and cleaning of the whole apparatus at the end of two years—besides the replacement of shares and sharpening of coulters for the plough, and the gradual wearing of the rope-porters. In all it has not nearly reached £10 a year, at which, nevertheless, we put it. The tear and wear of rope is reported as follows:—A new 400-yard rope, lately bought, costing £35, has made the stock stronger and better than it was at the beginning. This charge may therefore be put against more than two years' work, and is equal to about £15 a year. The weekly cost of labour when at work is as follows:—Engineer, 18s.; ploughman, 14s.; anchor lad, 9s.; two porter lads, 6s. each; horse and water cart, about 24s. weekly—in all, £3, 17s. weekly, or as nearly as possible 12s. a day. The cost for oil is 1s. a day, and for fuel, at nine or ten cwt. a day, it may be put at 10s. daily. The charge for depreciation at 10 per cent is £70 a year, and for interest of capital £35 a year. The whole annual cost may thus be estimated:—

Labour, 80 days	£48
Fuel and oil	44
Repairs and rope	25
Depreciation and interest of capital .	105
Total	£222

"But 500 acres of thrashing, and 70 or 80 acres per annum of steam ploughing for hire, equal in all to at least forty days' work per annum, are also done by this engine. And the profits of this work should be deducted from this sum before Mr Arnot's experience of his investment can be accurately described. The sum of £222, at which, if there had been no other use for engine and apparatus, his cost must have been estimated, is equal to 11s. per acre over the work accomplished, much of which, however, was 12 inches deep. But if the proper share of the interest and depreciation of capital be charged upon its work elsewhere for hire, the cost of steam ploughing will not exceed £190, or 10s. 6d. an acre. But Mr Arnot would contend that the engine is not £30 worse than when he purchased it two years ago; and one-half of this, with interest of capital, will amount to £50, two-thirds only of which should be charged against the plough-work; and £150 would thus appear to be the annual cost of ploughing 400 acres, or 7s. 6d. an acre. In fact, he might very well claim that this sum should be still further reduced by all the profit of his hire elsewhere, which can hardly be put at less than 20s. a day, and this on forty days per annum will amount to £40 or more; so that the net cost to him of his machinery has not been more than £110 a year, or 5s. 6d. an acre over his ploughing.

"What did it use to cost him when he worked thirteen horses on his farm? He now works six horses. His horses get 2½ bushels of oats, and 2½ trusses of hay weekly each, during seven months:—

30 weeks at 11s. amount to .	£16	10	0
22 weeks on clover, &c., at 5s. .	5	10	0
The annual food per horse costs	£22	0	0

"The annual charge for depreciation, farrier, blacksmith, saddler, and implements, is at least £5 per horse, and for interest of capital in horse and implements at least £2 more. This makes the annual cost of each horse £29. The wages paid, in cash and cottage, to ploughmen is at least £32 per pair, or £16 per horse, and the whole cost is thus equal to £45 per horse per annum; which over seven horses amounts to £315 per annum—one-half more than the expenditure, even on the highest estimate, upon the

engine which has displaced them, and nearly double what Mr Arnot has actually incurred when he deducts his profits on its hire.

"A clay land farm near Bedford (the Woolston or Bedford apparatus), the Tithe Farm of Stevington, occupied by Mr William Pike, is a tract naturally of poor clay soil. The extent farmed by Mr Pike has till lately been about 475 acres, of which 357 were arable; and fifteen horses were employed in five 3-horse teams upon this extent. Now, about 600 acres are farmed, of which 420 acres are arable; and the whole is managed with ten horses and an 8-horse power engine, working grubbers on the Woolston system. If the additional land requires the same horse-power per 100 acres as was needed on the original farm, then, in place of ten horses, seventeen or eighteen must have been needed, and probably Mr Pike's mere saving by the use of his 8-horse engine and cultivating apparatus does not fall short of £300 a year.

"The present cropping of the land is as follows:—125 acres are in wheat, of which 105 were partly after beans, cross-grubbed by steam-power before sowing, and partly after clover, having been cross-grubbed also by steam-power more than once before the previous harvest time, and then horse scarified and harrowed. The remainder was after horse cultivation. There are 60 acres of beans after wheat, its stubble having been dressed with farm-yard dung, and then ploughed by horse power. There are 60 acres of grass and clover; 20 acres now in vetches have been cross-grubbed after a manuring; 25 acres in mangolds and turnips have been cross-grubbed in autumn, and again steam-scarified and crossed in spring; 50 acres in barley, and 25 acres in oats, make up the extent of the farm, and were got in after steam cultivation. By 'cross-grubbing' it is meant that the operation was repeated.

"More horse cultivation than usual was done in 1860. Clay land was fit only on rare ocasions, and both horse and steam power were then used to the utmost. Mr Pike has had Mr Smith's grubber worked by an ordinary thrashing-engine since July 1858. Since that time 731 acres have been cross-grubbed, *i.e.*, doubly-worked. In addition to this Mr Pike informs me that he has also cross-grubbed for hire 300 acres of land. For this he charges 25s. an acre, the coals being supplied to the employer.

"Excluding this item from our consideration in the meantime, and assuming that 730 acres—double cultivated between July 1858 and June 1861—correspond to 250 acres annually, the average performance of the engine, including all stoppages except removals, has been six acres daily once cultivated. To do 250 acres twice would therefore occupy at least eighty-three days; adding three days for removals, there are eighty-six days' work of the steam-engine to be charged upon the steam cultivation of the farm. The following is the labour and its cost per week:—1 engineer, 16s.; 1 ploughman, 11s.; 2 men shifting anchors, 22s.; 1 man at windlass, 12s.; 1 porter-boy, 6s.; 1 boy and horse with water cart, 24s.: the whole amounts to £3, 19s., or 13s. 2d. daily. In addition to this we add the cost of coals, 10 cwts. at 19s. a ton on the ground, or 9s. 6d. daily. The oil at 5s. a gallon costs about 1s. a day.

"The daily cost thus comes to 23s. 6d., and this over eighty-six days amounts to about £100. Against the engine and apparatus, costing about £510, we must put 10 per cent., or £51, for depreciation, and 5 per cent., or £25, 10s., for interest of capital. The cost of repairs may perhaps be satisfied by an annual charge of £15; and for tear and wear of rope we have the following items: 1400 yards of iron wire-rope originally purchased, £50; steel ropes, 1400 yards, since purchased, £60. Probably the annual charge needed to maintain this may be made on the theory that the rope will last three years, and £25 a year may suffice for this particular. Adding up these items, we have a sum total of £216, 10s. to be charged against the farm for steam cultivation. Putting £216 against 500 acres once grubbed in the course of the year, we have a charge of about 8s. 7d. an acre for the grubbing. Mr Pike informed me that, during the three years of his steam cultivation, on several of the ten fields already specified, he has not used the plough at all. Even the mixing of manure with the soil is done by the grubber. No plough is used to bury it. It is laid upon the land, and grubbed to and fro, and thereby mixed sufficiently. The cleanness of the land, too, is a fair testimony to the quality of cultivation by implements which stir, but do not overturn the soil.

"Mr Pike has till lately used the grubber invented by Mr Smith of Woolston, with the turnbow apparatus for turning the tool at the land's end. Latterly he has used the cultivator of Messrs Howard, each tine of which is double, pointing both fore and aft, so that no turning at all is needed, the claw which follows in the wake of the working tooth as it goes coming into operation in its turn as it comes back again."

Mr Pike thus writes to Messrs Howard, of date December 2, 1861:—

"GENTLEMEN,—I have cultivated my farm by steam-power for the last four years, and therefore feel myself in a position to speak positively of the merits of the system.

"My farm, belonging to the Duke of Bedford, consists principally of poor, strong, hilly, clay land, which, before I entered upon it, was laid up in three yard ridges, with water gutters drawn across the ridges to take off the water. Since I have steam cultivated it, I have done away with ridges and furrows entirely; my fields of 40 and 50 acres each, which are steep in places, are all laid on the flat, and during the wettest season I have never seen any water stand upon them. I am convinced if land is broken up a good depth by the cultivator, and under drained, there is no need of any furrows, if it is ever so strong.

"I am enabled to manage my farm with about half the number of horses. I do it with less trouble to myself. I am always more forward with my work, and the horses I do keep *cost much less* per head than formerly, as all the *hard work* is done by steam.

"The effect of deep stirring this soil is very apparent in the crops; my land is naturally very poor, so that very large yields are out of the question; but I am convinced I can grow much more corn by steam than by horse cultivation, and I can also grow a larger breadth of root crops. I also find that by constant deep tillage my land moves easier every year, consequently it is less expense to cultivate. I seldom use the plough, except my horses have got nothing else to do.

"I break up my clover lays before harvest, and make a *bastard* fallow of them. I am convinced this is the surest way of getting a good wheat crop on strong soil; and, besides cleaning the land, it has this advantage, it does not leave so much work to do at Michaelmas. I also break up my tare land before harvest, so that after harvest I have nothing to do but cultivate my bean and wheat stubbles.

"I put away my tackle as soon as possible after we have heavy rains, the latter part of October or beginning of November, and do not bring it out again until the turnip land is ready to break up for barley. My object is to make the best use of the summer and the early autumn.

"When I commenced cultivating by steam, I used to set down to little pieces, but I found *that* too much trouble, therefore increased the length of my ropes, as I found it made very little difference to my 8-horse engine whether I had out a long or short length of rope. I have now sufficient to do a 50 acre field, without moving either engine or windlass; this is my largest field; I dug a pond at one end, and I do the whole without moving from the pond. When I can, I set my engine and windlass in an adjoining field, so as to finish headlands and all complete, without going into it. Water carting is a great expense, and in a wet season a great nuisance. I therefore have dug some ponds, and sometimes I dam up a ditch or master drain to obtain a supply.

"I am particularly pleased with the new apparatus you made for me last spring. The windlass is much easier moved about, and is very simple to manage. The cultivator takes less time at land's end, there is no danger of overturning, it does not jump so much in work, and the hind shares cause the land to lay looser. No matter

how hard the ground, it will break it up, and on sidehills it goes much steadier and better than my old one.

"The first steel rope I had did above 2000 acres, and I have a small portion of it at work yet. If people mean to have their ropes last, they must keep them off the ground, and attend well to the coiling on the windlass drums. I like your new rollers, which carry the rope further from the ground.—I am, Gentlemen, yours very truly,

" Messrs J. & F. Howard, Bedford. WILLIAM PIKE."

It is due to Messrs Howard to state that their numerous other customers concur in testifying to the general efficiency of their tackle, its little liability to breakage or derangement, and to the readiness with which their ordinary farm labourers have learned to work it efficiently.

By this time cultivation by steam-power had been adopted by enterprising individuals in nearly every county in England, and was making steady progress in the face of many hindrances. In every instance the purchaser and his servants had to learn the use of novel and somewhat complicated machinery; much of which, as first sent out, proved to be defective both in structure and in material. The fields also, through lack of preparation, often presented obstacles which, as experience was gained, were seen and remedied. In a few instances, where the purchaser of steam tackle was either unable to give his personal superintendence, or lacked the needed energy and perseverance to cope with the difficulties of a new enterprise, it proved a failure. But with rare exceptions, easily accounted for, it was everywhere demonstrated that by steam-power and appropriate implements, the tillage of the soil can be performed with a rapidity, efficiency, and economy far excelling what is practicable by animal power and the old implements.

In the autumn of 1866, by which date steam tillage had greatly extended, the Royal Agricultural Society of England sent out three sets of commissioners to inspect and report on the position of steam cultivation at that time. The reports obtained were published in the Society's *Journal* for 1867, and present a mass of most interesting and instructive information on the whole subject. The commissioners visited about 150 farms situated in nearly 40 different counties of England, and a few in East Lothian, containing an aggregate area of 66,000 acres, which they estimate to be about a third of the whole area *then* under steam cultivation. They amply confirm what has already been stated as to the success of this new system of tillage, and make it plain that the changes thus brought about are of such importance as really to amount to a revolution in modern agriculture.

At its annual show in 1871, at Wolverhampton, the English Society again provided for a careful competitive trial of steam-tillage machinery, when the following awards were made:—

CLASS I.—For the best combination of machinery for the cultivation of the soil by steam-power—
 1st Prize, £100—Awarded to Messrs J. Fowler & Co., Leeds.
 2d Prize, £50— do. do. do.

CLASS II.—For the best combination of machinery for the cultivation of the soil by steam-power, the weight of the steam-engine not to exceed 10 tons—
 1st Prize, £50—Awarded to Messrs Fowler, Leeds.
 2d Prize, £25—Awarded to the Ravensthorpe Engineering Co. (Fisken system).

CLASS III.—For the best combination of machinery for the cultivation of the soil by an ordinary agricultural engine, whether self-propelling or portable.
 1st Prize, £50—Awarded to Messrs Fowler, Leeds.
 2d Prize, £25—Awarded to Messrs Howard, Bedford.

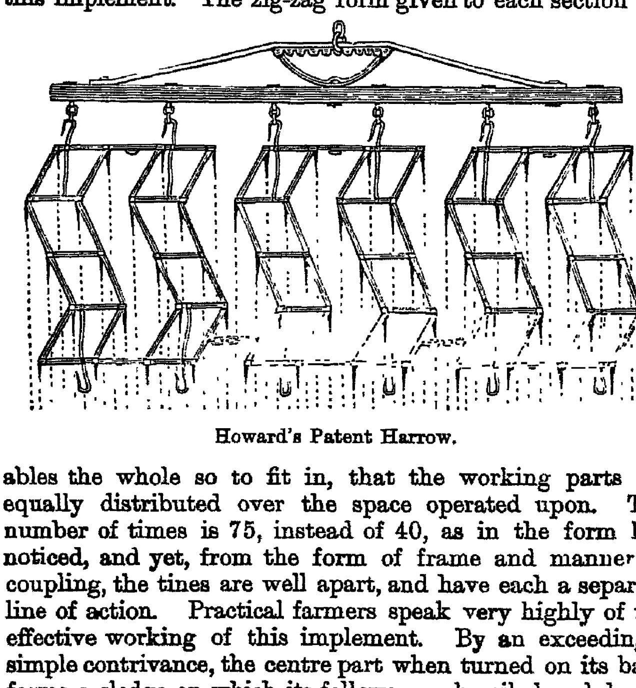
A Silver Cup, value £100, offered by the Right Hon. Lord Vernon, president, for the best combination of machinery for the cultivation of the soil by steam-power, the cost of which shall not exceed £700. The engine to be locomotive, and adapted for threshing and other farm purposes.—Awarded to Messrs Fowler & Co., Leeds.

Steam cultivation has now ceased to be a novelty, and is making rapid progress in all parts of Great Britain and in foreign countries. In March 1873, at an agricultural meeting, it was stated by Messrs Fowler & Co. of Leeds, that they are turning out annually from their works about 100 sets of their tackle for the home market, and from 50 to 60 for foreign countries. Of their home sales about half are to private individuals, and half to persons who work them for hire. In a district around Magdeburgh fifty sets of their tackle are employed in cultivating the soil for the growth of sugar-beet. The other leading makers are also doing a large business, with the certainty of its becoming larger every year. The expiry of several patents applicable to steam cultivating tackle is giving an additional stimulus to the manufacture of such machines. Partly in this way, and also by contrivances of their own, the Messrs Howard of Bedford have recently (1873) made very considerable changes and progress with their tackle. Their self-acting anchors, and their turning cultivator, which is constructed on an entirely new principle, are said to be respectively the best of their kind.

Section 5.—Harrows.

When a field has been broken up by the plough, it is usually next operated upon by the harrow, whether the object be to prepare it for and to cover in seeds, or to bring clods and roots to the surface. This is virtually a rake dragged by horses. In its most ordinary form, the framework is of wood with iron tines, of which each harrow contains twenty. Formerly each horse dragged a single harrow, although two or more were worked abreast. Under this arrangement the harrows had too much independent motion, and were liable to get foul of each other. This has been remedied, first, partially, by coupling them loosely by riders, and then more effectually by a hinge-like joining, which allows a separate vertical motion, but only a combined horizontal one. A rhomboidal form is also given to this *pair* of harrows—usually called *brakes*—so that when properly yoked, no two tines run in the same track. This description of harrow is now frequently made entirely of iron.

Howard's patent harrows are a further improvement on this implement. The zig-zag form given to each section en-



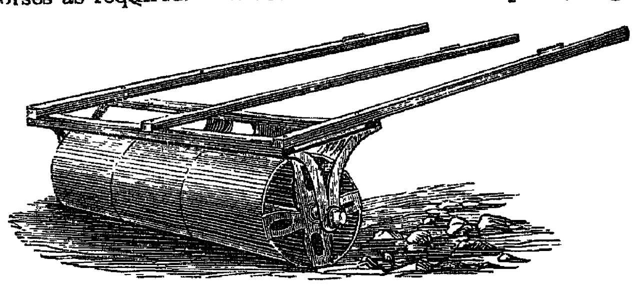
Howard's Patent Harrow.

ables the whole so to fit in, that the working parts are equally distributed over the space operated upon. The number of times is 75, instead of 40, as in the form last noticed, and yet, from the form of frame and manner of coupling, the tines are well apart, and have each a separate line of action. Practical farmers speak very highly of the effective working of this implement. By an exceedingly simple contrivance, the centre part when turned on its back forms a sledge on which its fellows can be piled and drawn along from one field to another. A light description of harrows, with smaller and more numerous tines, is sometimes used for covering in grass-seeds. If a harrow is to be used at all for this purpose, Howard's is a very suitable

kind, but a much better implement is Cartwright's chain-harrow, which abrades the surface over which it is drawn to a degree that could not be anticipated from a mere inspection of the implement. It is formed by attaching to a draught-bar pairs of square-linked chains, each 7½ feet long, connecting them by cross links, and keeping the whole expanded by two movable stretchers. The old-fashioned ponderous break harrow is now entirely discarded, and the more efficient cultivator used in its stead. A form of the latter, from its close resemblance to harrows, is noticed now rather than before. It is a very strong iron harrow, with the tines made longer, and very considerably curved forwards. An iron rod with a loop handle is fixed to the hind bar, by means of which the driver can easily hitch it up and get rid of weeds, &c. Two such harrows are coupled together and drawn by four horses. Its pulverising power is very considerable. But when clods have been brought to the surface, they are most effectually reduced by various kinds of rollers.

Section 6.—*Rollers.*

Those formerly used were solid cylinders of timber or stone attached to a frame and shafts, for which hollow ones of cast-iron are now generally substituted. The simplest form of these has a smooth surface, and is cast in sections to admit of more easy turning. They are made of diverse weights, so as to be adapted for the draught of one or two horses as required. Those of the former description, weigh-

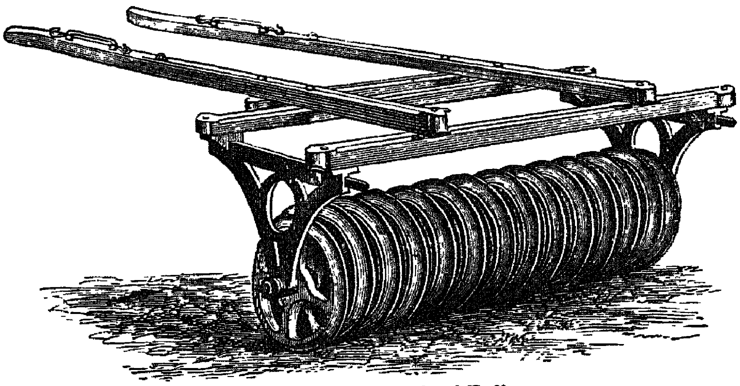


Smooth Cast-Iron Field Roller.

ing in all 6 cwt., and costing as many pounds sterling, are exceedingly useful for all purposes where expedition rather than heavy pressure is wanted. From their greater durability, smoother surface, and less liability to clog, the readiness with which they can be cast of any weight that is required, and their moderate price, it is probable that cast-iron cylinders will speedily supersede all others.

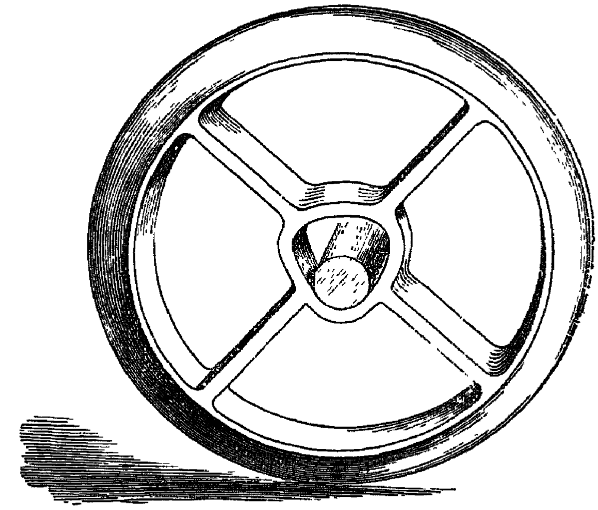
Several important variations on the common smooth roller have been introduced of late years. Of these the first notice is due to Crosskill's clod-crusher, on the ground both of its intrinsic merit and the date of its introduction. It consists of cast-iron discs 2½ feet in diameter, with serrated edge and a series of sideway-projecting teeth. Twenty-three of these discs are strung loosely upon a round axle, so as to revolve independently of each other. The free motion thus given to each disc, and which has latterly been increased by casting each alternate one of greater diameter in the eye, adds at once to the pulverising and self-cleaning power of the roller. Three horses yoked abreast are required to work it. The axle is prolonged at each end sufficiently to receive travelling wheels, on which it is transported from place to place. Although primarily designed and actually much used for breaking clods, it is even more in request for consolidating loose soils, checking the ravages of wire-worm, and covering in clover and grass seeds. For the latter purpose, its action is perfected by attaching a few bushes to it, which fill up the indentations, and leave a surface so beautifully even as to rival the accuracy and neatness of a well-raked border. It is now to be had on a smaller scale adapted to the draught of two horses.

Cambridge's roller possesses several features in common with Crosskill's, and is used for similar purposes. In the



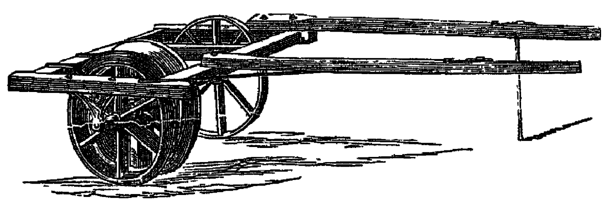
Cambridge's Press-Wheel Roller.

form in which it was first brought out it consisted of discs, fitting close to each other, with fluted instead of serrated edges. In its recently improved form the discs are not made of uniform diameter as formerly, but each alternate one in the set is raised about two inches, and has the centre hole, not circular and close fitting to the axle, but triangular and wide. The result is that while the discs press uniformly on the surface over which they are rolled, the larger ones rise above their fellows with a jerking motion, which gives a most efficient self-cleaning power to the implement, and thus admits of its being used when other rollers would be clogged. The eccentric discs are now made either with serrated or smooth edges as customers prefer. After careful trial we have come to the conclusion that it is the most useful roller for general purposes which we yet possess.



Disc of Cambridge's Roller, showing Self-cleaning Action.

Under this head may be noticed press drills, which, by means of a series of narrow cylinders with conical edges, form corresponding grooves in loose soil. Seeds sown broadcast over a surface thus treated come up in rows. The



Land-Presser.

land-presser is a modification of the press-roller. It is made with two or three conical edged cylinders to fit into the seams of as many plough furrows, the other end

of the axle on which they are fixed being supported by a plain carriage-wheel. It is drawn by one horse, and follows in the wake of two or three ploughs, according to the number of its cylinders. When wheat is sown after clover lea, this implement is found exceedingly useful in closing the seams and forming a uniform seed-bed.

The Norwegian, or, as it should rather be called, the Swedish harrow is strictly a clod-crushing implement. From its radiating spikes penetrating the surface over which it is drawn, it has been called a harrow; but its revolving motion entitles it rather to be classed with rollers. In its usual form it consists of three rows of cast-iron rowels arranged upon parallel axles fixed in an iron frame, which is supported on three wheels,—one in front and two behind. The outline and arrangements are in fact the same as in Finlayson's grubber, only substituting parallel rows of rowels for tines. There is also the same leverage for raising and depressing the frame. But this implement has recently been constructed on a much simpler and cheaper plan, in which the wheels and lever apparatus are discarded altogether. It thus consists of a simple wrought-iron frame with four rows of rowels. A few boards are laid across the frame, forming a platform over the rowels, on which the driver stands when it is wished to increase the weight and efficiency of the implement. On the upper side at either end is fixed a piece of wheel-tire, on which the implement, when turned on its back, can slide along, sledge-fashion, when it is wished to move it from place to place. As thus constructed it can be made for about £5. This is the best implement yet introduced for breaking *moist* clods.

Section 7.—Breast-Plough and Trenching-Fork.

Before leaving the implements of tillage, it may be proper to notice two, which have been a good deal brought under notice of late years, viz., the breast-plough and trenching-fork. The former is extensively used in carrying out the process of paring and burning. It is the implement known in Scotland as the flaughter (or thin turf) spade. In using it the workman guards his thighs with a piece of board, fastened on apron-wise, and with this presses against the cross-head of the implement, and urges forward its cutting edge. When a thin turf has thus been severed from the surface, he turns it over by a jerk of his arms. The fork is used in giving a deep autumn digging to land in preparation for root crops. Both operations can ordinarily be more economically performed by using horse-power with suitable implements. But for clearing out corners of fields, hedge sides, and similar places, manual labour with these tools can frequently be made to supplement the plough to good purpose.

Section 8.—Implements for Sowing.

A large portion of the grain annually sown in Great Britain is still distributed by hand from the primitive sowing-sheet.

> "The sower stalks
> With measured step, and liberal throws the grain
> Into the faithful bosom of the ground."

In Scotland a decided preference is still given to broadcast sowing, for which purpose a machine is used that covers from 15 to 18 feet, according to the width of ridge adopted. It consists of a long seed-box, carried on a frame mounted on two wheels. From these motion is communicated to a spindle which revolves in the seed-box, and expels the seed by means of cogs or brushes, through openings which can be graduated to suit the required rate of seeding. It is drawn by a single horse, is attended by one man, and can get over 30 acres a day. It is peculiarly adapted for the regular distribution of clover and grass seeds. Now that reaping by machinery has become so general, there is an obvious advantage in having the fields as level and with as few open forms as possible, and hence of having a marker attached to the sowing-machine. In one made by Sheriff at West Barns, by an ingenious apparatus on the principle of the odometer, the machine itself is made to register the space which it travels over, and thus to indicate the rate per acre at which it is distributing the seed. Excellent results have been, and still are, obtained from broadcast sowing. But as tillage becomes more perfect, there arises a demand for greater accuracy in the depth at which seeds are deposited in the soil, for greater precision in the rate and regularity of their distribution, and for greater facilities for removing weeds from amongst the growing crop. These considerations led, at a comparatively early period, to the system of sowing crops in rows or drills, and hence the demand for machines to do this expeditiously and accurately. We accordingly find, in our best cultivated districts, the sowing and after-culture of the crops now conducted with a precision which reminds the spectator of the processes of some well-arranged factory. This is accomplished by means of a variety of drilling-machines, the most prominent of which we shall now notice.

The Suffolk drill is the kind in most general use. It is a complicated and costly machine by which manure and seeds can be simultaneously deposited. That called the "general purpose drill" can sow ten rows of corn, with or without manure, at any width between the rows from 4½ to 10 inches, and at any rate per acre between two pecks and six bushels. It can be arranged also to sow clover and grass seeds,—the heavier seeds of clover being thrown out by minute cups,—and the lighter grass seeds brushed out from a separate compartment. It is further fitted for sowing beans and turnips—the latter either two drills at a time on the ridge, or three on the flat. This drill, as most recently improved by Messrs Hornsby of Grantham and Garrett of Leiston, has an apparatus for preserving the machine in a level position when working on sloping ground. As a main object in drilling crops at all is to admit of the use of the hoe, it becomes an important point to accomplish the drilling with undeviating straightness, and exact parallelism in each successive course of the drill. This is now obtained by means of a fore-carriage, which an assistant walking alongside so controls by a lever as easily to keep the wheel in the same rut down which it had previously passed. Messrs Hornsby have also introduced India-rubber tubes for conducting the seed, in place of the tin funnels hitherto used. These drills cost about £42.

The Woburn drill of the Messrs Hensman is simpler in its construction than those already noticed. "In all other drills, the coulters, which distribute the manure or seed, hang from the carriage. In this drill the carriage rests upon the coulters, which are like the iron of skates; it may be said, indeed, to run on four pairs of skates. Hence this drill's power of penetrating hard ground, and of giving a firm bed to the wheat-seed in soft ground. Each drill coulter, however, preserves its independence as when suspended. This self-adjustment is required by the inequality of tilled ground, and is thus obtained: each pair of coulters is fixed to the end of a balance beam, these again to others, and they to a central one. Thus each coulter, in well-poised rank, gives its independent share of support. It varies from the generality of drills, as it is drawn from the centre by whipple-trees instead of shafts; and the drill-man behind can steer or direct the drill with the greatest nicety. The corn-box of the drill is entirely self-acting, and delivers the seed equally well going either up or down hill. It is also capable of horse-hoeing, by attaching hoes to the levers instead of the coulter-shares.

It is drawn by a pair of horses, and the price from £18 to £20."[1]

Turnip drill.—In Scotland, and in the north and west of England, turnips are usually sown on the ridge by a machine which sows two rows at a time. In the south-eastern parts of England, which are hotter and drier, it is found better to sow them on the flat, for which purpose machines are constructed which sow four rows together, depositing manure at the same time. Both kinds are adapted for sowing either turnips or mangold-wurzel seeds as required. With the view of economising seed and manure, what are called drop-drills have recently been introduced, which deposit both—not in continuous streams—but in jets, at such intervals apart in the rows as the farmer wishes the plants to stand. What promises to be a more useful machine is a water-drill invented by a Wiltshire farmer—Mr Chandler of Market Lavington. "His water-drill pours down each manure-coulter the requisite amount of fluid, mixed with powdered manure, and thus brings up the plant from a mere bed of dust. Having used it largely during three years, I may testify to its excellence. Only last July, when my bailiff had ceased turnip sowing on account of the drought, by directing the use of the water-drill, I obtained from this latter sowing an earlier and a better show of young plants than from the former one with the dust-drill. Nor is there any increase of expense if water be within a moderate distance, for we do not use powder-manures alone. They must be mixed with ashes, that they may be diffused in the soil. Now, the expense and labour of supplying these ashes are equal to the cost of fetching mere water; and apart from any want of rain, it is found that this method of moist diffusion, dissolving, instead of mingling only, the superphosphate, quickens its action even upon damp ground, and makes a little of it go further."[2]

Section 9.—*Manure-Distributors.*

The practice of top-dressing wheat, vetches, clover, or meadows, with guano and various light manures, has now so much increased, and the inconvenience of scattering them over the surface by hand is so great, that various machines have recently been invented for distributing them, which can also be used for sowing such manures over turnip drills, covering three at once. Such machines will probably be used in future for distributing lime, which can thus be done much more regularly than by cart and shovel, especially when it is wished to apply small quantities for the destruction of slugs or for other purposes. It seems quite practicable to have this or a similar machine so constructed as that it could be readily hooked on to the tail of a cart containing the lime or other substance which it is desired to distribute by it. The top-dressing material could by such an arrangement be drawn into the hopper of the distributor as it and its tender move along, and the cart when emptied be replaced by a full one with little loss of time.

A cheap and effective machine, capable of being in a similar manner attached to a dung-cart, which could tear asunder fold-yard manure, and distribute it evenly in the bottoms of turnip drills, would be a great boon to farmers, and seems a fitting object to be aimed at by those possessed of the inventive faculty.

Section 10.—*Horse-Hoes.*

It has already been remarked that the great inducement to sow grain and green crops in rows is that hoeing may be resorted to, for the double purpose of ridding them of weeds and stimulating their growth by frequent stirring of the soil. It is now upwards of a century since Jethro Tull demonstrated, in his books and on his fields, the facility with which horse-power could be thus employed. His system was early adopted in regard to turnips, and led, as we have seen, to a complete revolution in the practice of agriculture. The peculiar manner in which he applied his system to grain crops, and the principles on which he grounded his practice, have hitherto been for the most part repudiated by agriculturists, who have thought it indispensable to drill their grain at intervals so narrow as to admit, as was supposed, of the use of the hand-hoe only. But the accuracy with which corn-drills perform their work has been skilfully taken advantage of, and we now have horse-hoes, covering the same breadth as the drill, which can be worked with perfect safety in intervals of but seven inches' width. By such a machine, and the labour of a pair of horses, two men, and a boy, ten acres of corn can be hoed in as many hours. Not only is the work done at a fifth of the expense of hand-hoeing, and far more effectually, but it is practicable in localities and at seasons in which hand-labour cannot be obtained.

Garrett's horse-hoe is admitted to be the best implement of its kind. It can be used for hoeing either beans, turnips, or corn, as the hoes can be adapted to suit any width betwixt rows, and the axle-tree being movable at both ends, the wheels, too, can be shifted so as to be kept between the rows of plants. The shafts can be attached to any part of the frame to avoid injury to the crop by the treading of the horses. Each hoe works on a lever independent of the others, and can be loaded with different weights, on the same principle as the coulters of the corn-drill, to accommodate it to uneven surfaces and varying degrees of hardness in the soil.

A great variety of implements, under the general names of horse-hoes, scufflers, scrapers, or drill-grubbers, fitted for the draught of one horse, and to operate on one drill at a time, is in use in those parts of the country where root crops are chiefly sown on ridgelets from 24 to 30 inches apart. With considerable diversity of form and efficiency, they in general have these features in common, viz., provision for being set so as to work at varying widths and depths, and for being armed either with hoes or tines, according as it is wished to pare the surface or stir the soil more deeply. A miniature Norwegian harrow is sometimes attached to drill-grubbers, by which weeds are detached from the soil, and the surface levelled and pulverised more thoroughly. Tennant's grubber, with its tines set close together, and two horses yoked to it abreast by a tree long enough to allow them to walk in the drills on either side of that operated upon, is the most effective implement for cultivating between the rows of beans, potatoes, turnips, or mangolds, that we have yet seen used for this purpose.

Section 11.—*Turnip-Thinners.*

It sometimes happens, as when drought prevails while the earlier sowings of turnips or mangold are made, and this is followed by copious rains and forcing weather, that the farmer finds it impracticable to get the thinning-out of the seedlings overtaken as fast as is needful. To aid him in such emergencies, a class of machines has been brought out, of which Huckvale's turnip-thinner may be named as a type. They are very favourably reported of by those who have used them. Such machines, drawn by one horse, and made to operate upon either one or two rows of young turnip plants, have first a paring apparatus, which clears off weeds from the sides of the rows, and along with this a set of revolving hoes by which gaps are cut in the rows of turnip plants, and tufts of them are left standing at any

[1] See Mr Pusey's Report on Implements, in the *Journal of the Royal Agricultural Society of England*, vol. xii. p. 604.

[2] Ibid., p. 607.

required distance apart. This does not dispense with the after use of the hand-hoe or fingers to effect a perfect singling of the plants; but as a large space can be gone over in a day at small cost, it enables the farmer to save his crop from getting overgrown and choked until he can overtake the more perfect thinning of it. The next class that claims attention is

Section 12.—*Harvesting Implements.*

These, till little more than twenty years ago, comprised only the reaping-hook and scythe. An implement by means of which horse-power could be made available for this important operation has long been eagerly desired by farmers. Repeatedly during the first half of the present century their hopes had been excited, only to be disappointed, by the announcement of successful inventions of this kind. These hopes were revived, and raised to a higher pitch than ever, by the appearance, in the Great Exhibition of the Industry of all Nations, of two reaping-machines, known as M'Cormick's and Hussey's, from the United States of America, where for several years they had been used extensively and successfully. These implements were subjected to repeated trials in different parts of England, on crop 1851, but never in circumstances which admitted of their capabilities being tested in a thoroughly satisfactory manner.

At the first of these trials, made under the auspices of the Royal Agricultural Society, the preference was given to M'Cormick's, to which the Exhibition Medal was in consequence awarded. It turned out, however, that at this trial Hussey's machine had not a fair chance, being attended by a person who had never before seen it at work, for, when a further trial took place before the Cleveland Agricultural Society, with Mr Hussey himself superintending his own machine, an all but unanimous decision was given in his favour. Hussey's machine was in consequence adopted by the leading implement makers, such as Messrs Garrett, Crosskill, &c.

Early in 1852, a very important communication from the pen of the late Mr James Slight, curator of the museum of the Highland and Agricultural Society, appeared in the Transactions of the Society, by which the attention of the public was recalled to a reaping-machine of home production, viz., that invented by the Rev. Patrick Bell, minister of the parish of Carmylie in Forfarshire, and for which a premium of £50 had been awarded to him by the Highland Society. This machine attracted much attention at that time. Considerable numbers were made and partially used, but from various causes the invention was lost sight of, until, by the arrival of these American machines, and the notoriety given to them by the Great Exhibition, with concurring causes about to be noticed, an intense interest was again excited regarding reaping by machinery. From Mr Slight's report, the public learned that the identical Bell's machine, to which the prize was awarded, had for the previous fourteen years been statedly employed on the farm of Inch-Michael in the Carse of Gowrie, occupied by Mr George Bell, a brother of the inventor, who, during all that period, had succeeded in reaping, on the average, four-fifths of his crop by means of it every year. Mr Slight further stated, that at least *four* specimens of it had been carried to America, and that from the identity in principle between them and those now brought thence, with other corroborating circumstances, there is little doubt that the so-called American inventions are after all but imitations of this Scottish machine. When it became known that Bell's machine was to be exhibited, and, if possible, subjected to public trial, at the meeting of the Highland and Agricultural Society at Perth, in August 1852, the event was looked forward to by Scottish farmers with eager interest. On that occasion it was accordingly again brought forward, with several important improvements made upon it, by Mr George Bell, already referred to, and was fully tested in competition with Hussey's, as made by Crosskill. To the disappointment of many, Mr M'Cormick did not think fit to enter the lists at this or at some subsequent opportunities.

The success of Bell's machine on this occasion, and at some subsequent public trials, gave it a high place in public estimation, and accordingly many of the implements manufactured by Mr Crosskill of Beverley, were sold to farmers in all parts of Great Britain, and especially in Scotland. After a hopeful start the success of this machine has not been so decided as was at first anticipated. In common with other reaping-machines, it had of course to contend with the disadvantages of unprepared fields and unskilful guides; but in addition to this, it was found to be too heavy in draught, too liable to derangement, and (in the first issues of it) too easily broken in some of its parts to be fitted for general use. These drawbacks were, to a greater or less extent, obviated by subsequent improvements, and the machine continued for a few years to receive a fair measure of public patronage. By-and-by it was in a great measure superseded by other self-delivery machines, such as Burgess & Key's M'Cormick, with its Archimedean screw, which, like Bell's, lays off the reaped grain in a continuous swathe, and by others which, by means of revolving rakes, lay it off in quantities suitable to form a sheaf. In crops of moderate bulk and standing erect, these self-delivery machines make rapid and satisfactory work, but when the crop is lodged and twisted they are nearly useless. The consequence is that for several years, and especially in those districts where reaping by machinery is most practised, the preference is given to manual-delivery machines, on the ground that they are lighter of draught, less liable to derangement, less costly, more easily managed, and thus more to be depended upon for the regular performance of a fair amount of daily work, than their heavier rivals. And, accordingly, light machines on Hussey's principle, but with endless variations, are at present most in demand.

Before leaving this subject, a remark is due in connection with the strange neglect of Bell's machine for twenty-five years, and the enthusiasm with which it was hailed on its reappearance. The first is so far accounted for by the fact noticed by Mr George Bell, that such specimens of his brother's machine as formerly got into the hands of farmers were so imperfectly constructed that they did not work satisfactorily, and thus brought discredit on his invention. The true explanation seems to be, that at that date the country was not ready for such a machine. Not only was manual labour then abundant and cheap, from the number of Irish labourers, who annually, as harvest drew near, flocked into the arable districts of Great Britain, but thorough draining had made little progress, and the land was everywhere laid into high ridges, presenting a surface peculiarly unfavourable for the successful working of a reaping-machine. Now, however, the conditions are reversed. Emigration to the colonies, and the ever-growing demand for labourers in connection with factories, mines, docks, and railways, have to a very great extent withdrawn the class of people that used to be available for harvest work, and have so largely raised the rate of wages to those who still remain as to render reaping-machines indispensable to the farmer. The progress of thorough draining has at the same time enabled him to dispense with the old-fashioned ridges and furrows, and to lay his corn lands in the level state so favourable for reaping and other operations of husbandry. In these altered conditions lies the true explanation of the former apathy and subsequent enthusiasm manifested by our farmers towards this invention.

Section 13.—*Mowing-Machines.*

Another class of labour-saving machines, closely allied to those we have just described, for which we are indebted to our American cousins, is mowing-machines. Several different forms of these were introduced and brought into somewhat general use during the years 1858 and 1859. Having used such machines for the past fourteen years we can testify to their thorough efficiency, and to the very great saving of labour, and still more of time, which can be secured by means of them. In one instance 30 acres of clover—a very full crop, and partially lodged—were mown in 32 hours, and this under all the disadvantages of a first start. This machine being of very light draught, a pair of horses can work it at a smart pace without difficulty. By employing two pairs of horses, and working them by relay, it can, in the long days of June and July, be kept going sixteen hours a day, and will easily mow from 16 to 18 acres of seeds or meadow in that time, making, moreover, better work than can ordinarily be obtained by using the scythe. These mowing-machines, which cost from £16 to £25 each, have proved a most seasonable and truly important addition to our list of agricultural implements. That they may be used to advantage, it is absolutely necessary to have the land well rolled and carefully freed from stones.

Section 14.—*Haymakers.*

Haymakers are valuable implements, and well deserving of more general use. They do their work thoroughly, and enable the farmer to get through a great amount of it in snatches of favourable weather. Where manual labour is scarce, or when, as in Scotland, haymaking and turnip-thinning usually come on hand together, the mower and haymaker render the horse-power of the farm available for an important process which cannot be done well unless it is done rapidly and in season.

Section 15.—*Horse-Rakes.*

Horse-rakes are in frequent use for gathering together the stalks of corn which are scattered during the process of reaping, for facilitating the process of haymaking, and also for collecting weeds from fallows. By an ingenious contrivance in the most improved form of this implement, the teeth are disengaged from the material which they have gathered without interrupting the progress of the horse.

We seem to be verging on the time when, by means of machines worked by horse-power, farmers will be enabled to cut and carry their grass and grain with little more than the ordinary forces of their farms.

Section 16.—*Wheel-Carriages.*

The cartage of crops, manure, &c., upon an arable farm, is such an important part of the whole labour performed upon it (equal, as shown by a recent estimate, to one-half),[1] that it is a matter of the utmost consequence to have the work performed by carriages of the most suitable kind. It was for a long time keenly debated by agriculturists, whether waggons or carts are most economical. This question is now undoubtedly settled. Mr Pusey says, "It is proved beyond question that the Scotch and Northumbrian farmers, by using one-horse carts, save one-half of the horses which south country farmers still string on to their three-horse waggons and three-horse dung-carts, or dung-pots, as they are called. The said three-horse waggons and dung-pots would also cost nearly three times as much original outlay. Few, I suppose, if any, farmers *buy* these expensive luxuries now, though it is wonderful they should keep them; for last year at Grantham, in a public trial, *five* horses with five carts were matched against five waggons with *ten* horses, and the five horses beat the ten by two loads."[2] The one-horse carts here referred to are usually so constructed as to be easily adapted to the different purposes for which wheel-carriages are needed upon a farm. For each pair of wheels and axle there is provided a close-bodied cart, and another with sparred sides and broad shelvings, called a long-cart, or harvest-cart, either of which can easily be attached to the wheels, according to the nature of the commodities to be carried. Sometimes a simple movable frame is attached to the close-body to fit it for carrying hay or straw; but although one or two such frames are useful for casual purposes throughout the year, they are inferior for harvest work to the regular sparred cart with its own shafts. In some districts the whole of the close-bodied carts used on the farm are made to tip. For many purposes this is a great convenience; but for the conveyance of grain to market, and generally for all road work, a firm frame is much easier for the horse, and less liable to decay and derangement. The Berwickshire practice is to have one pair of tip-carts on each farm, and all the rest firm or dormant-bodied, as they are sometimes called.

Many farms are now provided with a water or tank cart, for conveying and distributing liquid manure.

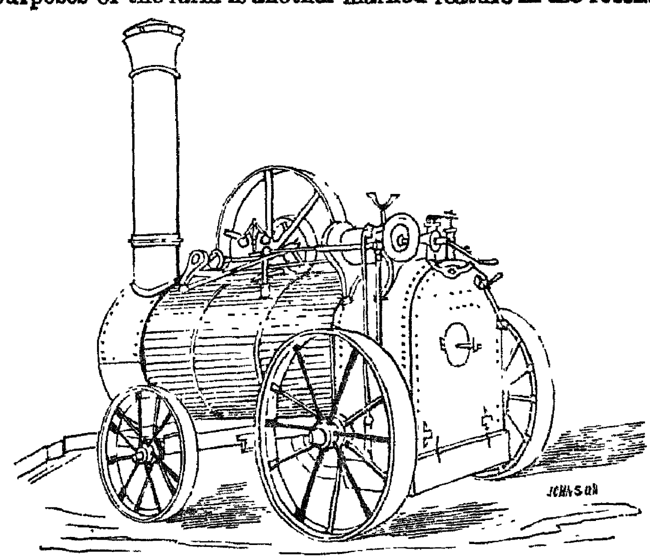
Section 17.—*Road-Engines.*

Although many attempts have been made to adapt the locomotive steam-engine for the conveyance both of passengers and goods on common roads, the results hitherto have not been altogether satisfactory. Progress is, however, undoubtedly being made in this effort; and in not a few instances such engines are actually in use for the carriage of heavy goods. If beet-sugar factories should increase in Great Britain, the carriage of the roots from the farms to the factories will probably be performed by traction engines; for the inexpediency of withdrawing the horse-power of the farm from its other urgent work at the season most suitable for delivering these roots to the sugar-maker presents at present a serious hindrance to the cultivation of this crop.

MACHINES FOR PREPARING CROPS FOR MARKET.
(Sections 18, 19, 20.)

Section 18.—*Steam-Engines.*

The extent to which steam-power is now employed for the purposes of the farm is another marked feature in the recent



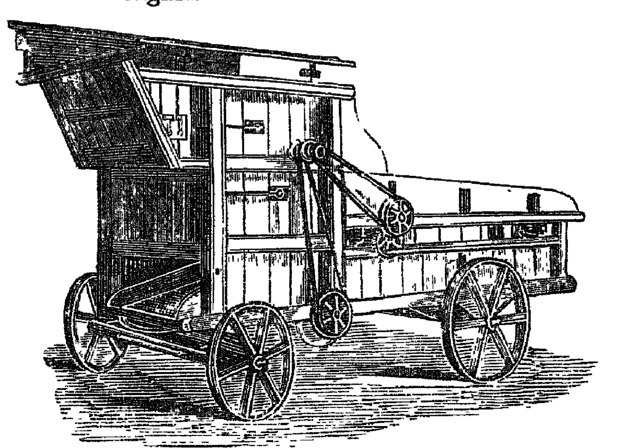
Portable Steam-Engine. (Clayton, Shuttleworth, & Co.)

progress of agriculture. We have already referred to the value of water-power for propelling agricultural machinery

[1] See *Morton's Cyclopædia of Agriculture.* Article "Carriages."

[2] Mr Pusey's Report, in the *Journal of the Royal Agricultural Society of England* vol. xii. p. 617.

when it can be had in sufficient and regular supply. As it is only in exceptional cases that farms are thus favoured, the steam-engine is the power that must generally be reckoned upon, and accordingly its use is now so common that a tall chimney has become, over extended districts, the prominent feature of nearly every homestead. It has been satisfactorily shown that grain can be thrashed and dressed by well-constructed, steam-propelled machinery, at one-fourth the cost of thrashing by horse-power and dressing by hand-fanners. So great, indeed, is the improvement in steam-engines, and so readily can the amount of power be accommodated to the work to be done, that we find them everywhere superseding the one-horse gin, and even manual labour, for pumping, churning, coffee-grinding, &c. Wherever, then, a thrashing-mill is used at all, it may be safely asserted that, next to water, steam is the cheapest power by which it can be propelled. The *portable* engine is the form which has hitherto found most favour in the southern parts of the kingdom. Mr Pusey thus states the reason for which he regards them as preferable to fixed engines:—"If a farm be a large one, and especially if, as is often the case, it be of an irregular shape, there is great waste of labour for horses and men in bringing home all the corn in the straw to one point, and in again carrying out the dung to a distance of perhaps two or three miles. It is therefore common, and should be general, to have a second outlying yard. This accommodation cannot be reconciled with a fixed engine.



Portable Thrashing-Machine. (Clayton, Shuttleworth, & Co.)

"If the farm be of a moderate size, it will hardly—and if small will certainly not—bear the expense of a fixed engine: there would be waste of capital in multiplying fixed engines to be worked but a few days in the year. It is now common, therefore, in some counties for a man to invest a small capital in a movable engine, and earn his livelihood by letting it out to the farmer.

"But there is a further advantage in these movable engines, little, I believe, if at all known. Hitherto corn has been thrashed under cover in barns; but with these engines and the improved thrashing-machines we can thrash the rick in the open air at once as it stands. It will be said, How can you thrash out of doors on a wet day? The answer is simple. Neither can you move your rick into your barn on a wet day; and so rapid is the work of the new thrashing-machines, that it takes no more time to thrash the corn than to move it. Open-air thrashing is also far pleasanter and healthier for the labourers, their lungs not being choked with dust, as under cover they are; and there is, of course, a saving of labour to the tenant not inconsiderable. But when these movable steam-engines have spread generally, there will arise an equally important saving to the landlord in buildings. Instead of three or more barns clustering round the homestead, one or other in constant want of repair, a single building will suffice for dressing corn and for chaff-cutting. The very barn-floors saved will be no insignificant item. Now that buildings are required for new purposes, we must, if we can, retrench those buildings whose objects are obsolete. Open-air thrashing may appear visionary, but it is quite common with the new machinery; nor would any one perform the tedious manœuvre of setting horses and men to pull down a rick, place it on carts, and build it up again in the barn, who had once tried the simple plan of pitching the sheaves at once into the thrashing-machine."[1]

To us these reasons are inconclusive.. A fixed engine can be erected and kept in repair at greatly less cost than a portable one of the same power. It is much easier to keep the steam at working pressure in the common boiler than in the tubular one, which, from its compactness, is generally adopted in portable engines. It is, no doubt, very convenient to draw up engine and machinery alongside a rick and pitch the sheaves at once upon the feeding-board, and very pleasant to do this in the sunshine and "caller air;" but we should think it neither convenient nor pleasant to have engine and thrashing-gear to transport and refix every time of thrashing, to have grain and chaff to cart to the barn, the thrashed straw to convey to the respective places of consumption, and all this in circumstances unfavourable to accurate and cleanly disposal of the products, and excessive exposure to risk of weather. Sudden rain will no doubt interrupt the carrying in of a rick in the one case as the thrashing of it in the other; but there is this vast difference in favour of the former, that the partially carried rick is easily re-covered; machinery, products of thrashing, and work-people, are safely under cover; and the engine is ready by a slight change of gearing for other work, such as bruising, grinding, or chaff-cutting.

It is urged on behalf of the portable engine, that in districts where the farms are generally small, one may serve a good many neighbours. Now, not to dwell on the expense and inconvenience to small occupiers of frequently transporting such heavy carriages, and of having as much of their crop thrashed in a day (there being manifest economy in having at least a day's work when it is employed) as will meet their demands for fodder and litter for weeks to come, we are persuaded that on farms of even 80 or 100 acres, a compact fixed engine of two or three horse-power will thrash, bruise grain, cut chaff, work a churn, and cook cattle food, &c., more economically than such work can be done in any other way. It is very usual to find on such farms, especially in dairy districts, an apparatus for cooking cattle food by steam, or by boiling in a large copper, where as much fuel is used every day, and as much steam generated, as would work such an engine as we have referred to, and do the cooking over and above. Even a small dairy implies a daily demand for boiling water to scrub vessels and cook food for cows. How manifestly economical, then, when the steam is up at any rate, to employ this untiring, obedient agent, so willing to turn the hand of anything, in performing the heavy work of the homestead with a power equal, perhaps, to that of all the men and horses employed upon the farm.

Whenever tillage by steam-power is fairly available, there will undoubtedly be an inducement to use the portable engine as a thrashing-power that has not hitherto existed, as there will be a manifest economy in having both operations performed by the same engine. Even then, however, there is a high probability of its being found impracticable to withdraw the engine even once a week for the needful thrashing during the six or eight weeks immediately after

[1] Mr Pusey's Report on Implements.—*Journal of the Royal Agricultural Society of England*, vol. xii. p. 621.

harvest, when it will be of such consequence to make diligent use of every available hour for pushing on the tillage.

The kind of fixed engine most approved for farm-work in the north of England and south of Scotland is the overhead crank engine, attached by direct action to the spur-wheel, and sometimes even to the drum shaft of the thrashing-machine. Their cheapness, simplicity of construction, easy management, and non-liability to derangement, fit these engines in an eminent degree for farm-work.[1]

Section 19.—Thrashing-Machines.

It is now sixty-five years since an ingenious Scotch mechanist, Andrew Meikle, produced a thrashing-machine so perfect that its essential features are retained unaltered to the present day. Indeed, it is frequently asserted that, after all the modifications and supposed improvements of the thrashing-machine which have been introduced by various parties, the mills made by Meikle himself have not yet been surpassed, so far as thorough and rapid separation of the grain from the straw is concerned. The unthrashed corn is fed evenly into a pair of slowly revolving fluted rollers of cast-iron, by which it is presented to the action of a rapidly revolving cylinder or drum armed with four beaters, which are square spars of wood faced with iron, fixed parallel to its axis, and projecting about four inches from its circumference. The drum is provided with a dome or cover, and the corn being partly held by the fluted rollers as it passes betwixt the drum and its cover, the rapid strokes of the beaters detach the grain from the ears, and throw the straw forward upon slowly revolving rakes, in passing over which the loose grain is shaken out of the straw, and falls through a grating into the hopper of a winnowing and riddling machine, which rids it of dust and chaff, and separates the grain from the unthrashed ears and broken straw, called *roughs* or *shorts*. The grain and roughs are discharged by separate spouts into the apartment below the thrashing-loft, whence the corn is fed into the rollers, and the thrashed straw falls from the rakes into the straw barn beyond. Since Meikle's time further additions have been made to the machinery. In the most improved machines driven by steam or a sufficient water power, the grain is raised by a series of buckets fixed on an endless web into the hopper of a double winnowing-machine, by which it is separated into clean corn, light, whites or capes, and small seeds and sand. The discharging spouts are sufficiently elevated to admit of sacks being hooked on to receive the different products as they fall. When barley is thrashed, it is first carried by a separate set of elevators, which can be detached at pleasure, into a "hummeller," in which it is freed from the awns, and then raised into the second fanners in the same manner as other grain. The hummeller is a hollow cylinder, in which a spindle fitted with transverse blunt knives revolves rapidly. The rough grain is poured in at the top, and, after being acted upon by the knives, is emitted at the bottom through an opening which is enlarged or diminished by a sliding shutter, according to the degree of trimming that is required. A large set of elevators is usually employed to carry up the roughs to the feeding-board, that they may again be subjected to the action of the drum. The roughs are emptied, not directly on the feeding-board, but into a riddle, from which the loose grain passes by a canvas funnel direct to the winnower in the apartment below, and only the unthrashed ears and short straw are allowed to fall upon the board.

The alterations that have been made upon the thrashing-machine since Meikle's time chiefly affect the drum. Meikle himself tried to improve upon his beaters by fixing a projecting ledge of iron on their outer edges, so as to give them a scutching action similar to that of flax-mills. This strips off the grain from oats or barley very well when thinly fed in; but its tendency is to rub off the entire ears, especially of wheat, and also to miss a portion of the ears, whenever there is rapid feeding in. More recent trials of drums on the scutching principle show them to be on the whole inferior to the plain beater.

We have already referred to the general use of portable thrashing-machines in the eastern counties of England. These, for the most part, have drums with six beaters upon a skeleton frame, which revolve with great rapidity (about 800 times per minute, hence often called high-speed drum), within a concave or screen, which encloses the drum for about one-third its circumference. This screen consists alternately of iron ribs and open wire-work, and is so placed that its inner surface can be brought into near contact with the edges of the revolving beaters, and admits of this space being increased or diminished by means of screws. No feeding-rollers are used with this drum, the unthrashed corn being introduced directly to it.

Another form of drum, acting on the same principle as that just referred to, but cased with plate-iron, and having for beaters eight strips of iron projecting about one-fourth of an inch from its surface, and which works within a concave which embraces it for three-fifths of its circumference, is in use when it is desired to preserve the straw as straight and unbroken as possible. These are made of sufficient width to admit of the corn being fed in sideways, and are called *bolting* machines, from the straw being delivered in a fit state for being at once made up into *bolts* or bundles for market. Although the term *beaters* is retained in describing these drums, it is evident that the process by which the grain is separated from the ears is rubbing rather than beating. This necessarily requires that only a narrow space intervene between drum and concave, and that the corn be fed in somewhat thinly. Such machines thrash clean, whether the ears are all at one end of the sheaf or not, and deliver the straw straight and uninjured; but it is objected to these by some that they are slower in their operation than those with the beating drum, are liable to choke if the straw is at all damp, that the grain is sometimes broken by them, and that they require greater power to drive them.

A further and more recent modification is the peg-drum. In this case the drum is fitted with parallel rows of iron pegs, projecting about 2½ inches from its surface, which in its revolutions pass within one-fourth of an inch of similar pegs fixed in the concave in rows running at right angles to the drum. Great things were at first anticipated from this invention, which, however, it has failed to realise. But iron pegs have more recently been added to the common beater-drum with apparent success. The beaters in this case are made one-half narrower than usual, and have stout iron pegs, formed of square rods, driven into their faces, angle foremost, and slightly reflected at the points. These act by a combination of beating and rippling, and are said to thrash clean and to be easily driven.

There is thus a great variety of thrashing-machines to be found in different parts of the country, the comparative merits of which are frequently and keenly discussed by agriculturists. The extraordinary discrepancies in the amount and quality of the work performed by different machines, and in the power required to effect it, are due quite as much to the varying degrees of skill with which their parts are proportioned and put together, as to varying merit in the respective plans of construction.

In the best examples of 6-horse power stationary steam-engines and thrashing-machinery, as found in the Lothians,

[1] See article on "Comparative Advantages of Fixed and Portable Steam Power for the Purposes of a Farm," by Robert Ritchie, Esq., C.E., Edinburgh, in *Transactions of Highland Society* for March 1852, p. 281.

fifty quarters of grain, taking the average of wheat, barley, and oats, are thrashed, dressed, and sacked up ready for market, in a day of ten hours, with a consumption of 7½ cwt. of good coals, and a gross expenditure for wages, value of horse labour, fuel, and wear and tear of machinery, of 9d. per quarter.

The exigencies of the labour market are giving a powerful stimulus to the use of labour-saving contrivances of all kinds; and hence the recent introduction of straw elevators, to be worked either by horse-power or by the same steam-engine that is driving the thrashing-machinery. The latter plan finds most favour in England, where it has already been adopted to a considerable extent.

The Royal Agricultural Society of England has done much towards ascertaining the real merits of the various thrashing-machines now in use, by the carefully conducted comparative trials to which it has subjected those which have been presented in competition for its liberal prizes. The accuracy of these trials, and the value of the recorded results, have been much enhanced by the use of an ingenious apparatus invented by Mr C. E. Amos, consulting engineer to the Society, which is figured and described at p. 479 of vol. xi. of the Society's *Journal*. A pencil connected with this apparatus traces a diagram upon a sheet of paper, recording every variation of the power employed during the experiment to work the machine under trial. For reasons already stated, we regard it as unfortunate that the patronage of this great Society has hitherto been so exclusively bestowed upon portable machines.

Section 20.—*Winnowing-Machines.*

We have already referred to the fanners, which, except in portable machines, are almost invariably found in combination with thrashing-machinery, so as to deliver the grain into the corn-chamber in a comparatively clean state; and we have also noticed the further contrivances by which, when there is a sufficient motive power at command, the complete dressing of the grain goes on simultaneously with the thrashing. The winnowers used in such cases do not differ in construction from those worked by hand. Indeed, it is usual to have one at least that can be used in either way at pleasure. In these machines the separation of the clean from the light grain, and of both from dust, sand, and seeds of weeds, or other rubbish, is effected by directing an artificial blast of wind upon a stream of grain as it falls upon a riddle. There is thus a combination of fanning and sifting, which is used in different degrees according to the views of the mechanist. In some forms of this machine the benefit of the artificial blast is in a great measure lost through an injudicious application of it.

Section 21.—*Corn-Bruiser and Grinding-Mill.*

The now frequent use of various kinds of grain in the fattening of live stock creates a necessity for machines to prepare it for this purpose, either by breaking, bruising, or grinding. A profusion of these, to be worked by hand, is everywhere to be met with. Such machines are always most economically worked by steam or water power. When that can be had, a set of rollers for bruising oats or linseed, and millstones to grind the inferior grain of the farm, form a most valuable addition to barn machinery.

Section 22.—*Cake-Crushers.*

Machines for breaking linseed-cake into large pieces for cattle, or smaller ones for sheep, are now in general use. The breaking is performed by passing the cakes between serrated rollers, by which it is nipt into morsels. These are usually driven by hand; but it is always expedient to have a pulley attached to them, and to take advantage of mechanical power when available.

Section 23.—*Chaff-Cutters.*

The use of this class of machines has increased very much of late years. Fodder when cut into lengths of from half-an-inch to an inch is somewhat more easily masticated than when given to animals in its natural state; but the chief advantages of this practice are, that it prevents waste, and admits of different qualities—as of hay and straw, straw and green forage, or chaff and pulped roots—being so mixed that animals cannot pick out the one from amongst the other, but must eat the mixture as it is presented to them. Such cut fodder also forms an excellent vehicle in which to give meal or bruised grain, either cooked or raw, to live stock. This applies particularly to sheep feeding on turnips, as they then require a portion of dry food, but waste it grievously when it is not thus prepared. Chaff-cutters are constructed on a variety of plans; but the principle most frequently adopted is that of radial knives bolted to the arm of a fly-wheel, which work across the end of a feeding-box fitted with rollers, which draw forward the straw or hay and present it in a compressed state to the action of the knives. A machine on this principle, made by Cornes of Barbridge, has gained the first premium in its class at recent meetings of the Royal Agricultural Society of England. Gillets' guillotine chaff-cutter is an exceedingly ingenious and efficient machine, performing its work with great accuracy, and without frequent sharpening of its one double-edged knife. These machines are most economically worked by the power used for thrashing. The most convenient site for them is in the upper loft of the straw-barn, where the straw can be supplied with little labour, and the chaff either shoved aside, or allowed to fall as it is cut through an opening in the floor into the apartment below, and at once conveyed to other parts of the homestead. The practice on some farms where there is a fixed steam-engine, is to thrash a stack of oats in the forenoon, and to cut up the straw, and bruise or grind the grain simultaneously, in the afternoon.

Section 24.—*Turnip-Cutters.*

Cattle and sheep which have arrived at maturity are able to scoop turnips rapidly with their sharp, gouge-like front teeth, and so can be fattened on this kind of food without an absolute necessity of slicing it for them. Even for adult animals there is, however, an advantage in reducing turnips to pieces which they can easily take into their mouths, and at once get between their grinders without any preliminary scooping; but for young stock, during the period of dentition, it is indispensable to their bare subsistence. It is largely through the use of slicing-machines that certain breeds of sheep are fattened on turnips, and got ready for the butcher at fourteen months old. It seems to be admitted on all hands that Gardener's patent turnip-cutter is the best that has yet been produced for slicing roots for sheep. It is now made entirely of iron, and is an exceedingly useful machine.

In cattle feeding it is not usually thought necessary to divide the roots given to them so minutely as for sheep. A simple machine, fashioned much on the principle of nut-crackers, by which, at each depression of the lever handle, one turnip is forced through a set of knives which divide it into slices each an inch thick, is very generally used in Berwickshire for this purpose. Many persons, however, prefer to have the turnips put into the cattle-troughs whole, and then to have them cut by a simple cross-bladed hand-chopper, which at each blow quarters the piece struck by it. The mode of housing fattening cattle largely determines whether roots can be most conveniently sliced before or after being put into the feeding-troughs.

Section 25.—Turnip-Pulpers.

An opinion now obtains, and is on the increase, that it is advantageous to rasp roots into minute fragments and mix them with chaff before giving them to cattle, as this not only facilitates mastication, but in wintry weather prevents the chilling effects of a bellyful of such watery food as turnips are when eaten alone. This system is peculiarly appropriate when it is desired to give a few roots to store cattle which are being fed mainly upon straw or coarse hay. When a few turnips or mangolds are put down in their natural state there is a scramble for the better food, in which the stronger cattle get more than their share, and the weaker are knocked about. But by pulping the roots and mixing them with a full allowance of chaff, every animal gets its fill, and there is nothing to quarrel about.

At the Carlisle meeting of the Royal Agricultural Society a premium was offered for machines to perform this kind of work, under the somewhat inappropriate designation of "pulping-machines." The prize was awarded to Mr Philips for his machine, which reduces roots to minute fragments by means of a series of circular saws. We learn from parties who have made trial of most of the machines of this class yet brought out, that they give the preference to that made by Bentall of Maldon in Sussex.

Section 26.—Steaming Apparatus for Cooking Cattle Food.

We have several times alluded to the cooking of food for cattle. This is performed either by boiling in a common pot, by steaming in a close vessel, or by infusion in boiling water. Varieties of apparatus are in use for these purposes. A convenient one is a close boiler, with a cistern over it, from which it supplies itself with cold water by a self-acting stop-cock. This is alike suitable for cooking either by steaming or infusing.

Section 27.—Weighing-Machines.

It is of course indispensable for every farm to be provided with beam and scales, or other apparatus, for ascertaining the weight of grain, wool, and other commodities, in quantities varying from 1 lb. to 3 cwt. But, besides this, it is very desirable to have a machine by which not only turnips, hay, manures, &c., can be weighed in cart-loads, but by which also the live weight of pigs, sheep, and bullocks can be ascertained. Such a machine, conveniently placed in the homestead, enables the farmer to check the weighing of purchased manure, linseed-cake, coal, and similar commodities, with great facility. It affords the means of conducting various experiments for ascertaining the comparative productiveness of crops, the quantities of food consumed by cattle, and their periodic progress, with readiness and precision. To persons unable to estimate the weight of cattle by the eye readily and accurately, such a machine is invaluable.

Section 28.—Concluding Remarks on Implements.

We have thus enumerated, and briefly described, those machines and implements of agriculture which may be held to be indispensable, if the soil is to be cultivated to the best advantage. The list does not profess to be complete; but enough is given to indicate the progress which has recently taken place in this department. We have already referred to this department of the proceedings of the Royal Agricultural Society of England, and would earnestly recommend to all engaged in agriculture the careful study of the reports on implements contained in the ninth and subsequent volumes of their *Journal*. The care with which they have selected their judges, and the skilful manner in which those entrusted with the difficult and responsible office have discharged their duties, are truly admirable. A few extracts from these reports will serve to show the extent and value of this department of the Society's labours. In the report for 1849, Mr Thomson of Moat-Hall says—"The Society's early shows of implements must be viewed chiefly in the light of bazaars or expositions. Neither stewards nor judges had yet acquired the experience requisite for the adequate discharge of their office, so that such men as Messrs Garrett, Hornsby, Ransome, and a few others, would have laughed in their sleeves had they been told that they could learn anything in the Society's show-yard. In spite, however, of a creditable display on the part of a few leading firms, the majority of the implements exhibited at these early shows were of inferior construction and workmanship, and the general appearance of the exhibitions meagre and unsatisfactory.

"The attention of some of the leading members of the Society (especially of the late lamented Mr Handley) was earnestly directed to the improvement of this department, and they soon perceived that little was gained by collecting implements in a show-yard for people to gaze at, unless an adequate trial could be made of their respective merits. To attain this end great exertions were made, and every improvement in the mode of trial was followed by so marked an increase in the number and merit of the implements brought forward at subsequent shows, as to prove the strongest incentive to further effort.

"At the Cambridge and Liverpool meetings, when these trials were in their infancy, their main attraction consisted of ploughing-matches on a large scale, which gratified sight-seers, but gave no results that could be depended upon, and therefore disappointed all practical men. It would occupy time unnecessarily to trace the gradual changes which have led to the discontinuance of these showy exhibitions, and the substitution in their place of quiet, business-like trials, in the presence of stewards and judges alone. Suffice it to say, that what they have lost in display, they have gained in efficiency, and consequently in favour with those classes for whose benefit they were designed. At the York meeting, the improved mode of trying the thrashing-machines supplied a deficiency which, until that time, had been much felt, viz., the absence of any means of ascertaining the amount of power expended in working the machines under trial; and it may now be asserted, with some confidence, that, with the exception of an occasional error or accident, the best implements are uniformly selected for prizes.

"It now remains to answer the question proposed for consideration, viz., to what extent the great improvement made of late in agricultural implements is due to the exertions of this Society; and with this view a tabular statement is subjoined, which shows the relative extent and importance of the Society's two first and two last shows of implements:—

	No. of Exhibitors.	Awards. Money.	Medals.
1839 Oxford . .	23	£5	4
1840 Cambridge .	36	0	7
1848 York . .	146	230	21
1849 Norwich . .	145	364	13

"From this it will be seen that at Cambridge, where the trial of implements was confined to one day, and was, in other respects, so immature as to be of little practical value, the number of exhibitors was only thirty-six, and the judges, in whom a certain discretionary power was vested, awarded no money and but seven medals, in consequence of the scarcity of objects deserving of reward; whilst at York, eight years after, when trials lasted several days, and had attained a considerable degree of perfection, the number of exhibitors had increased four-fold. The additional amount offered in prizes at the later meetings has undoubtedly assisted in creating this great increase of competition, but it cannot be considered the principal cause, since the imple-

ment-makers are unanimous in declaring that, even when most successful, the prizes they receive do not reimburse them for their expenses and loss of time. How, then, are the increased exertions of the machine-makers to be accounted for? Simply by the fact that the trials of implements have gradually won the confidence of the farmer, so that, when selecting implements for purchase, he gives the preference to those which have received the Society's mark of approval. This inference is corroborated by the makers themselves, who readily admit that the winner of a prize, for any implement of general utility, is sure to receive an ample amount of orders, and that the award of a medal is worth on an average £50."

In reporting upon the agricultural implement department of the Great Exhibition, Mr Pusey says—"The yearly shows and trials of the Royal Agricultural Society have certainly done more in England for agricultural machines within the last ten years, than had been attempted anywhere in all former time. . . . . It seems proved that since annual country shows were established by Lord Spencer, Mr Handley, and others yet living, old implements have been improved, and new ones devised, whose performances stand the necessary inquiry as to the amount of saving they can effect. To ascertain that amount precisely is difficult; but, looking through the successive stages of management, and seeing that the owner of a stock-farm is enabled, in the preparation of his land, by using lighter ploughs, to cast off one horse in three, and by adopting other simple tools to dispense altogether with a great part of his ploughing,—that in the culture of crops by the various drills, horse labour can be partly reduced, the seed otherwise wanted partly saved, or the use of manures greatly economised, while the horse-hoe replaces the hoe at one-half the expense,—that in harvest the American reapers can effect thirty men's work, whilst the Scotch cart replaces the old English waggon with exactly half the number of horses,—that in preparing corn for man's food, the steam thrashing-machine saves two-thirds of our former expense,—and in preparing food for stock, the turnip-cutter, at an outlay of 1s., adds 8s. a-head in one winter to the value of sheep; lastly, that in the indispensable but costly operation of draining, the materials have been reduced from 80s. to 15s.—to one-fifth, namely, of their former cost,—it seems to be proved that the efforts of agricultural mechanists have been so far successful, *as in all these main branches* of farming labour, taken together, to effect a saving, on outgoings, of little less than one-half."

Since these reports were made, the demand for improved agricultural implements and machinery has increased enormously, so much so that the manufacture of them is now a most important and a rapidly increasing branch of our national industry, and we quite anticipate that in a short time there will be such a general appreciation of the benefits of cultivation by steam power, and such a demand for engines and tackle to carry it out, as the makers and manufacturers will find it difficult to satisfy.

Scottish agriculturists, in reading these reports, will probably note with self-gratulation, that some of the improvements referred to as of recent introduction in England, viz., two-horse ploughs and one-horse carts, have long been established among themselves. Indeed, they will find graceful acknowledgment of the fact in these reports. Unless altogether blinded by prejudice, they will, however, see that our brethren south of the Tweed have already outstripped us in many particulars, and that unless our national Society, our mechanists, and farmers, exert themselves with corresponding judgment and zeal, we must henceforth be fain to follow, where we at least fancy that we have hitherto been leading. But we have more important motives and encouragements to exertion than mere national emulation. The extent to which the cost of production of farm produce has been lessened by recent improvements in the implements of husbandry, and in the details of farm management, is greater than many are aware of. It seems to be in this direction mainly that the farmer must look for a set-off against the steadily increasing cost of land and labour. If by further improvements in his machinery and implements he is enabled to keep fewer horses, to get his deep tillage performed by steam power, and his mowing and reaping accomplished by the ordinary forces which he requires throughout the year, the reduction upon the prime cost of his produce will be really important. A hopeful element in this anticipated progress is that it tends directly to elevate the condition of the rural labourer. Every addition to the steam power and labour-saving machines used upon the farm implies an increased demand for cultured minds to guide them, a lessening of the drudgery heretofore imposed upon human thews and sinews, an equalising of employment throughout the year, and a better and steadier rate of wages. Believing, as we do, that on every farm enormous waste of motive power—mechanical, animal, and manual—is continuously going on through the imperfection of the implements and machines now in use, we would urge upon all concerned to look well to this; for, with all our improvements, there is undoubtedly yet a large margin for retrenchment here.

Besides the bulky and costly implements now enumerated, every farm must be provided with a considerable assortment of hand-implements and tools, all of which it is of consequence to have good of their kind. Although not individually costly, they absorb a considerable capital in the aggregate. When not in use, they require to be kept under lock, and at all times need to be well looked after. Without waiting to describe these in detail, let us now see how the work of the farm is conducted.

CHAPTER VII.

PREPARATION OF THE LAND FOR TILLAGE OPERATIONS.

Section 1.—When Required.

Before those simple tillage operations which are necessary in every instance of committing seeds to the earth can be gone about, there are more costly and elaborate processes of preparation which must be encountered in certain circumstances, in order to fit the soil for bearing cultivated crops. It is now only in exceptional cases that the British agriculturist has to reclaim land from a state of nature. The low-country farmer does occasionally meet with a patch of woodland, or a bank covered with gorse or brushwood, which he sets about converting into arable land. It is in the higher districts that, from the facilities now afforded for readily enriching poor soils by portable manures, the plough still frequently invades new portions of muir and bog, and transforms them into fields. The occupiers of land in these upland districts are accordingly still familiar with the processes of paring and burning, trenching, removing earth-fast stones, and levelling inequalities of surface. In breaking up land that has been for a course of years under pasturage, paring and burning are also frequently resorted to in all parts of the country. The grand improvement of all, thorough underground drainage, is common to every district and class of soils.

Section 2.—Draining.

From the moist climate of Britain, draining is undoubtedly the all-important preliminary operation in setting about the improvement of the soil.

To drain land is to rid it of its superfluous moisture. The rivers of a country with their tributary brooks and rills are the natural provision for removing the rain water which either flows directly from its surface, or which, after percolating through porous strata to an indefinite depth, is again discharged at the surface by springs. The latter may

thus be regarded as the outlets of a natural underground drainage. This provision for disposing of the water that falls from the clouds is usually so irregular in its distribution, and so imperfect in its operation, that it leaves much to be accomplished by human labour and ingenuity. The art of the drainer accordingly consists—

1*st*, In improving the natural outfalls by deepening, straightening, or embanking rivers; and by supplementing these, when necessary, by artificial canals and ditches: and,

2*d*, In freeing the soil and subsoil from stagnant water, by means of artificial underground channels.

Surface. The first of these operations, called *trunk drainage*, is the most needful; for until it be accomplished there are extensive tracts of land, and that usually of the most valuable kind, to which the secondary process either cannot be applied at all, or only with the most partial and inefficient results. Very many of our British rivers and streams flow with a sluggish and tortuous course through valleys of flat alluvial soil, which, as the coast is approached, expand into extensive plains, but little elevated above the level of the sea. Here the course of the river is obstructed by shifting shoals and sand-banks, and by the periodic influx of the tides. The consequence is, that immense tracts of valuable land are at all times in a water-logged and comparatively worthless state, and on every recurrence of a flood are laid entirely under water. In a subsequent chapter on "Waste Lands" some account shall be given of the extent of this evil, and of the efforts that have been successfully devoted to its remedy. Some of these fen-land and estuary drainage works have been accomplished in the face of natural obstacles of the most formidable character, and constitute trophies of engineering talent of which the country may well be proud. Great as the natural difficulties are which have to be encountered in such cases, there are others of a different kind which have often proved more impracticable. It has been found easier to exclude the sea and restrain land-floods, than to overcome the prejudices and reconcile the conflicting interests of navigation companies, commissioners of sewers, owners of mills, and landed proprietors. Although all these classes suffer the most serious losses and inconveniences from the defective state of many of our rivers, it is found extremely difficult to reconcile their conflicting claims, and to allocate to each his proper share of the cost of improvements by which all are to benefit. A most interesting and instructive illustration of the urgent necessity for improving the state of our rivers, of the difficulties to be encountered in doing so, and of the incalculable benefits thus to be obtained, has been given in an essay on Trunk Drainage, by John Algernon Clarke, Esq., published in vol. xv. (part first) of the *Journal of the Royal Agricultural Society of England*. Mr Clarke, after some most important observations on trunk drainage, describes in detail works projected under powers granted in an Act of Parliament, passed in 1852, "constituting commissioners for the improvement of the river Nene and the navigation thereof."

There is not a district of the kingdom in which works similar in kind are not absolutely indispensable, before extensive tracts of valuable land can be rendered available for profitable cultivation by means of underground drainage. It is interesting to know that the necessity for trunk drainage, and the means of accomplishing it, were distinctly set before the public 200 years ago by a practical draining engineer, to whose writings the attention of the agricultural community has been frequently directed of late by Mr Parkes, Mr Gisborne, and others. From the third edition (1652) of *The Improver Improved*, by Walter Blithe, the author referred to, in which the true principles of land drainage are stated as distinctly, and urged as earnestly, as by any of our modern writers, we here quote the following remarks:—

"A strait water-course, cut a considerable depth, in a thousand parts of this nation, would be more advantageous than we are aware of, or I will task myself here to dispute further. And though many persons are interested therein, and some will agree, and others will oppose; one creek lyeth on one side of the river, in one lord's manor, and another lyeth on the other side, and divers men own the same; why may not one neighbour change with another, when both are gainers? If not, *why may they not be compelled for their own good, and the commonwealth's advantage?* I daresay thousands of acres of very rich land may hereby be gained, and possibly as many more much amended, that are almost destroyed; but a law is wanting herein for the present, which I hope will be supplied if it may appear advancement to the public; for to private interests it is not possible to be the least prejudice, when every man hath benefit, and each man may also have an equall allowance if the least prejudiced.

"But a word or two more, and so shall conclude this chapter—and it is a little to further this improvement through a great destruction (as some may say); it is the removing or the destroying of all such mills, and none else, as drown and corrupt more lands than themselves are worth to the commonwealth, and they are such as are kept up or dammed so high as that they boggyfie all the lands that lye under their mill-head. Such mills as are of little worth, or are by constant great charges maintained, I advise to be pulled down; the advance of the land, when the water is let run his course, and not impounded, will be of far greater value many times. But in case the mills should be so necessary and profitable too, and far more than the lands they spoil, I shall then advise, that under thy mill-dam, so many yards wide from it as may prevent breaking through, thou make a very deep trench all along so far as thy lands are putrefied, and thereinto receive all the issuing, spewing water, and thereby stop or cut off the feeding of it upon thy meadow, and carry it away back into thy back-water or false course, by as deep a trench, cut through the most low and convenient part of thy meads. But put case that thou shouldst have no convenient fall on that side thy mill-dam, then thou must make some course, *or plant some trough under thy mill-dam*, and so carry it under into some lower course that may preserve it from soaking thy meadows or pastures under it; and by this means thou maist in a good measure reduce thy land to good soundness, and probably wholly cure it, and preserve thy mill also."

It is painful to reflect that after the lapse of two centuries, we should still see, as Blithe did, much "gallant land" ruined for want of those draining operations which he so happily describes.

A clear outfall of sufficient depth being secured, the way is open for the application of *underground draining*. And here it may be proper to state, that there is very little of the land of Great Britain naturally so dry as not to be susceptible of improvement by artificial draining; for land is not in a perfect condition with respect to drainage, unless all the rain that falls upon it can sink down to the minimum depth required for the healthy development of the roots of cultivated crops, and thence find vent, either through a naturally porous subsoil or by artificial channels. Much controversy has taken place as to what this minimum depth is. Suffice it to say, that opinion is now decidedly in favour of a greater depth than was considered necessary even a few years ago, and that the best authorities concur in stating it at from three to four feet. There are persons who doubt whether the roots of our ordinary grain or green crops ever penetrate to such a depth as has now been specified. A careful examination will satisfy any one who makes it, that minute filamentary rootlets are sent down to extraordinary depths, wherever they are not arrested by stagnant water. It has also been questioned whether any benefit accrues to crops from this deep descent of their roots. Some persons have even asserted that it is only when they do not find food near at hand that they thus wander. But it must be borne in mind that plants obtain moisture as well as nourishment by means of their roots, and the fact is well known that plants growing in a deep soil resting on a porous subsoil seldom or never suffer from drought. It is instructive, too, on this point, to observe the practice of the most skilful gardeners, and see the importance which they attach to trenching, the great depth Subsoil.

Subsoil. at which they often deposit manure, and the stress which they lay upon thorough drainage. On the other hand, it is well known that soils which soonest become saturated, and run from the surface in wet weather, are precisely those which parch and get chapped the soonest in drought. The effectual way to secure our crops at once from drowning and parching, is to put the land in a right condition with respect to drainage.

All soils possess more or less the power of absorbing and retaining water. Pure clays have it in the greatest degree, and gritty siliceous ones in the smallest. In dry weather this power of attracting moisture is constantly operating to supply from below the loss taking place by evaporation at the surface. In heavy rains, as soon as the entire mass has drunk its fill, the excess begins to flow off below; and therefore a deep stratum, through which water can percolate, but in which it can never stagnate—that is, never exceed the point of saturation—is precisely that in which plants are most secure from the extremes of drought and drowning.

If a perfect condition of the soil with respect to drainage is of importance for its influence in preserving it in a right condition as respects moisture, it is still more so for its effects upon its *temperature*. All who are conversant with rural affairs are familiar with that popular classification of soils in virtue of which such as are naturally dry are also invariably spoken of as *warm* and *early;* and conversely, that wet soils are invariably described as being *cold* and *late*. This classification is strictly accurate, and the explanation of it is simple. An excess of water in soil keeps down its temperature in various ways. In passing into the state of vapour it rapidly carries off the heat which the soil has obtained from the sun's rays. Water possesses also a high radiating power; so that, when present in the soil in excess, and in a stagnant state, it is constantly carrying off heat by evaporation and radiation. On the other hand, stagnant water conveys no heat downwards; for although the surface is warmed, the portion of water thus heated being lightest, remains floating on the surface, and will give back its heat to the atmosphere, but conveys none downwards. When the surface of stagnant water becomes colder than the general mass, the very opposite effect immediately ensues; for as water cools its density increases, and thus causes an instant sinking of the portion that has been cooled, and a rising of a warm portion from below to take its place—this movement continuing until the whole has been lowered to 40°, at which point water reaches its maximum density, while, if the temperature be reduced a few degrees more, water will begin to freeze. It is thus that soil surcharged with water is kept at a lower temperature than similar soil that has a sufficient natural or artificial drainage.

But while the presence of stagnant water in a soil has this injurious power of lowering its temperature, a very different effect ensues when rain water can sink freely into it to a depth of several feet, and then find a ready exit by drainage; for in this case the rain water carries down with it the heat which it has acquired from the atmosphere and from the sun-heated surface, and imparts it to the subsoil. There is as yet a lack of published experiments to show the ordinary increase of temperature at various depths and in different soils, as the result of draining wet land. Those conducted by Mr Parkes, in a Lancashire bog in June 1837, showed, as the mean of thirty-five observations, that the drained and cultivated soil at seven inches from the surface was 10° warmer than the adjoining undrained bog in its natural state at the same depth. It is understood that later experiments conducted by the same gentleman on an extended scale fully establish the fact, that an increased temperature of the soil is an unfailing accompaniment of thorough draining. The importance of this result cannot well be over-rated. The temperature and other conditions of the atmosphere, which we call climate, are placed beyond human control; but this power of raising the temperature of all wet, and consequently cold soils, becomes tantamount in some of its results to a power of improving the climate. There are, accordingly, good grounds for stating that in numerous cases grain crops have ripened sooner by ten or twelve days than they would have done but for the draining of the land on which they grew.

The points which we have thus briefly touched upon are so essential to an intelligent appreciation of the subject, that we have felt constrained to notice them, however meagrely. But our space forbids more than a mere enumeration of some of the many evils inseparable from the presence of stagnant water in the soil, and of the benefits that flow from its removal. Wet land, if in grass, produces only the coarser grasses, and many sub-aquatic plants and mosses, which are of little or no value for pasturage; its herbage is late of coming in spring, and fails early in autumn; the animals grazed upon it are unduly liable to disease, and sheep, especially, to the fatal rot. When land is used as arable, tillage operations are easily interrupted by rain, and the period always much limited in which they can be prosecuted at all; the compactness and toughness of such land renders each operation more arduous, and more of them necessary, than in the case of dry land. The surface must necessarily be thrown into ridges, and the furrows and cross-cuts duly cleared out after each process of tillage, on which surface expedients as much labour has probably been expended in each thirty years as would now suffice to make drains enough to lay it permanently dry. With all these precautions the best seed-time is often missed, and this usually proves the prelude to a scanty crop, or to a late and disastrous harvest. The cultivation of the turnip and other root crops, which require the soil to be wrought to a deep and free tilth, either becomes altogether impracticable, and must be abandoned for the safe but costly bare fallow, or is carried out with great labour and hazard; and the crop, when grown, can neither be removed from the ground, nor consumed upon it by sheep without damage by poaching. The dung, lime, and other manure, that is applied to such land is in a great measure wasted; and the breaking of the subsoil and general deep tillage, so beneficial in other circumstances, is here positively mischievous, as it does but increase its power of retaining water. Taking into account the excessive labour, cost, and risk, inseparable from the cultivation of wet land, and the scanty and precarious character of the crops so obtained, it would in many cases be wiser to keep such lands in grass, than to prosecute arable husbandry under such adverse circumstances. These very serious evils can either be entirely removed, or, at the least, very greatly lessened by thorough draining. It often happens that naturally porous soils are so soaked by springs, or so water-logged by resting upon an impervious subsoil, or, it may be, so drowned for want of an outfall in some neighbouring river or stream, that draining at once effects a perfect cure, and places them on a par with the best naturally dry soils. In the case of clay soils, the improvement effected by draining is in some respects greater than in any other class, but still it cannot change the inherent properties of clay. This has sometimes been overlooked by sanguine improvers, who, hastily assuming that their strong land, when drained, would henceforward be as friable and sound as the more porous kinds, have proceeded to treat it on this assumption, and have found to their cost that clay, however well drained, will still get into mortar and clods, if it is tilled or trodden on too soon after rain. It is entirely owing to such rash and unskilful management that an opinion has sometimes got abroad, that clay lands are injured by draining. They merely retain the qualities

peculiar to clay, and when they are treated judiciously, show as good a comparative benefit from draining as other soils. The only instances in which even temporary injury arises from draining is in the case of some peaty and fen lands, which are so loose that they suffer from drought in protracted dry weather. As such lands are usually level and have water-courses near them, this inconvenience admits of an easy remedy by shutting up the main outlets, and then admitting water into the ditches. The drains in this way become ready channels for applying the needed moisture by a kind of subterraneous irrigation.

Thorough.

The beneficial effects of thorough draining are of a very decisive and striking kind. The removal of stagnant water from a stratum of 4 feet in depth, and the establishing of a free passage for rain water and air from the surface to the level of the drains, speedily effects most important changes in the condition of the soil and subsoil. Ploughing and other tillage operations are performed more easily than before in consequence of a more friable state of the soil. Moderate rains which formerly would have sufficed to arrest these operations do so no longer, and heavy falls of rain cause a much shorter interruption of these labours than they did when the land was in its natural state. Deep tillage, whether by the common or subsoil plough (which formerly did harm), now aids the drainage, and is every way beneficial. Ridges and surface furrows being no longer needed the land can be kept flat, with great benefit to crops and furtherance to field operations. An earlier seed-time and harvest, better crops, a healthier live stock, and an improved style of husbandry, are the usual and well known sequents of judiciously conducted drainage operations. In short, the most experienced and skilful agriculturists now declare with one consent that good drainage is an indispensable preliminary to good cultivation.

History.

Although it has been reserved to the present times to see land draining reduced to a system based on scientific principles, or very great improvement effected in its details, it is by no means a modern discovery. The Romans were careful to keep their arable lands dry by means of open trenches, and there are even some grounds for surmising that they used covered drains for the same purpose. Indubitable proof exists that they constructed underground channels by means of tubes of burned earthenware; but it seems more probable that these were designed to carry water to their dwellings, &c., than that they were used simply as drains. Recent inquiries and discoveries have also shown that it is at least several centuries, since covered channels of various kinds were in use by British husbandmen for drying their land. It is, at all events, two centuries since Captain Walter Blithe wrote as follows:—

Blithe.

"Superfluous and venomous water which lyeth in the earth and much occasioneth bogginesse, mirinesse, rushes, flags, and other filth, is indeed the chief cause of barrenesse in any land of this nature. . . . . Drayning is an excellent and chiefest means for their reducement; and for the depth of such draynes, I cannot possibly bound, because I have not time and opportunity to take in all circumstances. . . . . And for thy drayning trench, it must be made so deepe that it goe to the bottome of the cold, spewing moyst water, that feeds the flagg and the rush; for the widenesse of it, use thine owne liberty, but be sure to make it so wide as thou mayest goe to the bottome of it, which must be so low as any moysture lyeth, which moysture usually lyeth under the over and second swarth of the earth, in some gravel or sand, or else, where some greater stones are mixt with clay, under which thou must goe halfe one spades graft deepe at least; yea, suppose this corruption that feeds and nourisheth the rush or flagg should lie a yard or foure foot deepe, to the bottome of it thou must goe, if ever thou wilt drayne it to purpose. . . . . And for the drayning trench be sure thou indeavour to carry it as neare upon a straight line as possible. . . . . To the bottome where the spewing spring lyeth thou must goe, and one spades depth or graft beneath, how deep so ever it be, if thou wilt drayne thy land to purpose. I am forced to use repetitions of some things, because of the suitableness of the things to which they are applyed; as also because of the slownesse of peoples apprehensions of them, as appears by the non-practice of them, the which wherever you see drayning and trenching you shall rarely find few or none of them wrought to the bottome. . . . . Go to the bottome of the bog, and there make a trench in the sound ground, or else in some old ditch, so low as thou verily conceivest thy selfe assuredly under the level of the spring or spewing water, and then carry up thy trench into thy bogg straight through the middle of it, one foot under that spring; . . . . but for these common and many trenches, oft times crooked too, that men usually make in their boggy grounds, some one foot, some two, never having respect to the cause or matter that maketh the bogg to take that way, I say away with them as a great piece of folly, lost labour and spoyle. . . . . After thou has brought a trench to the bottom of the bog, then cut a good substantial trench about thy bog; and when thou hast so done make one work or two just overthwart it, *upwards and downwards*, all under the matter of the bog. Then thou must take good green faggots, willow, alder, elme, or thorne, and lay in the bottome of thy works, and then take thy turfe thou tookest up in the top of thy trench, and plant upon them with the green sward downwards; *or take great pebbles, stones, or flint stones, and so fill up the bottome of thy trench about fifteen inches high*, and take thy turfe and plant it as aforesaid, being cut very fit for the trench, as it may join close as it is layd downe, and then having covered it all over with earth, and made it even as thy other ground, waite and expect a wonderfull effect through the blessing of God."

Elkington

These sagacious arguments and instructions were doubtless acted upon by some persons in his own times and since; but still they had never attained to general adoption, and were ultimately forgotten. Towards the close of last century, Mr Elkington, a Warwickshire farmer, discovered and promulgated a plan of laying dry sloping land that is drowned by the outbursting of springs. When the higher lying portion of such land is porous, rain falling upon it sinks down until it is arrested by clay or other impervious matter, which causes it again to issue at the surface and wet the lower-lying ground. Elkington showed that by cutting a deep drain through the clay, aided when necessary by wells or augur holes, the subjacent bed of sand or gravel in which a body of water is pent up by the clay, as in a vessel, might be tapped, and the water conveyed harmlessly in the covered drain to the nearest ditch or stream. In the circumstances to which it is applicable, and in the hands of skilful drainers, Elkington's plan, by bringing into play the natural drainage furnished by porous strata, is often eminently successful. His system was given to the public in a quarto volume, edited by a Mr John Johnston of Edinburgh, who does not seem to have shared the engineering talents of the man whose discoveries he professes to expound. During the thirty or forty years subsequent to the publication of this volume, most of the draining that took place was on this system, and an immense capital was expended in such works with very varying results. Things continued in this position until about the year 1823, when the late James Smith of Deanston, having discovered anew those principles of draining so long before indicated by Blithe, proceeded to exemplify them in his own practice, and to expound them to the public in a way that speedily effected a complete revolution in the art of draining, and marked an era in our agricultural progress. Instead of

Smith of Deanston.

Smith of Deanston. persisting in fruitless attempts to dry extensive areas by a few dexterous cuts, he insisted on the necessity of providing every field that needed draining at all with a complete system of parallel underground channels, running in the line of the greatest slope of the ground, and so near to each other that the whole rain falling at any time upon the surface should sink down and be carried off by the drains. The distances between drains he showed must be regulated by the greater or less retentiveness of the ground operated upon, and gave 10 feet as the minimum, and 40 feet as the maximum of these distances. The depth which he prescribed for his parallel drains was 30 inches, and these were to be filled with 12 inches of stones small enough to pass through a 3-inch ring—in short, a new edition of Blithe's drain. A main receiving-drain was to be carried along the lowest part of the ground, with sub-mains in every subordinate hollow that the ground presented. These receiving drains were directed to be formed with a culvert of stone work, or of tiles, of waterway sufficient to contain the greatest volume of water at any time requiring to be passed from the area to which they respectively supplied the outlet. The whole cultivated lands of Britain being disposed in ridges which usually lie in the line of greatest ascent, it became customary to form the drains in each furrow, or in each alternate, or third, or fourth one, as the case might require or views of economy dictate, and hence the system soon came to be popularly called *furrow draining*. From the number and arrangement of the drains, the terms *frequent* and *parallel* were also applied to it. Mr Smith himself more appropriately named it, from its effects, *thorough draining*. The sound principles thus promulgated by him were speedily adopted and extensively carried into practice. The great labour and cost incurred in procuring stones in adequate quantities, and the difficulty of carting them in wet seasons, soon led to the substitution of tiles and soles of burned earthenware. The limited supply and high price of these tiles for a time impeded the progress of the new system of draining; but the invention of tile-making machines by the Marquis of Tweeddale and others, removed this impediment, and gave a mighty stimulus to this fundamental agricultural improvement. The substitution of cylindrical pipes for the original horse-shoe tiles has still further lowered the cost and increased the efficiency and permanency of drainage works.

Modern system. The system introduced and so ably expounded by Smith of Deanston has now been virtually adopted by all drainers. Variations in matters of detail (having respect chiefly to the depth and distance apart of the parallel drains) have indeed been introduced; but the distinctive features of his system are now recognised and acted upon by all scientific drainers.

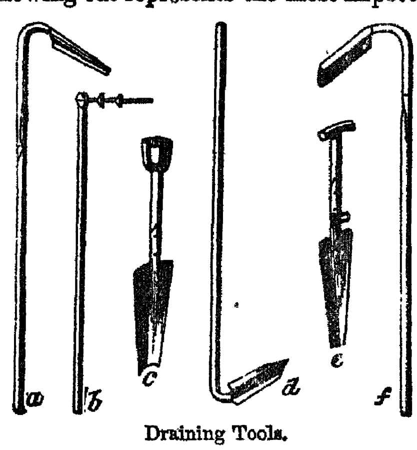
Outfall. In setting about the draining of a field, or farm, or estate, the first point is to secure, at whatever cost, a proper outfall. The lines of the receiving drains must next be determined, and then the direction of the parallel drains. The former must occupy the lowest part of the natural hollows, and the latter must run in the line of the greatest ascent of the ground. In the case of flat land, where a fall is obtained chiefly by increasing the depth of the drains at their lower ends, these lines may be disposed in any direction that is found convenient; but in undulating ground a single field may require several distinct sets of drains lying at different angles, so as to suit its several slopes. When a field is ridged in the line of the greatest ascent of the ground, there is an obvious convenience in adopting the furrows as the site of the drains; *but wherever this is not the case the drains must be laid off to suit the contour of the ground, irrespective of the furrows altogether.* When parts of a field are flat, and other parts have a considerable acclivity, it is expedient to cut a receiving drain near to the bottom of the slopes, and to give the flat ground an independent set of drains. In laying off receiving drains it is essential to give hedge-rows and trees a good offing, lest the conduit should be obstructed by roots. When a drain must of necessity pass near to trees, we have found it practicable to exclude their roots from it by the use of coal-tar. In our own practice, a drain carried through the corner of a plantation has by this expedient remained free from obstruction for now fourteen years. In this instance the tar was applied in the following manner:—Sawdust and coal-tar being mixed together to the consistency of ordinary mortar, a layer of this was laid in the bottom of the trench; the drain-pipes were then laid, and completely coated over with the same mixture to the thickness of an inch, and the earth carefully replaced in the ordinary way. When a main drain is so placed that parallel ones empty into it from both sides, care should be taken that the inlets of the latter are not made exactly opposite to each other. Indeed, we have found it expedient in such cases to have two receiving drains parallel to each other, each to receive the subordinate drains from its own side only. As these receiving drains act also as ordinary drains to the land through which they pass, no additional cost is incurred by having two instead of one, provided they are as far apart as the other drains in the field. Much of the success of draining depends on the skilful planning of these main drains, and in making them large enough to discharge the greatest flow of water to which they may be exposed. Very long main drains are to be avoided. Numerous outlets are also objectionable, from their liability to obstruction. An outlet to an area of from ten to fifteen acres is a good arrangement. These outlets should be faced with mason-work, and guarded by iron gratings.

Depths. The depths of the parallel drains must next be determined. In order to obtain proper data for doing so, the subsoil must be carefully examined by digging test-holes in various places, and also by taking advantage of any quarries, deep ditches, or other cuttings in the proximity, that afford a good section of the ground. We have already expressed an opinion that the drains should not be less than four feet deep; but it is quite possible that the discovery at a greater depth than four feet of a seam of gravel, or other very porous material charged with water, underlying considerable portions of the ground, may render it expedient to carry the drains so deep as to reach this seam. Such a seam, when furnished with sufficient outlets, supplies a natural drain to the whole area under which it extends. When such exceptional cases are met with, they are precisely those in which deep drains, at wide intervals, can be trusted to dry the whole area. When the subsoil consists of a tenacious clay of considerable depth, it is considered by many persons that a greater depth than three feet is unnecessary. The greater depth is, however, always to be preferred; for a drain of four feet, if it works at all, not only does all that a shallower one can do, but frees from stagnant water a body of subsoil on which the other has no effect at all. It has indeed been alleged that such deep drains may get so closed over by the clay that water will stand above them. If the surface of clay soil is wrought into puddle by improper usage, water can undoubtedly be made to stand for a time over the shallowest drains as easily as over the deepest. But the contraction which takes place in summer in good alluvial clays gradually establishes fissures, by which water reaches the drains. In such soils it is usually a few years before the full effect of draining is attained. This is chiefly due to the contraction and consequent cracking of clay soils in summer just referred to, and partly, as Mr Parkes thinks, to the mining operations of the common earth-worm. Both of these natural aids to drainage operate with greater force with drains four feet deep than when they are shallower. The tardy percolation of water through

clay soils seems also a reason why in such cases it should get the benefit of a greater fall, by making the drain deep.

Draining is always a costly operation, and it is therefore peculiarly needful to have it executed in such a way that it shall be effectual and permanent. We advocate a minimum depth of four feet, because of our strong conviction that such drains carefully made will be found to have both these qualities. And this opinion is the result of dear-bought experience, for we have found it necessary in our own case to re-open a very considerable extent of 30-inch drains in consequence of their having totally failed to lay the land dry, and to replace them by four feet ones, which have proved perfectly efficacious. In doing this we have seen a 30-inch drain opened up and found to be perfectly dry, and yet when the same trench was deepened to four feet there was quite a run of water from it. Now also that steam power has become available for the tillage of the soil, and is certain, at no distant day, to be in general requisition for that purpose, it is peculiarly expedient to have the drains laid at such a depth as to admit of that potent agency being used for loosening the subsoil to depths hitherto unattainable, not only without hazard to the drains, but with the certainty of greatly augmenting their efficiency. Therefore we earnestly dissuade all parties who are about to undertake drainage works from giving ear to representations about the sufficiency and economy of shallow drains. These, doubtless, cost somewhat less to begin with, but in thousands of cases they fail to accomplish the desired end, and the unfortunate owners, after all their outlay, are left to the miserable alternative of seeing their land imperfectly drained, or of executing the works anew, and thus losing the whole cost of the first and inefficient ones. The extreme reluctance with which the latter alternative is necessarily regarded will undoubtedly operate for a long time in keeping much land that has been hastily and imperfectly drained from participating in the benefits of *thorough* drainage. The distance apart at which the drains should be cut must be determined by the nature of the subsoil. In the most retentive clays it need not be less than 18 feet. On the other hand, this distance cannot safely be exceeded in the case of any subsoil in which clay predominates, although it should not be of the most retentive kind. In all parts of the country instances abound in which drains cut in such subsoils, from 24 to 30 feet apart, have totally failed to lay the land dry. When ground is once pre-occupied by drains too far apart, there is no remedy but to form a supplementary one betwixt each pair of the first set; and thus, by exceeding the proper width at first, the space betwixt the drains is unavoidably reduced to 12 or 15 feet, although 18 feet would originally have sufficed. It is only with a decided porosity in the subsoil, and in proportion to the degree of that porosity, that the space between drains can safely be increased to 24, or 30, or 36 feet. In those exceptional cases in which drains more than 36 feet apart prove effectual, their success is due to the principle on which Elkington's system is founded. A few years ago an opinion obtained currency, that as the depth of drains was increased their width apart might with safety be increased in a corresponding ratio. And hence it came to be confidently asserted, that with a depth of 5 or 6 feet a width of from 40 to 60 feet might be adopted with a certainty of success, even in the case of retentive soils. We believe that experience has already demonstrated the unsoundness of this opinion. At all events, in recommending a minimum depth of 4 feet, we do so on the ground that (other things being equal) the whole benefits of drainage are more fully and certainly secured by drains of this depth than by those of 2½ or 3 feet. In ordinary cases an increase of depth does not compensate for an increase of the width apart of the drains. Draining can be carried on at all seasons, but is usually best done in summer or autumn. The digging is usually paid for by task work, and the setting of the pipes by day's wages. A thoroughly trustworthy and experienced workman is selected for the latter work, with instructions to set no pipes until he is satisfied that the depth of the drains and level of the bottoms are correct. When the soil is returned into the drains all defects are of course buried, and it therefore behoves the landlord, or his substitute, whether tenant or bailiff, to exercise a vigilant oversight of draining operations. Unless carefully executed they cannot be efficient; and without efficient drainage all other agricultural operations must be carried on under grievous disadvantages. The extent of land in Great Britain naturally so dry as not to need artificial drainage is very much less than even practical farmers, who have not studied the subject, are at all aware of.

Cylindrical pipes with collars are undoubtedly the best draining material that has yet been discovered. The collars referred to are simply short pieces of pipe, just so wide in the bore as to admit of the smaller pipes which form the drain passing freely through them. In use, one of these collars is so placed as to encase the ends of each contiguous pair of tubes, and thus forms a loose fillet around each joining. The ends of these pipes being by this means securely kept in contact, a continuous canal for the free passage of water is infallibly insured, the joinings are guarded against the entrance of mud or vermin, and yet sufficient space is left for the admission of water. Pipes of all diameters, from 1 inch to 16 inches, are now to be had; those from 1 to 2 inches in the bore are used for subordinate drains; the larger sizes for sub-main and main receiving drains. Collars are used with the smaller sizes only, large pipes not being so liable to shift their position as small ones. In constructing a drain, it is of much importance that the bottom be cut out just wide enough to admit the pipes and no more. Pipes, when thus accurately fitted in, are much less liable to derangement than when laid in the bottom of a trench several times their width, and into which a mass of loose earth must necessarily be returned. This accurate fitting is now quite practicable in the case of soils tolerably free from stones, from the excellence of the draining tools that have lately been introduced. The following cut represents the most important of these tools. Pipes



Draining Tools.

c and *e* are long tapering spades for digging out the middle and bottom spits, *a*, *d*, and *f* recurved scoops for clearing out the debris, and *b* a pipe-layer, by means of which a workman standing at the margin of a drain hooks up a pipe and collar, and deposits them easily and accurately in the deep narrow trench.

If a quicksand is encountered in constructing a drain, it will be found expedient to put a layer of straw in the bottom of the trench, and then, instead of the ordinary pipe and collar, to use at such a place a double set of pipes—one within the other—taking care that the joinings of the inner set are covered by the centres of the outer ones. By such precautions the water gets vent, and the running sand is excluded from the drain. When a brook has been diverted from its natural course for mill-power or irrigating purposes, it often happens that portions of land are thereby deprived of the outfall required to admit of their being drained to

a proper depth. In such cases it is frequently practicable to obtain the needed outlet by carrying a main drain through below the water-course, by using at that point a few yards of cast-iron pipe, and carefully filling up the trench with clay puddle, so that there may be no leakage from the water-course into the drain. While this is being done the water must either be turned off or carried over the temporary gap in a wooden trough.

Cost. The cost of draining is so much influenced by the ever-varying price of labour and materials, and by the still more varying character of the land to be operated upon, that it is impossible to give an estimate of the cost that will admit of general application. The following tabular data, taken chiefly from Mr Bailey Denton's valuable treatise, are presented to aid those who wish to form such an estimate:—

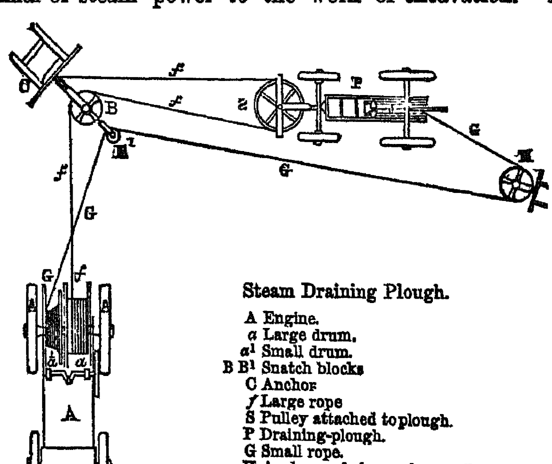
TABLE I.—*Showing the number of rods of drain per acre at given distances apart, and the number of pipes of given lengths required per acre.*

Intervals between the drains in feet.	Rods per acre.	12-inch pipes.	13-inch pipes.	14-inch pipes.	15-inch pipes.
18	146⅔	2420	2234	2074	1936
21	125 5/7	2074	1915	1778	1659
24	110	1815	1676	1555	1452
27	97 7/9	1613	1489	1383	1290
30	88	1452	1340	1244	1161

TABLE II.—*Showing the cost of draining per acre at different intervals between the drains.*

	18 feet apart.	21 feet apart.	24 feet apart.	27 feet apart.	30 feet apart.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Labour, cutting and filling in at 6s. per rod............	3 13 4	3 2 10	2 15 0	2 8 11	2 4 0
Material, pipes for minor drains, 18s. per 1000......	2 5 9	1 19 2	1 14 3	1 10 6	1 7 5
Haulage, two miles, and delivery in fields at 2s. 6d. per 1000	0 6 4	0 5 5	0 4 9	0 4 3	0 3 9
Pipe-laying and finishing, 1d. per rod..................	0 12 2	0 10 6	0 9 2	0 8 2	0 7 4
Superintendence, foreman..	0 5 0	0 5 0	0 5 0	0 5 0	0 5 0
Extra for mains..............	0 2 0	0 2 0	0 2 0	0 2 0	0 2 0
Iron-outlet pipes, and masonry, and extra labour...	0 1 6	0 1 6	0 1 6	0 1 6	0 1 6
Total...........	7 6 1	6 6 5	5 11 8	5 0 4	4 11 0
Add for collars, if used......	1 2 10	0 19 7	0 17 1	0 15 3	0 13 8
	8 8 11	7 6 0	6 8 9	5 15 7	5 4 8

Various attempts have from time to time been made to lower the cost of draining land by the direct application of animal or steam power to the work of excavation. The most successful of these attempts is the steam-draining apparatus invented by Mr John Fowler of Bristol, usually called *Fowler's draining plough.* A six-horse portable steam-engine is anchored in one corner of the field to be drained. It gives motion to two drums, to each of which a rope 500 yards long is attached, the one uncoiling as the other is wound up. These ropes pass round blocks which are anchored at each end of the intended line of drain, and are attached one to the front and the other to the hinder end of the draining apparatus. This consists of a framework, in which is fixed, at any required depth not exceeding 3½ feet, a strong coulter terminating in a short horizontal bar of cylindrical iron, with a piece of rope attached to it, on which a convenient number of drain pipes are strung. This frame being pulled along by the engine, the coulter is forced through the soil at a regulated depth, and deposits its string of pipes with unerring accuracy, thus forming, as it proceeds, a perfect drain. The supply of pipes is kept up by means of holes previously dug in the line of the drain, at distances corresponding to the length of the rope on which they are strung. This machine was subjected to a very thorough trial at the meeting of the Royal Agricultural Society of England at Lincoln in 1854, on which occasion a silver medal and very high commendation were awarded to it. In March 1855 it was publicly stated that five of these implements are now at work in different parts of England, and that already 10,000 acres of land have been drained by means of them. At the Lincoln trial it was satisfactorily proved that this implement could work at a depth of 3½ feet. As it moved along, the soil on each side, to the width of 2 or 3 feet, seemed to be loosened. It is therefore probable that this implement, or at least one propelled on the same principle, may yet be used as a subsoil disintegrator.



Steam Draining Plough.
A Engine.
a Large drum.
a¹ Small drum.
B B¹ Snatch blocks
C Anchor
f Large rope
S Pulley attached to plough.
P Draining-plough.
G Small rope.
H Anchor and sheave for small rope.

Drainage Acts. A great stimulus has recently been given to the improvement of land by the passing of a series of Acts of Parliament, which have removed certain obstacles that effectually hindered the investment of capital in works of drainage and kindred ameliorations. By the first of these Acts, passed in 1846, a sum of £4,000,000 of the public money was authorised to be advanced to landowners to be expended in draining their lands. The Enclosure Commissioners were charged with the allocation of this money and the superintendence of its outlay. The most important provisions of this Act are that it enables the possessors of entailed estates (equally with others) to share in the benefits of this fund; that it provides, on terms very favourable to the borrower, for the repayment of the money so advanced by twenty-two annual instalments; that before sanctioning the expenditure of these funds on drainage works, the commissioners must have a report from a qualified inspector, to the effect that they are likely to prove remunerative; and, finally, that the works must be performed according to specifications prepared by the inspector, and approved by the commissioners, who have seldom allowed of a less depth of drain than 3½ feet. By the end of the year 1854 the whole of this money was allocated, and more than half of it actually expended. Scottish landowners were so prompt to discern, and so eager to avail themselves of this public fund, that more than half of it fell to their share. The great success of this measure, and the rapid absorption of the fund provided by it, soon led to further legislative Acts, by which *private capital* has been rendered available for the improvement of land, by draining and otherwise, on conditions similar to those just enumerated. These Acts are—

1*st*, The Private Moneys Drainage Act (12 and 13 Vict. c. 100), limited to draining.

2*d*, The West of England, or South-West Land Draining Company's Act (11 and 12 Vict., c. 142), for the purpose of draining, irrigation and warping, embanking, reclaiming and enclosing, and road-making.

3d, The General Land-Drainage and Improvement Company's Act (12 and 13 Vict. c. 91), for the purposes of draining, irrigating and warping, embanking, reclaiming and enclosing, road-making and erecting farm-buildings.

4th, The Lands Improvement Company's Act (16 and 17 Vict. c. 154), for the same purposes as the above, with the addition of planting for shelter. This company's powers extend to Scotland.

By these Acts ample provision is made for rendering the dormant capital of the country available for the improvement of its soil. To the owners of entailed estates they are peculiarly valuable, from the power which they give to them of charging the cost of draining, &c., upon the inheritance. If such owners apply their own private funds in effecting improvements of this kind, they are enabled, through the medium of these companies, to take a rent-charge on their estates for repayment of the money they so expend, over which they retain personal control, so that they can bequeath as they choose the rent-charge payable by their successor. Besides their direct benefits, these Drainage Acts have already produced some very important indirect fruits. They have led to many improvements in the manner of accomplishing the works to which they relate, to the wide and rapid dissemination of improved modes of draining, &c., and, in particular, they have had the effect of creating, or at least of greatly multiplying and accrediting, a staff of skilful and experienced draining engineers, of whose services all who are about to engage in draining and similar works will do well to avail themselves.

Section 3.—*Removal of Earthfast Stones.*

Newly reclaimed lands, and even those that have long been under tillage, are frequently much encumbered with earthfast stones. This is particularly the case in many parts of Scotland. Their removal is always desirable, though necessarily accompanied with much trouble and expense. In our personal practice we have proceeded in this way. In giving the autumn furrow preparatory to a fallow crop, each ploughman carries with him a few branches of fir or beech, one of which he sticks in above each stone encountered by his plough. If the stones are numerous, particularly at certain places, two labourers, provided with a pick, a spade, and a long wooden lever shod with iron, attend upon the ploughs, and remove as many of the stones as they can, while yet partially uncovered by the recent furrow. Those thus dug up are rolled aside upon the ploughed land. When the land gets dry enough in spring, those not got out at the time of ploughing are discovered by means of the twigs, and are then dug up. Such as can be lifted by one man are carted off as they are, but those of the larger class must first be reduced by a sledge hammer. They yield to the hammer more easily after a few days' exposure to drought than when attacked as soon as dug up. Before attempting to break very large boulders a brisk fire of dried gorse or brushwood is kept up over them until they are heated, after which a few smart blows from the hammer shiver them completely. Portions of otherwise good land are sometimes so full of these boulders, that to render it available, the stones must be got rid of by trenching the whole to a considerable depth. When ploughing by steam-power becomes general, a preliminary trenching of this kind will in many cases be requisite before tillage instruments thus propelled can be used with safety.

Section 4.—*Paring and Burning.*

Paring and burning have, from an early period, been resorted to for the more speedy subduing of a rough uncultured surface. This is still the most approved method of dealing with such cases, as well as with any tough old sward which is again to be subjected to tillage. In setting about the operation, which is usually done in March or April, a turf, not exceeding an inch in thickness, is first peeled off in successive stripes by a paring-plough drawn by two horses, or by the breast-plough already described. These turfs are first set on edge and partially dried, after which they are collected into heaps, and burned, or rather charred. The ashes are immediately spread over the surface, and ploughed in with a light furrow. By this process the matted roots of the pasture plants, the seeds of weeds, and the eggs and larvæ of innumerable insects, are at once got rid of, and a highly stimulating top-dressing is supplied to the land. A crop of turnips or rape is then drilled on the flat, and fed off by sheep, after which the land is usually in prime condition for bearing a crop of grain. This practice is unsuitable for sandy soils, which it only renders more sterile; but when clay or peat prevails, its beneficial effects are indisputable. We shall, in the sequel, give an example of its recent successful application.

Section 5.—*Levelling.*

Land, when subjected to the plough for the first time, abounds not unfrequently with abrupt hollows and protuberances, which impede tillage operations. These can be readily levelled by means of a box shaped like a huge dust-pan, the front part being shod with iron, and a pair of handles attached behind. This levelling-box is drawn by a pair of horses. Being directed against a prominent part, it scoops up its fill of soil, with which it slides along sledge-fashion to the place where it is to discharge its load, which it does by canting over, on the ploughman disengaging the handles.

In all parts of Great Britain, abundance of pasture land, and often tillage land also, is to be met with lying in broad, highly raised, serpentine ridges. These seem to have originated when teams of six or eight bullocks were used in ploughing; and it has been suggested that this curvature of the ridges at first arose from its being easier to turn these long teams at the end of each land by sweeping round in a curve than by driving straight out. The very broad headlands found in connection with these curved ridges point to the same fact. A theory still lingers among our peasantry, that "water runs better in a crooked furrow than in a straight one," and has probably been handed down since the discovered awkwardness of curved ridges was first seen to need some plausible apology. These immense, wave-like ridges are certainly a great annoyance to the modern cultivator; but still the sudden levelling of them is accompanied with so much risk, that it is usually better to cut drains in the intervening hollows, and plough aslant them in straight lines, by which means a gradual approximation to a level surface is made. A field in our own occupation, which was levelled, by cleaving down the old crooked ridges, fifty years ago, still shows, by alternate curving bands of greater and less luxuriance, the exact site of the crowns and furrows of the ancient ridges.

Section 6.—*Trenching.*

But for its tediousness and costliness, trenching two or three *spits* deep by spade or fork is certainly the most effectual means for at once removing obstructions, levelling the surface, and perfecting the drainage by thoroughly loosening the subsoil. For the reasons mentioned, it is seldom resorted to on a large scale. But it is becoming a common practice, with careful farmers, to have those patches of ground in the corners, and by the fences of fields, which are missed in ploughing, gone over with the trenching-fork. The additional crop thus obtained may fail to compensate for this hand-tillage, but it is vindicated on the ground that these corners and margins are the nurseries of weeds which it is profitable to destroy.

CHAPTER VIII.

TILLAGE OPERATIONS.

Section 1.—*Ploughing.*

When the natural green sward, or ground that has been cleared of a cultivated crop, is to be prepared for the sowing or planting of further crops, the plough leads the way in breaking up the compact surface, by cutting from it successive slices, averaging about ten inches in breadth by seven in depth, which it turns half over upon each other to the right-hand side. This turning of the slices or furrows to one side only renders it necessary to square off the space to be ploughed into parallelograms, half the slices of which are laid the one way and the other half the other, by the going and returning of the plough. These parallel spaces are variously termed *ridges, stetches, lands*, or *feirings*, which in practice vary in width from a few furrows to 30 yards. When very narrow spaces are used, a waste of labour ensues, from the necessity of opening out and then reclosing an extra number of index or guiding furrows; while very wide ones involve a similar waste from the distance which the plough must go empty in traversing at the ends. The spaces thus formed by equal numbers of furrow-slices turned from opposite sides have necessarily a rounded outline, and are separated by open channels. In a moist climate and impervious soil, this ridging of the surface causes rain-water to pass off more rapidly, and keeps the soil drier than would be the case if it was kept flat. Hence the cultivated lands of Great Britain almost invariably exhibit this ridged form of surface. Until the art of under-ground draining was discovered, this was indeed the only mode of keeping cultivated ground tolerably dry. But it is at best a very defective method, and attended by many disadvantages. When land is naturally dry, or has been made so by thorough drainage, the flatter its surface is kept the better for the crops grown upon it. We are not forgetful that there are, in various parts of Great Britain, clays so impervious that probably no amount of draining or disintegration of the subsoil will render it safe to dispense with ridging. These, however, are exceptional cases, and, as a rule, such a condition of soil and subsoil should be aimed at as will admit of this rude expedient of ridging being altogether dispensed with. Unless land can absorb the whole rain which falls upon it, its full range of fertility cannot be developed; for the same showers which aggravate the coldness and sterility of impervious and already saturated soils carry down with them, and impart to those that are pervious, ever fresh supplies of genial influences. Instead, then, of this perennial source of fertility being encouraged to run off by surface channels, or to stagnate in the soil and become its bane, let provision be made for its free percolation through an open stratum several feet in thickness, and then for its escape by drains of such depth and frequency as each particular case requires. When this is attained, a flat surface will generally be preserved, as alike conducive to the welfare of the crops and to the successful employment of machinery for sowing, weeding, and reaping them.

In all treatises on British agriculture of a date anterior to the first quarter of the present century, we find great stress laid on the proper formation of the ridges, careful cleaning out of the separating channels or water-furrows, and drawing and spading out of cross-cuts in all hollows, so that no water may stagnate on the surface of the field. As thorough under-draining makes progress, such directions are becoming obsolete. But whether ridging or flat work is used, the one-sided action of the plough renders it necessary, in setting about the ploughing of a field, to mark it off into parallel spaces by a series of equi-distant straight lines. Supposing the line of fence, at the side at which he begins, to be straight, the ploughman takes this as his base line; and measuring from it, erects his three or more feiring poles perfectly in line, at a distance from the fence equal to half the width of the ridges or spaces in which it is proposed to plough the field. This operation—called in Scotland *feiring* the land—is usually entrusted to the most skilful ploughman on each farm, and is regarded as a post of honour. Having drawn a furrow in the exact line of his poles, which practice enables him to do with an accuracy truly admirable, he proceeds, using always the last furrow as a fresh base from which to measure the next one, until the field is all marked off. When this is done, it presents the appearance of a neatly ruled sheet of paper. Besides the poles just referred to, the ploughman is frequently furnished with a cross staff, by means of which he first of all marks off two or more lines perpendicular to the straight side at which he commences, and along these he measures with his poles, which are graduated for the purpose, in laying off his parallel lines. This feiring is only required when a process of fallowing, in preparation for green crop, has obliterated the former ridges. In breaking up clover lea or older sward, the ploughman begins at the open furrows, which afford him a sufficient guide.

In ploughing for a seed-bed the furrow-slice is usually cut about five inches deep. In the case of lea, it should be turned over unbroken, of uniform thickness, and laid quite close upon the preceding one, so as to hide all green sward. The improved wheel-plough already referred to does this work very beautifully, cutting out the slice perfectly square from the bottom of the furrow. The perfect uniformity in the width and depth of the slices cut by it permits the harrows to act equally upon the whole surface. When the slice is cut unevenly, they draw the loosened soil from the prominences into the hollows, so that one part is scraped bare, and the other remains untouched and unbroken. This must necessarily yield a poor seed-bed, and contrasts unfavourably with the uniform tilth produced by harrowing after such work as these wheel-ploughs invariably produce. In the Lothians and west of Scotland, a form of plough is much used for ploughing lea, which cuts out the slice with an acute angle at the land side. This, when turned over, stands up with a sharp ridge, which looks particularly well, and offers a good subject for harrows to work upon. But if a few of these furrow-slices are removed, the firm earth below exhibits the same ribbed appearance as the newly ploughed surface, instead of the clear level sole on which the right-angled slice cut by the wheel-plough is laid over so as to rest upon its lower angle. This ribbing of the unstirred subsoil is exceedingly objectionable in all kinds of ploughing.

In the autumn ploughing of stubble-ground in preparation for the root-crops of the following season, a much deeper furrow is turned over than for a seed-furrow. In ordinary cases it should not be less than nine inches, while in very many, if ten or twelve can be attained, so much the better. In all deep soils this bringing up and mixing with the surface of fresh material from below is highly beneficial. It must not, however, be practised indiscriminately. Siliceous and peaty soils need compactness, and to have the soil that has been artificially enriched kept a-top. For such deep work as we have noticed above, three or even four horses are frequently yoked to the plough. When a field slopes considerably one way, it is good practice to work the plough down the slope only, and return without a furrow. A pair of horses working in this way will turn as deep a furrow, and get over as much ground, as three will do taking a furrow both ways, and with less fatigue to themselves and to the ploughman. After bringing a heavy furrow downhill, they get recruited in stepping briskly back with only the plough to draw. This mode of ploughing one furrow *down* the slope tends less to gather the soil to-

ward the bottom than by using a turn-wrest plough *across* the slope. It is while giving this deep autumn furrow that the subsoil plough is used. It follows in the wake of the common plough, and breaks and stirs the subsoil, but without raising it to the surface. This is a laborious operation, and engrosses too much of the horse-power of the farm to admit of large breadths being overtaken in any one season. In all indurated subsoils, however, it repays its cost; for when once thoroughly done, it diminishes the labour of ordinary ploughings for several succeeding rotations, aids the drainage, and adds to the fertility of the soil. It is in the performance of this deep autumn tillage and breaking up of the subsoil, that the steam-engine, with appropriate tackle, has begun to play an important part, and for which it will probably one day supersede all other means.

Section 2.—Harrowing, &c.

The harrow, cultivator, and roller, are all more simple in their action and more easily managed than the plough. Harrowing is most effective when the horses step briskly along. The tines are then not merely drawn through the soil, but, in their combined swinging and forward movement, *strike* into it with considerable force. It is with reference to this that a single application of this implement is called a *stroke* of the harrows. Rollers are used to aid in pulverising and cleaning the soil, by bruising clods and lumps of tangled roots and earth which the other implements have brought a-top; in smoothing the surface for the reception of small seeds, or the better operation of the scythe and other implements; and for consolidating soil that is too loose in its texture. Except for the latter purpose, light rollers are much superior to heavy ones. When it is wanted, for example, to bruise clots of quickens, that the after harrowing may more thoroughly free the roots from the adhering earth, a light cast-iron roller, say of 5 cwt., drawn by one horse, effects this purpose as thoroughly as one double the weight drawn by a pair,—and does it, moreover, in much less time, at less than half the expense, and without injuriously consolidating the free soil. These light rollers are conveniently worked in pairs, the ploughman driving one horse and leading the other. With a pair of active horses, and such rollers, a good deal more than *double* the space can be rolled in a day, than by yoking them both to one heavy one of the same length of cylinder. For mere clod-crushing, provided the clods are moist, the Norwegian harrow is superior to any roller; and for compressing a loose surface or checking wire-worm, serrated or smooth-edged discs, such as Crosskill's or Cambridge's, are better than smooth cylinders of the same weight, so that the heavy smooth roller, requiring two or more horses to draw it, is superseded by better implements for all purposes where rollers are used at all, unless it be for the rolling of the grass-lands.

As a general rule, none of these tillage operations can be performed to advantage when the soil is wet. When rain falls inopportunely there is a strong temptation to push on the field operations, before the soil has recovered the proper state of dryness. When this is done the farmer almost invariably finds in the issue that the more haste he makes the worse he speeds. Soils with a good deal of clay in their composition are peculiarly susceptible of injury in this way. Nice discrimination is needed to handle them aright. They require, moreover, a full stock of well-conditioned horses, that the work may be pushed rapidly through in favourable weather. To manage such soils successfully, especially when root crops are grown, tries the skill of the farmer to the utmost. So at least it has hitherto been; but with steam-power to aid him, there is now a probability that the clay land farmer, by being able to break up his soil without treading it, and to get through with a large extent of tillage when his land is in trim for it, may find it practicable to grow root crops on equal terms with the occupier of freer soil.

Section 3.—Fallowing.

When, by such operations as have now been described, land has been reclaimed from its natural state, and rendered fit for the purposes of the husbandman, it is everywhere so charged with the germs of weeds, most of which possess in a remarkable degree the power of reproduction and multiplication, that it is only by the most incessant and vigorous efforts he can restrain them from encroaching upon his cultivated crops, and regaining entire possession of the soil. He can do much towards this by ordinary tillage, and by sowing his crops in rows, and hoeing in the intervals during the early stages of their growth. But if his efforts are restricted to such measures only, the battle will soon go against him. Besides this, all arable soils in which clay predominates, particularly when undrained, have such a determined tendency to become compact and soured, that under ordinary efforts they fail to yield a genial seed-bed. There is a necessity, therefore, for having recourse, from time to time, to that ameliorating process of lengthened tillage called fallowing. This process begins in autumn, immediately after the removal from the ground of the cereal crop, which had been sown upon the land newly broken up from clover lea or natural sward, and extends either to the time for sowing turnips and analogous crops in the following spring, or is continued during the entire summer in preparation for autumn-sown wheat. We shall first describe that modification of the fallowing process by which the soil is prepared for the sowing of drilled green crops, and then the more prolonged form of it usually called *summer* or *naked* fallow.

Green Crop Fallow.

The object aimed at being the thorough disintegration and cleaning of the soil, the usual practice is to begin by ploughing as deeply as is found practicable. This first or autumn furrow is accordingly turned over to a depth of 8 or 9 inches; or by using a stronger plough drawn by three or four horses, it is carried to 12 inches in depth; and in some cases, by following with a subsoil plough in the wake of the common one, the soil is stirred to the depth of 14 or 16 inches. All cultivators are agreed as to the importance of thus deeply and effectually disintegrating all soils that are naturally dry or thoroughly drained. In the case of undrained lands, and even of very unctuous clays, although well drained, such deep stirring of the soil in autumn does but increase its capacity of retaining the rains of winter, and of being thereby more effectually soured, and is therefore to be avoided. Assuming, however, that we have to do with soil thoroughly drained and moderately friable, it is undoubtedly beneficial to loosen it deeply and thoroughly at this stage. But before this deep ploughing is set about, it will be worth while to consider well its bearing upon the cleaning part of the process. On carefully examining the fields at the time of reaping the grain-crops, and from week to week thereafter, the roots of the couch grass are found at first lying close to the surface; but instantly, on their getting the ground to themselves, they begin to send out fresh fibres, and to push their shoots deeply into the soil. In these circumstances, to proceed at once, according to the customary practice, to plough deeply, allows these weeds much time to increase, while this laborious and tedious operation is going on; and although, when performed, it gives some present check to their progress, by burying them under a mass of loosened soil, it not only increases the difficulty of their after removal, but places them out of the reach of frost, and in the best

possible position for pervading the entire soil, on the first recurrence of mild weather. The consequence is, that fallows so treated are invariably found in spring more fully stocked with quickens than they were at the time of the autumn ploughing. The observation of this suggested the practice, now very common in England, of *cleaning fallows in autumn before giving the first deep furrow.* For this purpose, such implements as Biddle's scarifier, the broad-share paring-ploughs, or better still, the common plough, divested of its mould-board and fitted with a share a foot broad, are set to work as fast as the grain-crops are reaped, and the whole surface is rapidly pared at a depth of three or four inches. This completely loosens the yet shallow-lying roots of the couch-grass, which are then freed from the adhering earth by the Norwegian and chain-harrow, raked together and burned, or carted off. This pulverising of the surface soil in early autumn is usually followed by the springing up of an abundant crop of annual weeds and of shaken grain, which are thus got rid of by the subsequent ploughing. So great and manifold are the advantages of this modern practice, that in those districts where it is most in use, other autumn work, even wheat-sowing, is comparatively neglected until it is accomplished. When the weeds have been got rid of in this summary and inexpensive manner, deep ploughing is then resorted to with unalloyed benefit. Whenever steam-power becomes fully available for tillage operations, this autumn cleaning and deep stirring of fallows will be accomplished rapidly and effectually, and the teams will meanwhile be set at liberty for root-storing, wheat-sowing, and other needful work, which can be well done only when accomplished during the brief season of good weather, which usually intervenes betwixt the close of harvest and beginning of winter.

Autumn cleaning.

In the case of farms that have for a lengthened period been carefully cultivated, the stubble may be found so clean as not to require the whole area to be scarified in the manner now described. Instead of this, it may suffice to have the ground carefully examined, and such patches or stray plants of couch-grass, or other perennial weeds, as are met with, forked out. By this means the fallows are kept clean at little expense, and when spring arrives, those repeated ploughings, and other tedious and costly operations, are wholly avoided, in performing which the condition of the soil is marred and the best seed-time often missed. When fallows are thus cleaned in autumn, it is highly advantageous to cart on to them at once, and cover in with a deep furrow, all the farm-yard dung that is on hand up to the completion of their first ploughing. From the length of time which must elapse before the land can again be touched, it is quite safe, or rather it is highly advantageous, to apply all the recently made dung, although in a very rough state. In doing this, it is necessary that a person precede each plough, and trim the rank litter into the previous furrow, that it may be properly covered up and regularly distributed. Unless this precaution is observed, the ploughs are constantly choked and impeded, the manure is drawn together into unsightly hassocks, and the whole operation is imperfectly performed. The recommendations to this practice are—*First,* An important saving of labour; for the manure being carted direct from the yards, &c., on to the land, and evenly spread over it, there is no forming, covering up, and turning of dunghills, or refilling and carting in spring. This heavy work is accomplished at a season when time is less pressing than in spring, and the sowing of the crop can be proceeded with more rapidly when the time for it arrives, and while weather favours. *Second,* There is a saving of manure by burying it at once in its rough state, instead of first fermenting it in large heaps; and a large portion of the fallow-break can thus be dressed with home-made manure. *Third,* The rough dung thus ploughed in decomposes slowly, its virtues are absorbed and retained by the soil, with the whole mass of which it is thoroughly incorporated by the spring tillage, and which, in consequence, is found, after such treatment, in a peculiarly mellow and favourable condition for receiving the seed.

The advantages of autumn cleaning and manuring of land in preparation for green crops are so great that the utmost exertions should be made to secure them. Over a large portion of England the harvest is usually so early as to leave ample time for accomplishing the cleaning process before being arrested by bad weather. From the later harvest season and more humid climate of Scotland, it is there more difficult to carry it out to the whole extent of the fallow-break; but still, with promptitude and energy, much can be done. One of her shrewd and intelligent sons, Mr Tennant, the inventor of the grubber which bears his name, has, however, introduced a system of autumn tillage, founded upon the same principle, and accomplishing virtually the same end, but less expensive and better adapted to the climate of Scotland than that just described. So soon as the grain crops are harvested, Mr Tennant sets his light grubbers agoing, and by working them over the whole field several times and in opposite directions, stirs the whole surface soil to the depth of six or eight inches, tears up and brings to the surface all root-weeds, where, after being knocked about and freed from adhering soil by repeated harrowings and a final grubbing, they are left for the winter. In our own practice we have latterly improved, as we imagine, on Mr Tennant's plan by broadsharing the land before using the grubbers, and also by employing the Norwegian harrow instead of the common one. The broadsharing ensures that the whole of the couch-grass and other weeds are thoroughly loosened without being buried, and the Norwegian harrow shakes out the roots from the adhering earth better than the common harrow. When it is intended to treat a field in this way, care should be taken at harvest time to reap the crop as close to the ground as possible, as rank stubble seriously encumbers the tillage implements. In setting about the grubbing of a field it is expedient also to begin with the headlands, and to work them thoroughly all round twice over, before they are trodden down by the frequent turning of the horses upon them. If this is omitted it will be found nearly impossible to have the margins of the field as well cultivated as the rest of it. A field thus treated presents for a time a singularly untidy and unpromising appearance; but the ultimate effects of the practice, as well in the cleaning as the disintegrating of the soil, are very remarkable. When roots of couch-grass, &c., are freed from the soil, and fully exposed to the vicissitudes of the weather at a season when their vital force is at the lowest point, they are unable to resist its effects, and gradually die. If placed in similar circumstances in spring, with their vital energy in full play, the merest point of a root embedded in, or even in contact with, pulverised soil, enables them to push down fresh fibres, to re-establish their connection with the soil, and to grow as lustily as ever. But so completely is the destruction of these pests secured by this simple process of winter exposure, that on the return of spring they may be ploughed in with impunity. Mr Tennant assures us, that ever since he adopted this practice he has been enabled to dispense with the removal of these weeds. Having had an opportunity of inspecting his farm, we are enabled to testify to its cleanness and high state of fertility. On this plan, then, the cleaning of fallows is accomplished by tillage operations alone, without any outlay for raking or hand-picking, burning, or carting off. Nor is this done at the expense of the pulverising part of the process. On the contrary, Mr Tennant asserts, and we have so far verified his assertion by actual experiment, that by dis-

Tennant's system.

integrating the soil in autumn, as is done by this broadsharing, grubbing, and harrowing, it receives far more benefit from the alternation of frost and thaw, rain and drought, than when merely ploughed and left lying during winter in compact furrow-slices. This plan affords the same facilities as the other for autumn manuring, if the weeds are raked off at once from so much of the fallow-break as it is wished to manure before winter. When the remainder is ploughed in April following, more of it may then have the farm-yard dung applied to it in the same way. Agriculturists owe a large debt of gratitude to Mr Tennant for the invention of his beautifully simple and efficient grubber, and for this scientific application of it to the fallowing process. Those who have been pursuing this system of tillage will be much interested in observing that it has been adopted by Mr Smith of Woolston, who is carrying it out to perfection by means of his steam-drawn implements.

The autumn tillage of the fallows having been accomplished in one or other of the ways described, the land is left untouched till the return of spring. If it is infested by annual weeds, it is expedient, as soon as it is dry enough to bear treading with impunity, to level and stir the surface by a turn of the harrows. This slight moving of the mellowed surface-soil induces the seeds of weeds to germinate more quickly than they would otherwise do, and thus a crop of them is got rid of by the next tilling. This preliminary harrowing is useful also in affording a level course for the tillage implements. By the time that the labour connected with the sowing of spring crops is over, the fallows are usually dry enough to be stirred with safety. This point, must, however, be well seen to, as irreparable mischief is often done by going upon them too soon. And now it is, that, instead of rigidly following any customary routine of so many ploughings, harrowings, and rollings, the skilful cultivator will regulate his procedure by the actual circumstances of his soil, and the object which he has in view. What is needed for the successful growth of drilled green crops is to have the soil free from weeds, thoroughly disintegrated to the depth of six or eight inches, and yet moist enough to ensure the ready germination of seeds deposited in it. Where such autumn cleaning and manuring as we have described have been successfully carried out, all that is needed, in order to obtain a proper tilth, is to go to work with light grubbers, first in the line of the previous furrows and then across them, and then to harrow, roll, and remove any weeds that have been missed in autumn, after which the soil will be in the best possible condition for drilling. On friable soils, this method of performing the spring tillage by means of the grubber instead of the plough is perfectly practicable, and has manifold advantages to recommend it. The saving of labour is very great, as a man and pair of horses will more easily grub four acres than plough one acre. Weeds are more easily removed, as the grubber pulls them out unbroken, whereas the plough cuts them in pieces. The soil that has been all winter subjected to the mellowing influences of the weather, and which, in consequence, is in the best possible condition to yield a genial seed-bed, is retained a-top, whereas ploughing buries it and brings up clods in its stead. And, lastly, the soil being merely stirred, without having its surface reversed, its natural moisture (or *winter sap*) is retained, whereby the germinating of seeds sown in it becomes almost a certainty. The importance of this last point in the cultivation of such crops as the turnip, whose seeds must usually be sown during hot and dry weather, can scarcely be overrated. This practice is peculiarly appropriate for soils of loose texture, which are invariably injured by repeated ploughings. But it is also resorted to successfully on soils of the opposite extreme. Many farmers in the Lothians now grow abundant and extensive crops of turnips on strong clay soils by spreading a liberal dressing of dung on the stubble in autumn, ploughing it in with a deep furrow, leaving the land untouched until sowing-time has fully arrived, and then stirring the mellowed surface soil by the grubbers, removing weeds, and drilling and sowing at once without any ploughing. When this system is adopted on tenacious soils, it is prudent to operate upon portions of the field in detail, taking in only so much at a time as can be grubbed and drilled the same day; for if rain should intervene betwixt the grubbing and the drilling, the soil would set like mortar and the tide be lost. When once the ridgelets are made up in good condition, they can withstand a fall of rain with comparative impunity; and hence the occurrence of a course of fine weather, when the season is yet too early for sowing, is sometimes taken advantage of by preparing the land and making it up into ridgelets, although it should require to remain in this state weeks, or even months, before sowing takes place. In such a case, immediately before sowing, the ridgelets are first partially levelled by harrowing length-wise, in order to loosen the soil and destroy annual weeds, and then again made up by using a double-breasted plough. We must here, however, insist upon the importance of having the grubbing thoroughly performed, which it cannot be unless the tines penetrate the soil as deeply as the plough has done at the autumn ploughing. It is owing to the neglect of this that the system has failed in the hands of many farmers, who first mismanage the operation, and then throw the blame upon the grubbers. To ensure success, the implement must be set so as to work at its full depth, sufficient motive power being applied by yoking three horses, if necessary, to each grubber at the first and also at the second going over, and there must be vigilant superintendence exercised lest the ploughman do the work slightly. It is sometimes objected to this system of spring tillage, that it fails to rid the land of thistles and other tap-rooted weeds; but it is surely easier to fork these out as they appear, than to plough a whole field merely to destroy as many thistles as a man, it may be, would dig up in a day. By taking advantage of the tilth obtained by the action of the elements, instead of first ploughing down the mellowed surface, and then attempting laboriously to reduce the obdurate furrows by mechanical means, skilful and energetic farmers now succeed in preparing even tenacious soils for drilled green-crops, at little expense, and with a good measure of certainty.

On these opposite classes of soils, then—the very loose, and the tenacious—spring tillage, in preparation for root-crops, is performed to better purpose by means of the grubber than the plough. Betwixt these extremes, however, lies the most valuable class of soils—the strong fertile loams—on which the heaviest crops and best quality of Swedes are grown. With these it is usually expedient to have recourse to at least one spring ploughing, as soon, but only as soon, as the soil is dry enough to crumble freely to the very bottom of the furrow. As this usually occurs from four to six weeks before the time of sowing the crop, it is advisable to plough the entire field, and leave it so until rain falls, when a moderate use of the grubber, harrows, and light roller, usually suffices to produce a good tilth for ridging. When operations are not thus facilitated by a seasonable fall of rain, it is necessary to proceed somewhat differently. The field is lying as it was left by the plough, with a rough dried surface. If harrowed while in this state, an abundant crop of clods is brought to the surface, which quickly harden when thus fully exposed to drought. To avoid this inconvenience, the field is *first* rolled with a heavy roller, and then grubbed across the direction in which it was last ploughed. By this means the clods, being partially crushed and pressed down amongst the loose earth, resist the grubber, and are crumbled by it, instead of being

merely raked out and left entire on the surface, as would happen but for this preliminary rolling. The grubbers are followed closely by harrows and a light roller, and these again by the grubbers; but this time with *seven* tines on instead of five, after which a sufficient tilth is usually obtained. All this is on the supposition that the land is clean when these spring operations are commenced; for should it be otherwise, it is usually better to begin with the grubber on the stale winter furrow, and to get rid of the weeds, before using the plough. If it is found necessary to plough near to the time of sowing, then the harrow and roller must keep pace with the ploughs in order to retain moisture and prevent the formation of clods. The Norwegian harrow is the proper implement to use in such cases. Let it ever be borne in mind that if the soil is cleaned and sufficiently disintegrated, the less working it gets at this stage the better.

It may be well indeed to remind the reader that although the fallowing process can most conveniently be gone about during the period which intervenes betwixt the removal of a grain-crop from the ground and the sowing of the succeeding root-crop, and on this account is often spoken of in a loose way as being performed "in preparation for the root-crop," it is a fallacy to regard this laborious and costly process of tillage and cleaning as undertaken solely or mainly for the benefit of the turnip or other root-crop, then about to be sown. The other crops of the rotation benefit by it in a far greater degree, and it would be required on their account although turnips were not grown at all, as may be seen in the case of clay lands with their periodic naked fallows. It is the overlooking of this fact which has led people to charge the whole cost of this fallowing process, and of all the manure then applied to the land, against the turnip-crop, and then to represent this crop as the most costly one which the farmer grows,—one which often yields him less than it cost to produce it. Undoubtedly the cost of the fallow must be charged equally against all the crops of the rotation.

Summer or Naked Fallow.

Having thus described at length that modification of the fallowing process by which the soil is prepared for the sowing of green crops, we shall now, as proposed, speak of that prolonged form of it called a *summer* or *naked* fallow. From the facilities now afforded, by means of tile-draining and portable manures, for an extended culture of green crops, this laborious and costly process, which in its day was justly regarded as the very key to good and profitable farming, is now restricted to the more obdurate clay soils, or to cases where draining and other modern improvements are neglected. The manifold advantages of having abundant crops of turnips, or mangel-wurzel, instead of naked fallow, sometimes tempt the occupiers of clay soils to push the cultivation of these crops beyond due bounds. We know of cases where, after large expenditure in draining, the cultivation of turnips has been carried to such an extent, and conducted so injudiciously, that the land has got foul and soured, and its gross produce has been reduced below what it was while the land was undrained, and under a regular system of all but exclusive naked fallows. However thoroughly drained, clay soils retain their ticklish temper, and are so easily disconcerted by interference during unfavourable weather, that the preparing of them for the cultivation of root-crops, and still more the removing of these crops when grown, is at best a hazardous business, and requires to be conducted with peculiar tact. Judicious farmers, who know by experience the difficulties that have to be overcome in cultivating such soils, are of opinion that all that can yet be ventured upon with safety is to prolong the period of the naked fallow's recurrence, rather than entirely to dispense with it. After a series of alternate grain and cattle crops, it is accordingly still their practice to wind up with a summer fallow, by which they rectify unavoidable defects in the tillage of preceding years, and put their land in good humour for entering again upon a fresh course of cropping.

This process is begun by a deep ploughing in autumn, in performing which the land is gathered into ridges, that it may be kept as dry as possible during winter. When the more urgent labours of the following spring are so far disposed of as to afford leisure for it, a second ploughing is given to the fallow, usually by reversing the furrows of autumn. This is followed at intervals by two cross-ploughings, which are made to reverse each other, in order to keep the land level. As it is the nature of these soils to break into lumps, under the action of the plough, rather than to crumble down, the clods thus produced get so thoroughly parched in dry weather, that root-weeds enclosed in them are killed by sheer desiccation. To further this cheap mode of getting rid of them, the land is not rolled, but stirred by the grubber and harrow as frequently as possible, so as to expose the clods freely to the drought. We know by experience that fallows can be cleaned effectually by thus taking advantage of the tendency in clay soils to bake excessively under exposure to the hot dry weather which usually prevails in June and July. Should the season happen to be a showery one, this line of tactics must needs be abandoned, and recourse had to the judicious use of the grubber, Norwegian and common harrow, in order to free the weeds from the soil, and then clear them off by raking or hand-picking. This is more costly, and, as we believe, less beneficial to the soil than the simple method first noticed, which should therefore be attempted in the first place. As in hay-making, much can here be done in a few favourable days, by keeping grubbers and harrows at work, and turning the clods frequently. When farm-yard dung is to be applied to such fallows, it is desirable that it should be carted on and ploughed in before July expires. In applying it, two methods are followed. That usually adopted is, after marking off the ridges, to put down the dung in small heaps, at regular distances, and forthwith to spread it and plough it in. In the other, the land is formed into ridgelets, running diagonally across the intended line of the ridges, and the dung is enclosed in them in the manner to be hereafter described in treating of turnip culture. In either way, after the lapse of several weeks, the surface is levelled by harrowing, and the land is gathered into ridges by the last of this series of ploughings, hence called the seed-furrow. When lime is to be applied to such land, this is the stage of the rotation which is usually chosen for doing so. It is spread evenly over the surface, immediately before the last ploughing. In finishing off this fallowing process, it is necessary, on undrained lands, to be careful to clean out the ridge-furrows and cross-cuts, in anticipation of winter rains. But if such land is worth cultivating at all, it is surely worth draining, and this operation once thoroughly performed, puts an end to all further solicitude about furrows.

CHAPTER IX.

SUCCESSION OF CROPS.

Section 1.—*Rotation necessary.*

There are few agricultural facts more fully ascertained than this, that the growth, year after year, on the same soil, of one kind of plants, or family of plants, and the removal from it, either of the entire produce, or at least of the ripened seeds of such plants, rapidly impairs the general fertility of that soil, and, in particular cases, unfits it for bearing further crops of the kind by which it has been exhausted. The explanation of the causes of this phenomenon

belongs to the agricultural chemist or vegetable physiologist, to whom we willingly leave the task. What we have to do with is the fact itself, and its important bearing on agricultural practice. There is no natural tendency in the soil to deterioration. If at any time, therefore, the earth fails to yield its increase for the use of man, it is owing to his own ignorance and cupidity, and not to any defect in the beneficent arrangements of the Creator. The aim, then, of the agriculturist, and the test of his skill, is to obtain from his farm abundant crops at a remunerative cost, and without impairing its future productiveness. In order to this, two conditions are indispensable,—first, that the elements of fertility abstracted from the soil by the crops removed from it be duly and adequately restored; and, second, that it be kept free from weeds. The cereal grains, whose seeds constitute the staple food of the human family, are necessarily the most important and valuable of our ordinary crops. The stated removal from a farm of the grain produced on it, and its consumption elsewhere, is too severe a drain upon its productive powers to admit of these crops being grown every year on the whole, or greater part of it, without speedily impairing its fertility. Supposing, however, that this waste could be at once repaired by the annual return to the soil of manure equivalent in constituent elements to the produce removed, the length of time which grain-crops occupy the soil, and their habit of growth, interpose peculiar difficulties in the way of cleaning it thoroughly, either before they are sown, or while they occupy the ground. Again, although bread-corn is the most important product of our soil, other commodities, such as butcher-meat, dairy produce, vegetables, wool, and flax, are indispensably required. The economical culture of the soil demands the employment of animal power, which, to be profitably used, must be so distributed as to fill up the year. The maintenance of the working cattle, and of other live stock, implies the stated culture of a large amount of herbage and forage. Now, these varied conditions are duly met by cultivating grain and cattle crops alternately, and in about equal proportions. In carrying out these general principles, much discrimination is required in selecting the particular plants best adapted to the soil, climate, and other circumstances, of each farm, and in arranging them in the most profitable sequences; for not only is it necessary duly to alternate grain and green crops, but, in general, there is a necessity, or at least a high expediency, in so varying the species or varieties of the latter class as to prolong, as much as possible, the periodic recurrence of any one of them on the same field. In settling upon a scheme of cropping for any particular farm, regard must be had to its capabilities, to the markets available for the disposal of its products, and to the command of manure. When these things have been maturely considered, it is always beneficial to conduct the cropping of a farm upon a settled scheme. The number of men and horses required to work it is regulated chiefly by the extent of the fallow-break, which it is therefore desirable to keep as near to an average annual breadth as possible. When the lands of a farm vary much—as regards fertility, fitness for particular crops, and proximity to the homestead,—they must be so apportioned as to make the divisions alloted to each class of crops as equal as possible in all respects, taking one year with another. Unless this is done, those fluctuations in the gross produce of farms which arise from varying seasons are needlessly, it may happen ruinously, aggravated; or such an accumulation of labour is thrown on certain years which may prove unfavourable ones as to weather, that the work is neither done well nor in due season.

No better rotation has yet been devised for friable soils of fair quality than the well-known four-field or Norfolk system. By this course half the arable lands are in grain-crops, and half in cattle-crops, annually. It is indeed true that, in the way in which this course has hitherto been usually worked, both turnips and clover have recurred so frequently (every fourth year) on the same fields, that they have become subject to disease, and their produce excessively precarious. But the excellence of this course is, that its main features can be retained, and yet endless variation be introduced in its details. For example, instead of a rigid one-fourth of the land being each year under turnips, barley, clover, and wheat or oats, respectively, half only of the barley division is frequently in practice now sown with clover seeds, and the other half cropped in the following year with beans, peas, potatoes, or vetches. On the same set of fields, coming round again to the same point, the treatment is reversed by the beans, &c., and clover, being made to change places. An interval of *eight* years is thus substituted for one of *four*, so far as these two crops are concerned. Italian rye-grass, unmixed with any other plant, is now frequently taken in lieu of clover on part of the division usually allocated to it, and proves a grateful change both to the land and to the animals which consume it. In like manner, instead of sowing turnips unvaryingly every fourth year on each field, a portion of the annual division allotted to this crop can advantageously be cropped with mangel-wurzel, carrots, or cabbages, care being taken to change the site occupied by each when the same fields again come in turn. The same end is even so far gained by alternating Swedish with yellow or globe turnips. It is also found expedient, either systematically or occasionally, to sow a field with clover and pasture grasses immediately after turnips, without a grain crop, and to allow it to remain in pasture for four years. A corresponding extent of the other land is meanwhile kept in tillage, and two grain crops in succession are taken on a requisite portion to equalise the main divisions, both as respects amount of labour and the different staple products. A closer cover of grasses and a better pasture is obtained in this way than by first taking the customary grain crop after turnips; the land is rested and invigorated for future tillage, the outlay on clover and grass-seeds somewhat diminished, and the land better managed for the interests of all concerned than by a rigid adherence to the customary rotation.

Section 2.—Restrictive Clauses in Leases Hurtful.

It is common enough for landlords, or their agents, to tie down the tenantry over large estates to the rigid observance of some pet rotation of their own. In an unimproved state of agriculture, and for a tenantry deficient both in capital and intelligence, such trammels, kindly enforced, may be as beneficial to them as to their landlord. But when the culture of the soil is undertaken by men of good education, who bring to the business ample capital, and skill to use it to the best advantage, such restrictions are much more likely to do harm than good to both parties. It is to be observed in regard to those restrictive clauses usually inserted in farm-leases,—such as, that two grain-crops shall never be taken in immediate succession; that no hay, straw, or turnips, shall be sold from the farm; that only certain limited quantities of potatoes or flax shall be grown; that land shall be two or more years in grass, &c.,—that they all proceed on the supposition that the farm is to maintain its own fertility. They obviously do not contemplate the stated purchase of large quantities of guano, bones, and similar extraneous manures, or the consumption by live stock of linseed-cake, grain, or other auxiliaries to the green crops produced on the farm. Now, not only are such clauses incompatible with such a system of farming as we have just now indicated, but their direct tendency, if enforced, is to hinder a tenant from adopting it even when disposed to do so. We hear now-a-days of tenants who are

annual purchasers of these extraneous fertilising substances to the extent of 20s. to 30s. worth for every acre occupied by them. To enforce the same restriction on such men as on others who buy none at all is obviously neither just nor politic; and we believe that any practical farmer, if he had his choice, would rather be the successor of a liberal manurer, however he may have cropped, than of one who has farmed by rule on the starving system. We are quite aware that, in regard to the first-mentioned of these restrictions (viz., that which forbids taking two grain-crops in immediate succession), the contrary practice is still asserted by agricultural authorities to be necessarily bad farming. Now, we do not concur with this opinion, but believe, on the contrary, that when land is kept clean, and is as highly manured and well tilled as it must be to grow cattle-crops in perfection, the second successive crop of grain will usually be better than the first, its production nowise injurious to the land, and the practice, *in such circumstances*, not only not faulty, but an evidence of the skill and good management of the farmer. A frequent encomium applied to a particularly well-cultivated farm is, that "it is like a garden." The practice of market-gardeners is also frequently referred to as a model for farmers. Now, the point with them is to have every inch of their ground under crop of some kind at all seasons, and to carry everything to market. Under such incessant cropping, the fertility of the soil is maintained only by ample manuring and constant tillage. By these means, however, it is maintained, and the practice is extolled as the perfection of management. Such a system must therefore be as true in farming as in gardening, when the like conditions are observed. Undoubtedly he is a good farmer, who, while keeping his land clean and in good heart, obtains the greatest produce from it at the least proportionate outlay; and it is no valid objection to his practice merely to say that he is violating orthodox rotations.

Section 3.—*Experiments at Rothamstead and Lois Weedon.*

Some curious information has been obtained regarding the effects of growing successive crops of one kind of plant on the same field, from two examples of it that attracted much attention. We refer to the experiments of Mr Lawes at Rothamstead, and of the Rev. Mr Smith at Lois Weedon. It is well known that Mr Lawes for a number of years devoted a considerable extent of land to the prosecution of a series of interesting experiments, one field being allotted to experiments with wheat, another to turnips, and another to beans. One acre in the wheat-field bore upwards of twenty successive crops of wheat without any manure whatever. The land was annually scarified and thoroughly cleaned as soon as the crop was removed; it was then ploughed and again drilled with wheat, which was duly hoed in spring. Now, with occasional variation, due to the character of particular seasons, Mr Lawes found that the average annual produce of this acre was 16 bushels of grain and 16 cwt. of straw, below which he failed to reduce it by these successive crops. His soil was a strong clay loam, resting at a depth of five or six feet upon chalk. In the case of turnips, he found that, when treated in the same way, they cease after a few years to grow larger than radishes, nor could he, by the application of any amount or variety of manure which he tried, obtain a second successive crop equal to the first. With the wheat, on the contrary, the addition of four cwt. of Peruvian guano at once doubled the produce. Mr Smith's experiments, as is well known, were a revival of Jethro Tull's system of growing wheat continually on the same field, by a plan of alternate strips of wheat and bare fallow, made to change places annually. He improved in so far upon Tull's practice, inasmuch as he thoroughly drained his land, and his fallow spaces were deeply trenched every autumn, as well as ploughed and hoed during the growing season. The result was that his land thus treated yielded an average annual produce of 34 bushels per acre for eleven or twelve successive crops. Now, it is not our intention to offer any opinion on this as a system of wheat growing. We refer to it along with Mr Lawes's, for the purpose of showing that, notwithstanding the prevalent opinion that grain-crops exhaust the fertility of soils more rapidly than green crops, this is true only in a very restricted sense. Green crops judiciously interposed do undoubtedly serve a most important purpose in the means which they furnish for maintaining the fertility of a farm; but it is worthy of note, that whereas, by the addition of suitable manure, thorough tillage, and diligent removal of weeds, clay soil at least will stand an indefinite succession of grain crops, the same means entirely fail to yield the same results with our most popular green crops. Our personal experience quite accords with this; for we suppose it will be admitted that the corn crops of the country are at the present day superior, both in quality and quantity, to those of any preceding period; whereas potatoes, turnips, and clover, which we have so long regarded as our sheet-anchor, have become increasingly precarious, and threaten to fail us altogether. We offer these facts for the consideration of those who out-and-out condemn the practice of sowing two white crops in immediate succession. In stating this opinion, we must, however, guard against misapprehension. Unless the land is highly manured and kept thoroughly clean, we are just as much opposed to the practice as any one can be; but when mischief is done by it, we believe that it is due rather to the presence of weeds than to the second grain-crop. Neither do we plead for the absolute removal of restrictive clauses from farm leases. Human nature being what it is, men who do not see it to be for their own advantage to farm well, will, through ignorance or greed,[1] impoverish their land unless they are restrained. Clauses as to cropping should, however, be prohibitory rather than prescriptive—have reference rather to what is removed from the farm than to what is grown upon it—and they should be contingent upon the other practices of the tenant. So long as he continues, by ample manuring and careful tillage, to maintain the fertility and general good condition of the farm rented by him, it can be no advantage to his landlord to hinder him from cropping it at his own discretion. It will be seen from these remarks, that we attach more importance to those general principles which should regulate the succession of crops, than to the laying down of formulæ to meet supposed cases. The man who cultivates by mere routine is unprepared for emergencies, and is sure to lag in the race of improvement; while he who studies principles is still guided by them, while altering his practice to suit changing circumstances.

CHAPTER X.

MANURES.

Section 1.—*Farm-yard Dung.*

In our remarks on tillage operations and on the succession of crops, we have seen how much the practice of the husbandman is modified by the kinds and amount of manures at his disposal. In describing the crops of the farm and their culture, frequent reference will also necessarily be made to the use of various fertilising substances; and we shall, therefore, before proceeding to that department of our subject, enumerate and briefly remark on the most important of them. In such an enumeration, the first notice is unquestionably due to farm-yard dung.

This consists of the excrements of cattle, their litter, and the refuse of their fodder; usually first trodden down in successive layers, and partially fermented in the farm-yard, and then removed to some convenient place and thrown together in heaps, where, by further fermentation and decay,

it is reduced to a dark-coloured, moist, homogeneous mass, in which state it is usually applied to the land. It is thus the residuum of the whole products of the farm, *minus* the exported grain, and that portion of the other crops which, being first assimilated in the bodies of the live stock, is sold in the form of butcher-meat, dairy-produce, or wool. In applying farm-yard dung to land there is thus a returning to it of what it had previously produced, *less* the above exceptions, and such waste as may occur during the process of decay by gaseous exhalation or liquid drainage. It is obvious that the value of such dung as a fertilising agent must depend much on two circumstances, viz., 1*st*, The nature of the food consumed by the animals whose excrements are mingled with it; and, 2*d*, The success with which waste from drainage and exhalation has been prevented. When cattle used during the winter months to be barely kept alive on straw and water, and were confined in an open yard, which, in addition to its own share of rain, received also the drip from the eaves of the surrounding buildings—which, after percolating the litter, flowed unchecked into the neighbouring ditch—it is needless to say that the dung resulting from such a process was all but worthless. It is much to be regretted that, from the faulty construction of farm-buildings, farmers still find it impossible to guard their dung-stores from injury and waste. When cattle-yards are slightly hollowed towards their centre, and the surrounding eaves are spouted, the litter absorbs the whole of the urine and the rain which falls upon the uncovered area, while the treading of the cattle goes far to prevent undue fermentation and escape of gases. The same remark applies still more strongly to covered boxes, the dung resulting from this mode of housing fattening cattle being of the best quality. In the case of byres and stables it is certainly desirable to have a covered depôt, into which the litter and solid excrements may be wheeled daily, and to have the urine conveyed by proper drains and distributed over this mass of solid matter. As there is usually more liquid than these can at once absorb, it is well to have a tank at the lowest part of this depôt in which to store the surplus, that it may from time to time be returned upon the adjoining mass, or conveyed to heaps in the fields. Advantage is usually taken of frosty weather to cart out to the fallow division of the farm the dung that has accumulated in yards and boxes. It is formed into large square heaps about four feet deep, in situations most convenient for ready application to the land when the season for sowing the crops arrives. It is desirable to prepare a site for these heaps by carting together and spreading down a quantity of earth (or peat, when that can be got), for the purpose of absorbing the ooze from the fermenting mass laid upon it. At the beginning of winter, the loaded dung-carts are driven on to the heaps, and their contents are spread evenly over it, layer above layer, both to equalise the quality of the dung-heap as a whole, and, by the compression thus applied, to prevent a too rapid fermentation. When the heap has attained the requisite bulk, a covering of earth or peat is spread over it to keep it moist and to prevent the escape of its ammonia. When this home-made manure was the only kind statedly at the command of the farmer, it was considered necessary, and we believe truly, to have it in an advanced state of decomposition before applying it to a turnip crop. There was a waste of manure by this practice, but unless it was in a state to supply instant nourishment and stimulus to the young turnip plants, the crop was certain to be a deficient one. The application, along with farm-yard dung, of guano, superphosphate of lime, and other portable manures, quite does away with the necessity of having the former much rotted. These concentrated manures stimulate the growth of the plants during their early stage, and put them in the best condition for making gradual use of the slowly dissolving dung. Excessive decomposition of farm-yard dung is now therefore avoided, and pains rather bestowed to improve its quality by protecting it from the weather, and retaining its ammonia and natural juice. The cheapest, and perhaps also the best, way of doing this is to cart the dung direct from the cattle-yard to the fields, and at once to plough it in.

Section 2.—Liquid Manures.

We have spoken of the importance of carefully retaining the urine of the housed live stock, by having it absorbed in the solid matter of the dung-heap, and of collecting the surplus into a suitable tank, where it may be available for moistening the heap from time to time, and especially when about to be applied to the land. A system has, however, lately attracted much notice, by which pains are taken not only to preserve every drop of urine and ooze from dung-heaps, but, as far as practicable, to apply the whole manure produced on the farm in a liquid form. It is in Ayrshire, and especially on the farm of Myremill, that this system has been carried out most fully. Our reference will be best explained by quoting at length from the *Minutes of Information* issued by the General Board of Health regarding sewage manure.

"The next farm visited was in the immediate vicinity of Glasgow, where the supply of liquid manure is derived from another source, and distributed in a different manner. The supply is from a dairy of 700 cows, attached to a large distillery; the entire drainage from the former flows in a full continuous stream into a tank containing 30,000 or 40,000 gallons, whence it is pumped up immediately by a 12-horse power engine, and forced through 4-inch iron pipes, laid about 18 inches under ground, into large vats or cisterns placed on the highest points of the land to be irrigated. From these it descends by gravitation through another system of pipes laid along the ridges of the hills, finding an outlet through stand-cocks placed at intervals, from which it is distributed through movable iron pipes fitting into each other, and laid along the surface in whatever direction the supply is required. The land thus irrigated consists of three farms lying at some distance apart, the farthest point to which the liquid is conveyed being about two miles, and the highest elevation 80 feet above the site of the tank and engine. The principal use to which the irrigation has been applied has been to preserve the fertility of the pastures, the general appearance of which was at first rather disappointing, but this was explained by the fact that they are fully stocked, and that the cows rush with avidity to those parts that have been last irrigated, and eat them down quite bare. As is the case in other instances, however, by far the most profitable application has been found to be Italian rye-grass, of which 15 (Scotch) acres were under cultivation, some with seed supplied by Mr Dickinson, whose successful cultivation of it by similar means near London has long been known. The first cutting of this had yielded about ten tons the acre, the second nine, and the third, which was ready for cutting, was estimated at eight or nine more. Some crops of turnips and cabbages were pointed out to us in a state of vigorous growth, and with more than common promise of abundance; these were raised by a dressing of ashes and refuse (of little fertilising value, having been purchased at 2s. 6d. a ton), conjoined with four doses of liquid, one after the preceding crop of oats had been carried, one prior to sowing, and two more at different stages of growth. The enterprising gentleman who has carried out these works at his own expense, and in spite of the discouragement arising from partial failure in his earlier attempts, though speaking cautiously, as was natural in a tenant on a nineteen years' lease, of the pecuniary results of this undertaking, imparted some facts which leave little doubt that it must have been largely remunerative. Besides maintaining, if not increasing, the fertility of the pastures, to which the solid manure from the byres was formerly devoted, at a heavy expense of cartage (the whole of which is now saved), he is enabled to sell all this manure, of which we estimated the quantity at about 3000 tons a year, at 6s. a load. For a good deal of the Italian rye-grass not required for his own consumption, he obtained upwards of 13s. a ton, the profit on which, taking into account the yield before stated, may easily be imagined. Thirteen carts, each containing six barrels of ten gallons each, are used to convey the milk to market, where it is sold at 5d. the Scotch pint, equal to six pints imperial measure. The income from milk would, therefore, be not less than £43, 6s. 8d. per day, or £15,816, 13s. 4d. per annum.

"The next place visited was the farm of Myremill, near Maybole, in Ayrshire, the property of Mr Kennedy, who adopted and improved on the method of distribution just described. On this

farm, about 400 imperial acres of which are laid down with pipes, some of the solid as well as the liquid manure has been applied by these means, guano and superphosphate of lime having been thus transmitted in solution, whereby their value is considerably enhanced. This is especially the case with guano, the use of which is thus rendered in great measure independent of the uncertainties of climate, and it is made capable of being applied with equal advantage in dry as in wet weather. In some respects the farm labours under peculiar disadvantages, as water for the purpose of diluting the liquid has to be raised from a depth of 70 feet and from a distance of more than 400 yards from the tanks where it is mixed with the drainage from the byres. These tanks are four in number, of the following dimensions respectively:—48 × 14 × 12; 48 × 14 × 15; 72 × 14 × 12; 72 × 17 × 12. They have each a separate communication with the well from which their contents are pumped up; which are used in different degrees of 'ripeness,' a certain amount of fermentation induced by the addition of rape-dust being considered desirable. The liquid is diluted, according to circumstances, with three or four times its bulk of water, and delivered at the rate of about 4000 gallons an hour, that being the usual proportion to an acre. The quantity to be applied is determined by a float-gauge in the tank, which warns the engineer, whose business it is to watch it, when to cut off the supply, and this is a signal to the man distributing it in the field to add another length of hose, and to commence manuring a fresh portion of land. The pumps are worked by a 12-horse power steam-engine, which performs all the usual work on the farm, thrashing, cutting chaff and turnips, crushing oil-cake, grinding, &c., and pumping. The pipes are of iron; mains, submains, and service pipes, five, three, and two inches in diameter respectively, laid eighteen inches or two feet below the surface. At certain points are hydrants to which gutta-percha hose is attached in lengths of twenty yards, at the end of which is a sharp nozzle with an orifice ranging from one to one and a half inch, according to the pressure laid on, from which the liquid makes its exit with a jet of from twelve to fifteen yards. All the labour required is that of a man and a boy to adjust the hose and direct the distribution of the manure, and eight or ten acres may thus be watered in a day. There are now 70 acres of Italian rye-grass and 130 of root crops on the farm. The quantity they would deliver by a jet from a pump worked by a 12-horsepower steam-engine would be 40,000 gallons, or 178 tons, per diem, and the expense per ton about 2d., but a double set of men would reduce the cost. The extreme length of pipe is three quarters of a mile, and with the hose the total extent of delivery is about 1,900,000 yards, or 400 acres. To deliver the same quantity per diem by water-carts, to the same extreme distance, would be impracticable. One field of rye-grass, sown in April, had been cut once, fed off twice with sheep, and was ready (August 20th) to be fed off again. In another, after yielding four cuttings within the year, each estimated at 9 or 10 tons per acre, the value of the aftermath for the keep of sheep was stated at 25s. an acre. Of the turnips, one lot of swedes, dressed with 10 tons of solid farm manure, and about 2000 gallons of the liquid, having six bushels of dissolved bones along with it, was ready for hoeing 10 or 12 days earlier than another lot dressed with double the amount of solid manure without the liquid application, and were fully equal to those in a neighbour's field which had received 30 loads of farm-yard dung, together with 3 cwt. guano and 16 bushels bones per acre; the yield was estimated at 40 tons the Scotch acre, and their great luxuriance seemed to me to justify the expectation. From one field of white globe turnips sown later, and *manured solely with liquid*, from 40 to 50 tons to the Scotch acre was expected. A field of carrots, treated in the same manner as the swedes, to which a second application of liquid was given just before thinning, promised from 20 to 25 tons the acre. Similarly favourable results have been obtained with cabbages; and that the limit of fertility by these means has not yet been reached, was clearly shown in one part of the Italian rye-grass which had accidentally received more than its allowance of liquid, and which showed a marked increase of luxuriance over that around it. The exact increase of produce has not been accurately determined, but the number of cattle on the farm has increased very largely, and by means of the Italian rye-grass at least *four* times as many beasts as before can be kept now on the same extent of land, *the fertility of the land being at the same time increased.* This plant, of all others, appears to receive its nourishment in this form with most gratitude, and to make the most ample returns for it; and great as are the results hitherto obtained, I believe that the maximum of productiveness is not yet reached, and that the present experiment must be carried yet further before we know the full capabilities of this manure. Of one important fact connected with this crop, I am assured, that notwithstanding the rank luxuriance of its growth, animals fed upon it not only are not scoured, but thrive more than on any other kind of grass in cultivation.

"Taking into the irrigation account the whole cost of the engine, and the whole of the fuel and wages—although half of these might have been deducted—the following appears to be the capital account and working expenses for fertilising Myremill farm:—

	£	s.	d.
"Tanks complete	£300	0	0
Steam engine	150	0	0
Pumps	80	0	0
Iron pipes, laying, and hydrants	1000	0	0
Gutta-percha distributing pipes, &c.	56	0	0
	£1586	0	0
"Annual interest on £1586, and wear and tear, at 7½ per cent.	£118	19	0
Annual wages	104	0	0
Fuel	58	10	0
	£281	9	0

This amount, divided by the number of acres, is equal to the annual sum of 14s. per acre.

"I now come to the practical results of so cheap a mode of fertilising land.

"Mr Young informed me that in one of the fields he had himself measured the growth of Italian rye-grass, and had found it to be two inches in twenty-four hours; and that within seven months, Mr Kennedy had cut from a field we were passing at the time 70 tons of grass per acre. Where the whole is cut, four or five heavy crops are thus taken; but upon some of the land during the last two years 20 sheep to the acre have been penned in hurdles, and moved about the same field from time to time; after each remove the fluid has been applied, and immediately followed by an abundant growth of food. There is not the slightest appearance of exhaustion in the land,—its fertility appears to increase. I was informed that, before the liquid manure was used, the land would not keep more than a bullock or five sheep to the acre; now it will maintain, if the crops are cut and carried in, five bullocks or twenty sheep to the acre. Some beans, bran, and oil-cake are bought for the stock; but, on the other hand, one-third or more of the farm is kept in grain, notwithstanding the great number of live stock.

"*Canning Park.*—Mr Telfer's farm, near Ayr. This is a small dairy farm of 40 acres, near the level of the sea, and about a mile and a half west of the town of Ayr. The subsoil is beach gravel with a slight admixture of clay. Water is too abundant. It lies dead within about 20 inches of the surface, and in winter nearer than that.

"No bedding or litter is used here. The cows lie on cocoa-nut mats. The ventilation is perfect; and the air sweeter than in the majority of the dwelling-houses of human beings.

"The following appears to be the cost of carrying out the system of Mr Telfer's farm:—

	£	s.	d.
"Tank	£30	0	0
Engine	60	0	0
Iron pipes and hydrants	100	0	0
Distributing hose-pipe, &c.	20	0	0
	£210	0	0
"Annual interest on £210, and wear and tear, at 7½ per cent.	£15	15	0
Wages and fuel	11	0	0
	£26	15	0

"In summer the cows have a quantity of oil-cake, as well as grass; and in winter they have turnips or mangel-wurzel, bean or barley meal, and cut hay or grass; the whole mess being steamed together. Miss Bell, the cousin of Mr Telfer, manages the dairy, and said that last year the hay bought would amount to from £30 to £40, and she should think the grain to not less than £200. In general terms, the other food is produced upon the farm. As to the produce of grass, which is the chief article, the first cutting during the present year was in the latter end of March about 18 inches thick. The second was from 18 inches to 2 feet thick. The third was from 3 feet to 4 feet 6 inches thick. The fourth nearly the same. The fifth was 2 feet thick; and the sixth, in process of cutting at the time I was there, we measured at 18 inches thick. Taking the mean, where two dimensions are given for the same crop, I find the aggregate depth of grass, grown and cut off this farm within seven months, to be not less than 14 feet 3 inches. All this is, however, eaten upon the premises, and the whole marketable produce of the farm is represented by the milk and butter.

"As to the quantity and value of these, Miss Bell stated that the previous week the butter was 114 lb and 120 lb—together 234 lb, sold at 1s. per pound. This, she stated, was about the average quantity and price. The amount for butter would therefore be £11, 14s. per week, or per annum £608, 8s. She informed me farther, that during about eight months in the year, the cold milk realises about the same amount as the butter. In the summer months, during hot weather, the market value of the milk is only about half that of the butter. From these data, the amount for milk sold per annum is £507.

"The total receipts for the two articles of milk and butter amount to £1115, 8s. per annum.

"I only need to add that, previously to the adoption of the present system of farming, these 40 acres of land were barely sufficient to support eight or nine cows, and would have been well let at a rental of 30s. an acre."

The attention now so generally directed to this subject, and the importance attached to it in many quarters, justify this lengthened quotation, and call for some remarks upon it. We have carefully examined two of the instances referred to in this report, viz., Port-Dundas and Myremill; and some smaller experiments more cursorily. After doing so we are sorry to say that we have arrived at a very different estimate of this system of manuring from that expressed in the above quotations. We at once, and with pleasure, acknowledge that in so far as concerns the storing up and preparing of the liquid manure, its application to the land, and the production, by means of it, of crops of Italian rye-grass almost surpassing belief in their luxuriance and weight of produce, Mr Kennedy's experiments have been crowned with complete success. The excellence of this grass as food for live stock, and their relish for it, is also indisputable. Neither do we dispute the statements of those who tell us that manure, when largely diluted with water, and properly applied in the liquid form, is more beneficial to plants than in any other way in which it can be presented to them. Admitting all this, the question remains, Has it yet been shown that this system can be economically applied to ordinary farms? Data are still wanting from which to answer this question conclusively, but we shall state some of the reasons which constrain us, with our present information, to do so in the negative.

Supposing an adequate motive power already to exist, and to be partly employed for other purposes, the capital that must be invested in providing the tanks and other apparatus necessary for carrying out this system amounts to about £4 per acre over a farm of average extent. If the system be a sound one, the great amount of this outlay cannot fairly be urged as an objection to it. The addition of a permanent rent charge of 5s. per acre to an entire farm, for a benefit which in any one year can be available to but a limited portion of it, is however a serious matter. In each case referred to in the *Minutes of Information*, the whole annual charge, whether arising from interest on capital, wear and tear of machinery, or working expenses, is divided by the whole acreage of the farm. In the first seven cases given in the tabular statement, this mode of calculation is correct, as the whole areas do actually benefit

TABLE III.—*Showing Cost, &c., of the Application of Sewerage Waters and Liquid Manures.*

Name of Place	No. of English acres.	Mode of Application.	Cost of Works and Apparatus. £	s.	d.	Annual Interest, &c., at 7½ per cent. £	s.	d.	Annual Working Expenses. £	s.	d.	Total Annual Charge per English acre. £	s.	d.	Observations.
Edinburgh. Craigentinny Meadows.	63	Steam-engine, pumps, and open gutters and panes,	2000	0	0	150	0	0	117	12	0	4	4	11	Average rental upwards of £16 per English acre.
High-level Sea Meadows.	38	Gravitation, open gutters and panes, . . .	700	0	0	52	10	0	19	17	6	1	18	1	Worth about £20 per English acre; worthless before.
Old Meadows.	228	Do. do.	2700	0	0	202	10	0	119	5	0	1	8	2½	Maximum rental, £25 per English acre.
Nottinghamshire. The Duke of Portland. Clipstone Meadows.	300	Catchmeadow, gravitation, and open gutters, . .	36,000	0	0	2700	0	0	150	0	0	9	10	0	Worth upwards of £12; previously worth from 3s. to 5s. per acre per annum.
Wiltshire. Wiley Meadows.	150	Beadwork of ridge and furrow, gravitation and open gutters, . .	3000	0	0	225	0	0	52	10	0	1	17	0	Four heavy crops of grass per annum.
Devonshire. The Duke of Bedford. Tavistock Meadows.	90	Beadwork and catch-meadows, gravitation and open gutters, . .	1183	0	0	88	14	6	67	10	0	1	14	8½	Land more than quadrupled in value after only 4 years irrigation.
Berkshire. Pusey Meadows.	100	Catchmeadow, gravitation, and open gutters, . .	445	0	0	33	7	6	37	18	4	0	14	3	Land not previously worth more than 5s. per acre, yielding six heavy crops of grass per annum.
Glasgow. Mr Harvey's farm.	508	Steam-engine, pumps, underground iron main pipes and iron distributing pipes, . . .	1450	0	0	108	15	0	240	10	0	0	13	9	10 feet thick of grass cut from an acre in six months.
Ayrshire. Myremill farm.	508	Steam-engine, pumps, underground iron mains, gutta-percha hose, and jet pipe, . . .	1586	0	0	118	19	0	162	10	0	0	11	1	70 tons of grass cut from an acre in six months.
Canning Park farm.	50	Do. do.	210	0	0	15	15	0	11	0	0	0	10	8½	14½ feet of grass cut in seven months.
Leg or Dunduff farm.	50	Gravitation, underground iron mains, gutta-percha hose, and jet pipe, . .	191	0	0	14	6	6	3	10	0	0	7	1½	80 stacks per annum; in place of 12, as previously.
Staffordshire. The Duke of Sutherland. Hanchurch farm near Trentham.	33	Steam-engine, pumps, underground iron mains, gutta-percha hose, and jet pipe, . . .	520	13	4	39	1	0	18	6	0	0	13	9¾	Tanks constructed sufficient for 300 acres.
Lancashire. Halewood farm.	120	Do. do.	521	12	0	39	2	5	19	15	2	0	9	9¼	One dressing of liquid equal to 25 or 30 tons of farm-yard manure per acre.
Cheshire. Lescard farm.	150	Do. do.	672	1	10	50	8	0	17	11	0	0	9	8¾	A fourth crop of grass being weighed, was found equal to 10 tons per acre. It was the lightest crop cut off the same land.
Glamorganshire. Porth Kerry Farm.	50	Gravitation, underground iron mains, gutta-percha hose and jet pipe . .	300	0	0	22	10	0	0	10	0	0	13	0	Tanks constructed sufficient for 300 acres. Between 9 and 10 feet of grass cut.

each year by the irrigating process. But when we come to those irrigated by machinery, we find that a half or two-fifths only of the land receives the benefits of it in any one year. If the annual charge in this latter class of cases is divided by the acreage actually irrigated, it becomes evident that the expense is double that of the Pusey meadows, and

equal to that of the old meadows near Edinburgh, instead of being less, as it is made to appear. Again, in estimating the profits an opposite course is followed. While the charges are made to appear less by spreading them over the whole area of the farm, the enormous produce of grass from the irrigated parts is put prominently forward, and little is said about its produce as a whole. In the dairy cases, too, we are told of enormous gross profits, without being pointedly reminded that the larger portion of the keep of the cows, such as distillery offal, bean-meal, hay, and even straw and turnips, is actually purchased; that in this way a quantity of extraneous manure becomes available for the associated farm, sufficient (however applied) to maintain it in a state of fertility; and that there would be handsome profits from the dairy, irrespective of the farm altogether. In fact, town dairies usually have no land attached to them. The cows are maintained solely by purchased food, and the sale of manure, liquid and solid, forms one of the stated items of income. In Mr Harvey's and similar cases, two separate businesses are in fact mixed up, and yet the whole is spoken of in such a way as if the profit was mainly due to the use of liquid manure. Indeed, the whole of these *Minutes of Information* issued by the General Board of Health have an air of special pleading about them, which to us seriously detracts from their value.

The entire annual cost of applying manure in this manner is stated to amount to from 10s. to 14s. per acre for the whole extent of the farm. Now this would suffice to provide annually from 1 to 1½ cwt. of Peruvian guano (even at its present high price) for every acre of the farm, or from 2 to 3 cwt. per acre, if applied, as the liquid is, to the portion under green crop only. The stated application of such a dressing of guano, in separate portions, and during showery weather, will be found to yield results little inferior to those obtained by the use of liquid manure. To do this requires no costly apparatus or permanent sinking of capital, and its application can be desisted from at any time when found unremunerative. The adoption of this plan of applying the liquid manure of the farm necessarily demands that the whole system of management be accommodated to it. In order to furnish this liquid manure, the whole green crops must, summer and winter, be conveyed to the homestead, and there consumed in such a manner as that the urine and dung of the animals fed upon it may be scoured into the tanks. It is no such easy matter to replenish these tanks as some persons seem to think. When cattle are housed in boxes or properly protected yards, the whole of the urine is absorbed by the litter, and goes to the field in the dung-cart. This is certainly a more expensive way of conveying it to the fields than by pipes. But then, as in the new system, the urine, &c., is diluted with at least three times its volume of water, there are four tons of manure to convey on the one plan for one on the other. Even where pipes are used, all the litter, and a portion at least of the dung, has still to be carted out, so that no claim of a saving of carriage can validly be put forward on behalf of this system; but its merits must be grounded solely on the superior efficacy of manure, when applied in a liquid instead of a solid form.

In the case of dry and loose soils, the consuming of the turnip crop, by folding sheep upon it, has hitherto been regarded as at once the cheapest way in which it can be converted into wool and mutton, and the land consolidated and enriched, so as to fit it for producing grain and other crops. On tenacious soils, and in a moist climate, which is quite the case at Myremill, it is certainly impracticable to pursue this system in winter. It is perhaps also the case that sheep are healthier, fatten more rapidly, and yield more wool, when fed under cover, than when folded on the open turnip field. Admitting all this, however, we are disposed to think that these benefits are better secured by Mr Randell of Chadbury's plan of littering the pens with burnt clay, which keeps the sheep clean, and their feet in good order, and, when mingled with their urine and dung, forms a most valuable manure for any kind of land. Were this carried out by means of movable covered pens, which could be erected and easily shifted from place to place in the turnip field, the carriage of the turnips and manure would be greatly reduced, especially if accomplished by means of the portable railway.

In the case of dairies near towns, where the cows are largely fed on brewery or distillery offal and other purchased food, the circumstances are totally different from those of ordinary farms, depending solely on their own resources. The liquid manure that would otherwise run to waste, when thus applied, is so much clear gain, in so far as the value of the increased produce exceeds the cost of application. It may form a wholesome caution to some persons to mention here that, notwithstanding all that has been written about the success of the spirited operations at Port-Dundas, we were told by Mr Harvey, that so dubious is he still about it, that if the thing were to do again, he would rather keep his money in his pocket, and let the urine run into the canal as formerly. If there is doubt even in such a case, how much more when the manure must virtually be purchased. And this leads us to remark that we have better hopes of the ultimate success of this plan of manuring, when it is restricted to the application of the surplus liquid manure of the homestead to some piece of meadow near at hand, supplementing this supply, when necessary, by dissolving guano in water, and sending it through the pipes. These remarks apply even more strongly to the sewage from towns. The liquid, in this case, is highly charged with fertilising ingredients of the most valuable kind, seeing that it consists largely of night-soil from a population consuming much animal food. With few exceptions, this valuable liquid, which flows in such quantities from all our towns, is not only utterly lost, but is a grievous nuisance, by polluting our streams and generating disease. In applying it as manure, the expense lies entirely in providing and working the necessary apparatus. In such cases, then, with an unfailing supply of highly fertilising liquid, costing nothing to begin with, there is every inducement to put into operation any plan by which it can be economically applied to field crops. The enhanced value of green forage in the vicinity of towns is an additional motive for attempting this. The profitable disposal of town sewage in a way neither injurious to the health nor offensive to the senses of the community, is, however, a problem yet remaining to be solved.

The ingenuity and enterprise displayed by Mr Kennedy and others, in their endeavours to cheapen by this means the cost of farm produce, and the frankness and untiring patience with which they have shown and explained their proceedings to the unceasing stream of visitors, which the novelty of the operations attracted from all parts of the kingdom, and even from foreign countries, are altogether so admirable and praiseworthy that it requires no slight effort to speak of them otherwise than approvingly. The confidence with which various influential parties have proclaimed the complete success of this scheme of irrigation, and recommended it for general adoption, seems, however, to require that those who have examined it, and arrived at an opposite conclusion, should publicly say so.

It is unreasonable to expect that private parties are to divulge their whole business affairs; and yet, without a full *Dr.* and *Cr.* account for some ordinary arable farm treated on this system, it is impossible to arrive at a sound judgment on its merits. Until this can be done, it would be better to abstain from publishing partial statements, which tend only

to mislead the public mind. We offer these remarks in no spirit of hostility to this new system of farming. We shall rejoice unfeignedly to find that our opinion of it is erroneous, and that it really warrants the sanguine expectations which some parties entertain regarding it. We simply maintain that as yet the case is "not proven," and our counsel to those who are disposed to try it is, not to embark in it to an extent that would embarrass them, if, as we fear, it should prove a failure.

Section 3.—Guano.

Next to farm-yard manure, which must ever be looked to as the chief means of maintaining the fertility of a farm, guano claims our notice. This substance is the dung of seafowl, and is found on rocky islets in parts of the world where rain seldom falls. The droppings of the myriads of birds by which such places are frequented have in many cases been permitted to accumulate during untold ages, and are now found in enormous deposits. The principal supply, both for quantity and quality, has hitherto come from the Chincha Islands, on the coast of Peru. The introduction of this powerful and exceedingly portable manure gave a prodigious impetus to agricultural improvement. It is about thirty years since a few casks of this article were brought to Liverpool from Peru, where it has been known and prized as a valuable manure from the remotest periods. No sooner had its value been discovered by our British agriculturists than the demand for it became so keen, that the quantity imported rose from 2881 tons in 1841 to 283,300 tons in 1845. The price at which it was sold at first was £20 per ton, from which, with increased supplies, it fell to £11, when the discovery in 1844 of a considerable deposit on the island of Ichaboe, on the coast of Africa, at once reduced the price to £9.

Discoveries have from time to time been made of other deposits on the African coast and in Australia. The quality of both is much inferior to that from Peru. It is in a more advanced state of decay, and contains more moisture and sand. Great as was the deposit of this valuable fertiliser on the Chincha Islands, it rapidly diminished under the excessive demand for it from Great Britain and other countries. Gradually the quality became very inferior, and in 1871 it was announced that this deposit was entirely exhausted. Considerable supplies are still obtained from other parts of the Peruvian coast; but unfortunately the quality is very inferior to that formerly obtained from the Chinchas. This circumstance would not be of much consequence if the guano was offered for sale on fair terms; but as the agents of the Peruvian Government sell it only at one uniform price per ton, although different cargoes, and even different portions of any one cargo, vary excessively in quality, it is now an unsafe article for farmers to purchase.

We give here, from the Board of Trade returns, a table of the quantities of guano imported yearly, with the computed real value, from 1854 to 1872.

Table showing the Imports of Guano from 1854 *to* 1872.

Year.	Tons.	Value.	Year.	Tons.	Value.
1854	235,111	£2,530,272	1864	131,358	£1,457,088
1855	305,061	3,137,160	1865	237,393	2,675,995
1856	191,501	2,136,431	1866	135,697	1,439,679
1857	288,362	3,613,074	1867	192,308	2,109,506
1858	353,541	4,084,170	1868	182,343	2,039,478
1859	84,122	769,333	1869	210,010	2,640,983
1860	141,435	1,557,895	1870	280,311	3,476,680
1861	178,423	2,022,283	1871	178,678	1,994,145
1862	141,636	1,635,322	1872	118,704	1,201,042
1863	233,574	2,658,856			

The dung of birds, from its including both liquid and solid excrements, is superior as a manure to that of quadrupeds. Pigeons' dung has long been in high repute as an excellent fertiliser, and brought a high price in days when portable manures were scarcely to be had. It is now little heard of, guano, the excrement of fowls which feed upon fish, being superior, weight for weight. The dung of domestic poultry is usually mixed with the general dung-heap, but it could be turned to better account if kept by itself. It has been recommended to strew the floors of poultry-houses daily with sawdust or sand, and to rake this with the droppings into a heap to be kept under cover and used like guano.

Section 4.—Bones.

It is now about sixty years since ground bones began to be used by farmers in the east side of England as a manure for turnips. At first bones were roughly smashed by hammers and applied in great quantities. By and by mills were constructed for grinding them to a coarse powder, in which state they continued to be used as a dressing for turnips, at the rate of sixteen to twenty bushels per acre, in all parts of the kingdom and to a very great extent, until the admirable discovery by Baron Liebig of the mode of preparing superphosphate of lime by dissolving bones in sulphuric acid. We shall not attempt to explain on chemical principles the wonderful superiority of this substance over simple bone-dust in promoting the growth of the turnip plant. What we should do indifferently, by borrowing from others, will be found well done by various accomplished chemists who write specially on these subjects. We can, however, testify from experience to the important fact, that *one* bushel of bone-dust dissolved by a third of its weight of sulphuric acid is as a manure superior in value to *four* bushels of simple bone-dust. It is not merely, or even chiefly, in the lessened cost at which an acre of turnips can be manured that this superiority lies, but especially in this, that from the extraordinary stimulus given by superphosphate of lime to newly germinated turnip plants, they usually arrive at the stage when they are fit for thinning in from ten to fifteen days earlier than when sown over farm-yard dung or simple bone-dust, or both combined. This shortening of the critical period during which the attacks of the insignificant but dreaded turnip-beetle so often baulk the hopes of the husbandman is an advantage not easily estimated, and one well fitted to inspire him with confidence in the science to which he owes the discovery, and with grateful respect for the eminent discoverer. This powerful effect in quickening the growth of the young turnip plants is possessed in nearly as great a degree by Peruvian guano, when it is supplied with sufficient moisture. In climates and seasons which may be characterised as moist and cool, guano will show best results, whereas in those which are rather hot and dry superphosphate has the advantage. Accordingly we find guano the comparative favourite in Scotland, and its rival in the drier counties of England.

Guano is believed to encourage a great expanse of foliage, and to be more especially suited for early sowings; and superphosphate to influence development of bulb, and to deserve the preference for a later seed-time. The obvious inference is that, for the turnip crop at least, these valuable fertilisers should be used in combination; and actual experiment has verified its soundness. The use of them is universal and ever on the increase. They constitute also the standard by which farmers estimate the cost and effects of other purchased manures. The extent to which they are used, their high price, and the facility with which they can be adulterated with comparatively worthless ingredients, have led to almost unparalleled frauds. The adulteration of manures has, in fact, become a regular trade. Had farmers only their bodily senses to aid them, the detection of this fraud would be difficult—perhaps impossible. Here,

however, they can call the chemist to their aid, with the certainty of ascertaining the real character of the articles which they are invited to purchase. If purchasers of manures would but insist in every instance on getting from the seller an analysis by some competent chemist, and along with it a written warrandice that the stock is of the quality therein indicated, detection and punishment of fraud would be easy. In regard to superphosphate of lime, the farmer can purchase bone-dust and sulphuric acid and prepare it himself. We conducted this process for several years in the following way:—A trough was provided 7 feet × 3·4 × 2·10, made of 2½-inch deal, strongly jointed, and secured at the corners by wooden pegs, as iron nails would be corroded by the acid. This holds conveniently 48 bushels of bones. The heap of bone-dust is then gone over with a barley riddle, and the small dust which passes through this is laid aside to be used as a drying material for the other portion, after it is subjected to the acid. We find that a third part of the bone-dust passes through the riddle. Three bottles, or carboys as they are called, of concentrated acid, averaging 180 lb. each, are then emptied into the trough and mixed with cold water at the rate of 1½ of water, by measure, to 1 of acid. In practice, the water is poured in first and then the acid. Into this mixture 48 bushels of bones, previously measured and laid close to the trough, are rapidly shovelled by two labourers, who will do well to be attired in clothes and shoes past spoiling. So soon as the bones begin to be thrown in, violent ebullition commences. By the time that the whole of the bones are thrown in, there will be barely liquid enough to moisten the last of them. The labourers therefore dig down at one end of the trough till they reach the bottom, and then carefully turn back and mix the whole quantity until they reach the other end. The surface is then levelled and covered with a layer of the dry riddlings two inches thick. In this state it is allowed to remain for two days, when the trough is emptied, and the same process is repeated until the whole quantity is gone over. When shovelled out of the trough the bones are found to have become a dark-coloured paste, still very warm, and emitting a sweetish smell. While one person throws it out, another adds to it its proportion of dry riddlings, and mixes them carefully. This mass is heaped up in the corner of a shed, and augmented at each emptying of the trough, until the requisite quantity is obtained. After this the mass is carefully turned over several times, at intervals of five or six days, and is then dry enough for sowing either by hand or machine. Some prefer moistening the bones with boiling water, and then adding pure acid as they are shovelled into the trough; but by first mixing the acid and water there is greater certainty of all the bones being equally acted upon. There is also great convenience in using the finest portion of the bone-dust for drying the other, as suitable material for this purpose is sometimes difficult to procure. The homely process now described is quite inferior to, and more costly than, that pursued in factories, and should only be resorted to when a genuine article cannot otherwise be obtained.

We have referred to superphosphate of lime prepared from bones. A new source of supply has, however, been discovered of late years, the extent and importance of which is becoming more apparent as investigation proceeds. We allude to those phosphoric deposits found in such abundance in the crag, and upper and lower green-sand formations in the south of England. The existence of these fossil animal remains was first pointed out by Drs Mantel and Buckland, though it is to Professor Henslow that we are indebted for having called attention to their eminent agricultural value, and described the localities whence they may be most readily obtained. These remains consist of the fractured and rolled bones of sharks, gigantic sea-lizards, and whales, which at one period of our earth's history must have existed in myriads in our oceans and seas. Mixed with these bones are found many fish-teeth and shells of different species, and likewise immense numbers of rolled, water-worn pebbles, which at one period were imagined to be the fossilised excrements of the animals themselves, and were on this account called *coprolites* by Professor Henslow and others. Although this has since been proved a mistake, the name has been adopted, and will probably be continued. These fossil bones, and so-called coprolites of the crag, are found in enormous quantities on the coast of Suffolk, Norfolk, and Essex, whence Mr Lawes of Rothamstead obtained nearly the whole of the material which he employed in the preparation of his well-known "coprolite manure," or "Lawes' superphosphate." Already, it is believed, several thousands of tons of these fossils in one form or other are annually sold for manure, with a rapidly increasing demand. Those found in the crag formation are exceedingly hard, and require to be ground by powerful machinery, and dissolved in sulphuric acid, to render the phosphate of lime available as manure. Fossils, though less abundant in the green-sand, can be reduced to the requisite fineness by simple machinery, and are then fit for agricultural purposes without any chemical preparation. They are found plentifully in the parish of Farnham, so long celebrated for the excellence and abundance of its hops, which are now discovered to be due to the presence in the soil of these fossil remains. The discovery of these *mines* of manure in various parts of our country was made most seasonably, and has proved of immense national importance. When Liebig predicted that, "in the remains of an extinct animal world England is to find the means of increasing her wealth in agricultural produce, as she has already found the great support of her manufacturing industry in fossil fuel," he was regarded by many as merely indulging a fine philosophic fancy; but enough has already been realised to convince the most sceptical of the importance of the data on which he founded his opinion.[1]

On mixing a quantity of bone-dust with its own bulk of mould or sand, and wetting the whole with the liquid which oozes from the dung-heap, violent fermentation immediately ensues, dissolving the bones, and making them more readily available for the nourishment of the turnip crop. Many farmers are so satisfied with this preparation, that they dispense with the acid. This is not judicious, as the superphosphate of lime is a more valuable manure than bones dissolved by simple fermentation.

Bones are sometimes applied as a top-dressing to grass land with singular success. "This Cheshire practice consists in applying an extraordinary dose of bones to pasture-land. 'For pasture land, especially the poorer kind,' says Mr Palin, 'there is nothing equal to bone manure, either as regards the permanency of its effects, or the production of a sweet luxurious herbage, of which all cattle are fond. Many thousand acres of the poor clay soils have been covered with this manure during the last eight or ten years.' The average quantity used is about a ton and a half to the acre; it is therefore a landlord's improvement, on which seven or eight per cent. is generally paid. Boiled bones act as long as unboiled bones, retaining the phosphorus, though not so quickly, having lost the animal matter. Boiled bones (1845) cost £3, 10s. per ton; the outlay then was five guineas per acre, sometimes £7 or £8. 'I have known,' says a correspondent, 'many instances where the annual value of our poorest clay lands has been increased by an outlay of from £7 to £8 an acre, at least 300 per cent.; or, in other words, that the land has been much cheaper after this outlay at 30s., than in its native state at 10s. per acre; with the satisfaction of seeing a miserable covering

[1] *Journal of the Royal Agricultural Society of England*, vol. ix. p. 56, and vol. xii. p. 91.

of pink-grass, rushes, hen-gorse, and other noxious weeds, exchanged for a most luxuriant herbage of wild clover, trefoil, and other succulent grasses.' Though much of the clover and trefoil may disappear in five or ten years (some times they last fifteen years), an excellent herbage remains. 'Draining,' the writer adds, '*may be carried too far* where bones are used, for boned lands suffer by a dry summer. The land should be kept cool.' I have found the same thing on water meadows. The freer the grass is growing, the more it suffers from drought; and this is natural, for a larger supply of sap is required. This writer adds, 'I have known many a poor, honest, but half-broken man, raised from poverty to comparative independence, and many a sinking family saved from inevitable ruin, by the help of this wonderful manure.' Indeed, I believe, land after boning will keep three cows where two fed before. As to this practice, however, caution is necessary. It seems to belong to cold clays for grass in Cheshire, though on such soil it would hardly answer elsewhere, even for turnips. A Cheshire landlord told me that he had tried it vainly for grass in Suffolk. I know no case of its success out of Cheshire, unless in the bordering counties, and have heard some cases of its failure even in those. It will not do, therefore, at all to adopt it hastily. We only know it to have succeeded about Cheshire, which is on the red marls geologically, and on the rainy side of the country, and must remember that it is a costly proceeding, striking in its success, but as yet circumscribed in its practice, and therefore in the proof of its efficacy."[1]

Section 5.—Rape-Cake, &c.

Rape-cake reduced to powder forms an excellent manure for wheat and other crops. It is usually applied at the rate of from four to eight cwt. per acre. The cakes resulting after oil has been expressed from camelina, hemp, and cotton seeds, and from pistachio and castor-oil nuts, from beech and other mast, all possess considerable value as manure, and were at one time available for that purpose. Most of them now command a price for cattle feeding that forbids their use as manure unless when in a damaged state.

Section 6.—Blood, &c.

All parts of the carcases of animals form valuable manure, and are now carefully used in that way whenever they are unfit for more important uses. The blood and other refuse from shambles and from fish-curers' yards, when mixed with earth and decomposed, make a valuable manure, and are eagerly sought after by farmers to whom such supplies are accessible. In London a company has been formed by whom the blood from the shambles is purchased, and employed instead of water in preparing superphosphate of lime, which, when thus manufactured, contains an amount of ammonia which adds considerably to its efficacy as a manure. In Australia and South America it has long been the practice to slaughter immense numbers of sheep and cattle for the sake of their hides and tallow only, there being no market for them as beef and mutton. To obtain the whole tallow, the carcases are subjected to a process of boiling by steam and afterwards to pressure, and are then thrown aside in great piles. This dried residuum is afterwards used as fuel in the furnaces of the steaming apparatus, and the resulting ashes constitute the bone-ash of commerce, which is now an important raw material in our manure factories.

After many abortive attempts to convey Australian beef and mutton to the British market, the difficulty has at last been overcome by enclosing the meat in a par-boiled state in tin cases, hermetically sealed. This has already grown to a large trade, with every likelihood of its increasing rapidly. As the meat in these cases is sent free from bone, a plan has been found for rendering the bones also a profitable article of export. For this purpose they are crushed into compact cakes 6 inches square by 3 inches thick, in which form they can be stowed in comparatively small space.

The refuse from glue-works; the blubber and dregs from fish-oil; animal charcoal that has been used in the process of sugar-refining; the shavings and filings of horn and bones from various manufactures, and woollen rags, are all made available for manure.

Section 7.—Night-Soil.

Night-Soil is a powerful manure; but owing to its offensive odour it has never been systematically used in Britain. Various plans are tried for obviating this objection, that most in repute at present being its mixture with charred peat. From the universal use of water-closets in private dwellings, the great mass of this valuable fertilising matter now passes into sewers, and is carried off by streams and rivers, and is for the most part totally lost as a manure. When sewage water is used for irrigation, as in the neighbourhood of Edinburgh, it is to the night-soil dissolved in it that its astonishing effects in promoting the growth of grass are chiefly due. We have already expressed our views in regard to the use of it in this diluted form of sewage water. That mode of applying it is necessarily restricted to lands in the vicinity of towns. Hitherto the numerous and costly attempts that have been made to separate the fertilising matter from the water in which it is contained have proved utter failures. The most feasible plan for the utilisation of night-soil that we have hitherto heard of is that brought forward by the Rev. Henry Moule, Fordington Vicarage, Devon. In a tract addressed to cottagers he says,—"Now, my discovery is this: The earth of your garden, if dried—or dried and powdered clay—will suck up the liquid part of the privy soil; and, if applied *at once* and *carefully mixed*, will destroy all bad smell and all nasty appearance in the solid part, and will keep all the value of the manure. Three half pints of earth, or even one pint, will be enough for each time. And earth thus mixed *even once* is very good manure. But if, after mixing, you throw it into a shed and dry it, you may use it again and again; and the oftener you use it the stronger the manure will be. I have used some seven and even eight times; and yet, even after being so often mixed, there is no bad smell with the substance; and no one, if not told, would know what it is." To adapt a privy for using dried earth in this way, he says,—"Let the seat be made in the common way, only without any vault beneath. Under the seat place a bucket or box, or, if you have nothing else, an old washing-pan. A bucket is the best, because it is more easily handled; only let it have a good-sized bail or handle. By the side of the seat have a box that will hold (say) a bushel of dried earth, and a scoop or old basin that will take up a pint or a pint and a half, and let that quantity of earth be thrown into the bucket or pan every time it is used. The bucket may be put in or taken out from above by having the whole cover moved with hinges; or else, through a door in front or at the back." He has also invented and patented an *earth-closet*, as a substitute for the ordinary water-closet, which he describes thus:—"The back contains dried and sifted earth, which enters the pan through a hole at the back of it, and covers the bottom. The bottom is moved by the handle and lever; the side of the pan acts as a scraper; and all that is upon the bottom is pushed off, falling into the bucket or shaft below. The earth thus applied at once prevents fermentation, and almost all exhalation and offensive smell. The bottom returns to

[1] Article by Mr Pusey. See *Journal of Royal Society of England*, vol. xi. p. 409.

its place by means of a spring, and a fresh supply of the earth falls upon it from the box."[1]

This scheme has now been tested for a sufficient length of time, and on a wide enough scale, to show that in the case of private houses in rural districts, as well as in prisons, asylums, hospitals, public schools, military camps, and factories, it is entirely successful as regards the sanitary results of its use, and the value of the manure when applied to gardens attached to the premises from which it is obtained. But the cost and annoyance of moving so bulky a substance, and the small percentage of fertilising matter contained in it, forbid the expectation of its being adopted in towns.

Section 8.—*Sea-Weed.*

Along our sea-board large supplies of useful manure are obtained in the shape of drifted sea-weed. This is either applied as a top-dressing to grass and clover, ploughed in with a light furrow, for various crops, or mixed in dung-heaps. It requires to be used in large quantities per acre —from 40 to 60 loads—and is evanescent in its effects. Grain grown on land manured with sea-weed is generally of fine quality, and is in repute as seed corn.

Section 9.—*Manure Crops.*

Crops of Buckwheat, Rape, Vetches, and *Mustard* are sometimes ploughed in, while in a green, succulent state, to enrich the land. It is, however, more usual to fold sheep on such crops, and so to get the benefit of them as forage, as well as manure to the land. The leaves of turnips are frequently ploughed in after removing the bulbs, and have a powerful fertilising effect.

Section 10.—*Lime.*

Besides manures of an animal and vegetable origin, various mineral substances are used for this purpose. The most important and extensively used of these is lime. In the drier parts of England it is not held in much esteem, whereas in the western and northern counties, and in Scotland, its use is considered indispensable to good farming. Experienced farmers in Berwickshire consider it desirable to lime the land every twelve years, at the rate of from 120 to 200 bushels of the unslacked lime per acre. It is found especially beneficial in the reclaiming of moory and boggy lands, on which neither green nor grain crops thrive until it has been applied to them. Its use is found to improve the quality of grain, and to cause it in some cases to ripen earlier. It facilitates the cleaning of land, certain weeds disappearing altogether for a time after a dressing of lime. It is the only known specific for the disease in turnips called "fingers-and-toes," on which account alone it is frequently used in circumstances which would otherwise render such an outlay unwarrantable. The practice, still frequent, of tenants at the beginning of a nineteen years' lease, liming their whole farm at a cost per acre of from £3 to £5, proves conclusively the high estimation in which this manure is held. The belief—in which we fully concur —is however gaining ground, that moderate and frequent applications are preferable to these heavy doses at lengthened intervals.

When bare fallowing was in use, it was commonly towards the close of that process that lime was applied. Having been carted home and laid down in large heaps, it was, when slaked, spread evenly upon the surface and covered in by a light furrow. It is now frequently spread upon the autumn furrow preparatory to root crops, and worked in by harrowing or grubbing, and sometimes by throwing the land into shallow ridgelets. Another method much used is to form it into compost with decayed quickens, parings from road-sides and margins of fields, &c., which, after thorough intermixture by frequent turnings, is spread evenly upon the land when in grass. A cheap and effectual way of getting a dressing of such compost thoroughly comminuted and incorporated with the surface soil, is to fold sheep upon it, and feed them there with turnips for a few days. The value of such compost is much enhanced by mixing common salt with the lime and earth, at the rate of *one part* of salt by measure to *two parts* of lime. A mixture of these two substances in these proportions prepared under cover, and applied in a powdery state, is much approved as a spring top-dressing for corn crops on light soils. In whatever way lime is applied, it is important to remember that the carbonic acid which has been expelled from it by subjecting it in the kiln to a red heat, is quickly regained from the atmosphere, to which therefore it should be as little exposed as possible before applying it to the land. A drenching from heavy rain after it is slaked is also fatal to its usefulness. Careful farmers therefore guard against these evils by laying on lime as soon as it is slaked; or when delay is unavoidable, by coating these heaps with earth, or thatching them with straw. In order to reap the full benefit of a dressing of lime it must be so applied as, while thoroughly incorporated with the soil, to be kept near the surface. This is more particularly to be attended to in laying down land to pasture. This fact is so well illustrated by an example quoted in the article "Agriculture" in the 7th edition of the present work that we here repeat it.

"A few years after 1754," says Mr Dawson, "having a considerable extent of outfield land in fallow, which I wished to lime previous to its being laid down to pasture, and finding that I could not obtain a sufficient quantity of lime for the whole in proper time, I was induced, from observing the effects of fine loam upon the surface of similar soil, even when covered with bent, to try a small quantity of lime on the surface of this fallow, instead of a larger quantity ploughed down in the usual manner. Accordingly, in the autumn, about twenty acres of it were well harrowed in, and then about fifty-six Winchester bushels only, of unslaked lime, were, after being slaked, carefully spread upon each English acre, and immediately well harrowed in. As many pieces of the lime, which had not been fully slaked at first, were gradually reduced to powder by the dews and moisture of the earth,—to mix these with the soil, the land was again well harrowed in three or four days thereafter. This land was sown in the spring with oats, with white and red clover and rye-grass seeds, and well harrowed without being ploughed again. The crop of oats was good, the plants of grass sufficiently numerous and healthy; and they formed a very fine pasture, which continued good until ploughed some years after for corn.

"About twelve years afterwards I took a lease of the hilly farm of Grubbet, many parts of which, though of an earthy mould tolerably deep, were too steep and elevated to be kept in tillage. As these lands had been much exhausted by cropping, and were full of couch-grass, to destroy that and procure a cover of fine grass, I fallowed them, and laid on the same quantity of lime per acre, then harrowed and sowed oats and grass-seeds in the spring, exactly as in the last-mentioned experiment. The oats were a full crop, and the plants of grass abundant. Several of these fields have been now above thirty years in pasture, and are still producing white clover and other fine grasses; no bent or fog has yet appeared upon them. It deserves particular notice, that more than *treble* the quantity of lime was laid upon fields adjoining of a similar soil, but which being fitter for occasional tillage, upon them the lime was ploughed in. These fields were also sown with oats and grass seeds. The latter throve well, and gave a fine pasture the first year; but afterwards the bent spread so fast, that in three years there was more of it than of the finer grasses."

The conclusions which Mr Dawson draws from his extensive practice in the use of lime and dung deserve the attention of all cultivators of similar land:—

"1. That animal dung dropped upon coarse benty pasture produces little or no improvement upon them; and that, even when sheep or cattle are confined to a small space, as in the case of folding, their dung ceases to produce any beneficial effects after a few years, whether the land is continued in pasture or brought under the plough.

[1] *Manure for the Million,* by Rev. Henry Moule, price 1d. Mr Moule has also published a pamphlet on the same subject, entitled *National Health and Wealth.*

"2. That even when land of this description is well fallowed and dunged, but not limed, though the dung augments the produce of the subsequent crop of grain, and of grass also for two or three years, its effects thereafter are no longer discernible either upon the one or the other.

"3. That when this land is limed, if the lime is kept upon the surface of the soil, or well mixed with it, and then laid down to pasture, the finer grasses continue in possession of the soil, even in elevated and exposed situations, for a great many years, to the exclusion of bent and fog. In the case of Grubbet-hills, it was observed, that more than thirty years have now elapsed. Besides this, the dung of the animals pastured upon such land adds every year to the luxuriance, and improves the quality of the pasture, and augments the productive powers of the soil when afterwards ploughed for grain; thus producing upon a benty outfield soil effects similar to what are experienced when rich infield lands have been long in pasture, and which are thereby more and more enriched.

"4. That when a large quantity of lime is laid on such land, and ploughed down deep, the same effects will not be produced, whether in respect to the permanent fineness of the pasture, its gradual amelioration by the dung of the animals depastured on it, or its fertility when afterwards in tillage. On the contrary, unless the surface is fully mixed with lime, the coarse grasses will in a few years regain possession of the soil, and the dung thereafter deposited by cattle will not enrich the land for subsequent tillage.

"*Lastly*, It also appears from what has been stated, that the four-shift husbandry is only proper for very rich land, or in situations where there is a full command of dung; that by far the greatest part of the land of this country requires to be continued in grass two, three, four, or more years, according to its natural poverty; that the objection made to this, viz., that the coarse grasses in a few years usurp possession of the soil, must be owing to the surface soil not being sufficiently mixed with lime, the lime having been covered too deep by the plough."—*Farmers' Magazine*, vol. xiii. p. 69.

Section 11.—*Marl.*

Our remarks hitherto have had reference to carbonate of lime in that form of it to which the term *lime* is exclusively applied by farmers. But there are other substances frequently applied to land which owe their value chiefly to the presence of this mineral. The most important of these is marl, which is a mixture of carbonate of lime with clay, or with clay and sand, and other compounds. When this substance is found in the proximity of, or lying under, sandy or peaty soils, its application in considerable doses is attended with the very best effects. The fen lands of England, the mosses of Lancashire, and sandy soils in Norfolk and elsewhere, have been immensely improved in this way. In Lancashire, marl is carried on the mosses by means of portable railways at the rate of 150 tons, and at a cost of about £3 per acre. In the fens long trenches are dug, and the subjacent marl is thrown out and spread on either side at an expense of 54s. per acre. By this process, often repeated, of *claying* or *marling*, as it is variously called, the appearance and character of the fen lands have been totally changed, excellent wheat being now raised where formerly only very inferior oats were produced. As the composition both of peat and of clay marl varies exceedingly, it is always prudent, either by limited experiment or chemical analysis of both substances, to ascertain the effect of their admixture. Lime is always present in those cases which prove most successful; but an overdose does harm.

Section 12.—*Shell-Marl.*

Under some mosses and fresh-water lakes extensive deposits of shell-marl are frequently found. It contains a larger percentage of lime than clay marl, and must be applied more sparingly.

Section 13.—*Chalk.*

Throughout the extensive chalk districts of England, the practice of spreading this substance over the surface of the land has prevailed from the remotest times. In the case of the Lincolnshire Wolds, once as celebrated for desolate barrenness as they now are for high culture and smiling fertility, chalking was one important means of bringing about this wonderful improvement, as it still is in maintaining it. "The soil being but a few inches in depth, and often containing a large proportion of flints, naturally possesses very little fertility—often being a light sand, not strong enough naturally to grow turnips—so that the farmers were at first obliged to *make* a soil, and must now maintain its new-born productiveness. The three principal means by which this is done are the processes of *chalking*, and *boning*, and *manuring with sheep*. A dressing of 80 or 100 cubic yards per acre of chalk is spread upon the land, and then a crop of barley is obtained if possible, being sown with seeds for grazing. The fields are grazed with sheep two years, the sheep being at the same time fed with oil-cake; and then the land will be capable of producing a fine crop of oats. Bones are also used frequently for the barley crop, and when they first came into use were thrown upon the land in a chopped state, neither broken nor crushed, and as much as 40 or even 50 bushels per acre. The boning and sheep-feeding are in constant operation, but chalking is required only at intervals of a few years. On the western side of the Wold district, wherever the chalk adjoins the white or blue marl, an extensive application of it is made to the surface. Thus immense quantities of earth and stone have been added by manual labour and horse-carriage to the thin covering of original soil; and, besides this, the soil is being continually deepened by deep ploughing, the chalk fragments thus brought to the surface crumbling into mould."[1]

In Dorsetshire "it is usual to chalk the land once in twenty years, the sour description of soil being that to which it is found most advantageous to apply it. The chalk is dug out of pits in the field to which it is applied, and it is laid on sometimes with barrows, but chiefly with the aid of donkeys. The first method costs 40s. an acre, the last 35s. when hire donkeys are used; 20s. to 25s. where the donkeys are the property of the farmer. The chalk is laid on in large lumps, which soon break down by the action of frost and exposure to the weather. Chalk is occasionally burned and applied as lime, in which state it is preferred by many farmers, notwithstanding the additional cost of the burning."[2]

Section 14.—*Shell-Sand and Limestone Gravel.*

On the western shores of Great Britain and Ireland are found great quantities of sand mixed with sea-shells in minute fragments. This calcareous sand is carried inland considerable distances, and applied to the land as lime is elsewhere. Limestone gravel is also found in various places and used in the same way.

Section 15.—*Gypsum.*

Sulphate of lime or gypsum is considered an excellent top-dressing for clover and kindred plants. It is thought by some that the failure of red clover is to be accounted for by the repeated crops of that plant having exhausted the gypsum in the soil. Its application has been followed by favourable results in some cases, but has yet quite failed in others. It is applied in a powdered state at the rate of *two* or *three* cwt. per acre when the plants are moist with rain or dew.

Section 16.—*Burnt Clay.*

About fifty years ago burnt clay was brought much into notice as a manure, and tried in various parts of the country, but again fell into disuse. It is now, however, more extensively and systematically practised than ever. Frequent

[1] "Farming of Lincolnshire," by John Algernon Clarke; *Journal of Royal Agricultural Society*, xii. 331.

[2] See Caird's *English Agriculture*, 1850 and 1851, p. 61.

reference to the practice is to be found in the volumes of the *Journal of the Royal Agricultural Society of England.* This burning of clay is accomplished in several ways. Sometimes it is burned in large heaps or clamps containing from 80 to 100 cart-loads. A fire being kindled with some faggots or brushwood, which is covered up with the clay, taking care not to let the fire break out at any point, more fuel of the kind mentioned, or dross of coals, is added as required, and more clay heaped on. A fierce fire must be avoided, as that would make the clay into brickbats. A low, smothered combustion is what is required; and to maintain this a good deal of skill and close watching on the part of the workman is necessary. A rude kiln is sometimes used for the same purpose. Either of these plans is suitable where the ashes are wanted at a homestead for absorbing liquid manure, &c.; but for merely spreading over the land, that called clod-burning is preferable, and is thus described in volume viii. page 78, of the *Royal Agricultural Society's Journal*:—"Roll and harrow, in dry weather, till the majority of clods are about the size of a large walnut; nothing so good as the clod-crusher to forward this operation: when perfectly dry, collect them into rows about six yards apart, with iron-teethed rakes; take a quarter of a whin faggot, or less, according to size, previously cut into lengths by a man with an axe; place these pieces about four yards apart in the rows, cover them with clods, putting the finest mould upon the top of the heap, to prevent the fire too quickly escaping; observe the wind, and leave an opening accordingly; having set fire to a long branch of whin, run from opening to opening till two or three rows are lighted, secure these, and then put fire to others, keeping a man or two behind to attend to the fires and earthing up till the quantity desired may be burned, which will generally take four or five hours, say from 25 to 35 loads per acre of 30 bushels per load.

"This work is often put out to a gang of men at about 10s. per acre for labour, and the whins cost 4s. 6d. per acre, not including the carting.

"When the heaps are cold, spread and plough in. The great advantage of burning clods in these small heaps, in preference to a large one, is the saving of expense in collecting and spreading; there is much less red brick earth and more black and charred; no horses or carts moving on the land whilst burning; and a large field may be all burned in a day or two, therefore less liable to be delayed by wet weather. In the heavy land part of Suffolk, the farmers purchase whins from the light land occupiers, and often cart them a distance of fourteen or sixteen miles, when there is no work pressing on the farm. These are stacked up and secured by thatching with straw, that they may be dry and fit for use when required. Bean straw is the next best fuel to whins or furze, and it is astonishing to see how small a quantity will burn the clods if they are of the proper size and dry. Observe, if the soil is at all inclined to sand, it will not burn so well. I will here mention, that I often sift and store up a few loads of the best blackened earth to drill with my turnips, instead of buying artificial manure, and find it answers remarkably well, and assists in maintaining the position that a heavy land farm in Suffolk can be farmed in the first-rate style without foreign ingredients."

Burnt clay is an admirable vehicle for absorbing liquid manure. A layer of it in the bottom of cattle-boxes does good service, at once in economising manure, and in yielding to the cattle a drier bed than they would otherwise have until the litter has accumulated to some depth. Valuable results have also been obtained by using it for strewing over the floors of poultry-houses, and especially of pens in which sheep are fed under cover. In the latter case it is mixed with the excrements of the sheep as they patter over it, and forms a substance not unlike guano, nor much inferior to it as a manure. As an application to sandy or chalky soils it is invaluable. It is mainly by this use of burnt clay, in combination with fattening of sheep under cover, that Mr Randell of Chadbury has so astonishingly increased the productiveness of his naturally poor clay soil. A Berwickshire proprietor, himself a practical farmer, who visited Mr Randell's farm in the summer of 1852, thus writes:—"I have visited most of the best managed farms in England, at least those that have so much of late been brought under general notice; but without exception, I never saw land in the splendid condition his is in. The beauty of the system lies in the cheap method by which he has imparted to it this fertility, and in the manner in which he keeps it up. A large part of the farm consisted, fourteen years ago, of poor clay, and was valued to him at his entry at 7s. 6d. per acre. It is now bearing magnificent crops of all kinds, the wheat being estimated to yield from 6 to 7 quarters per acre.

"Mechi has enriched Tiptree-heath, it is true; but then it is effected at a cost that will make it impossible for him to be repaid. Mr Randell, on the other hand, has adopted a course that is nearly self-supporting, his only cost being the preparation of the clay. The great secret of his success lies in his mode of using it; and as I never heard of a similar process, I will briefly explain to you how it is done:—His heavy land not permitting him to consume the turnip and mangold crops on the ground, he carts them home, and feeds his sheep in large sheds. They do not stand on boards or straw, but on the burnt clay, which affords them a beautiful dry bed; and whenever it gets the least damp or dirty, a fresh coating is put under them. The mound rises in height; and in February, when the shearlings are sold (for the sheep are only then twelve months old), the mass is from 7 to 8 feet deep. He was shearing his lambs when I was there, as he considers they thrive much better in the sheds without their fleeces. They are half-bred Shropshire downs; and at the age I mention, attain the great weight of 24 lbs. per quarter.

"I walked through the sheds, but of course they were then empty. I saw the enormous quantity of what he called his 'home-made guano;' the smell from it strongly indicated the ammonia it contained. He had sown his turnips and other green crops with it, and what remained he used for the wheat in autumn. He assured me he had often tested it with other manures, and always found 10 tons of the compound quite outstrip 4 cwt. of guano, when they were applied to an acre of land separately."

Section 17.—*Charred Peat.*

Charred peat has been excessively extolled for its value as a manure, both when applied alone, and still more in combination with night-soil, sewage water, and similar matters, which it dries and deodorises. So great were the expectations of an enormous demand for it, and of the benefits to result to Ireland by thus disposing of her bogs, that a royal charter was granted to a company by whom its manufacture was commenced on an imposing scale. This charcoal is doubtless a useful substance; but, as Dr Anderson has proved, peat, merely dried, is a better absorber and retainer of ammonia than after it is charred.

Section 18.—*Soot.*

Soot has long been in estimation as an excellent top dressing for cereal crops in the early stage of their growth, and for grasses and forage plants. It is applied at the rate of 15 to 30 bushels per acre. On light soils the addition of 8 or 10 bushels of salt to the above quantity of soot is said to increase materially its good effect. This mixture trenched, or deeply ploughed in, is also re-

commended as one of the most powerful of all manures for carrots.

In *London Labour and the London Poor* we find the following statistics as to metropolitan soot:—

	Bush. of Soot per annum.
"53,840 houses, at a yearly rental above £50, producing six bushels of soot each per annum . . .	323,040
90,002 houses, at a yearly rental above £30 and below £50, producing five bushels of soot each per annum	450,010
163,880 houses, at a yearly rental below £30, producing two bushels of soot each per annum . . .	327,760
Total number of bushels of soot annually produced throughout London . . .	1,100,810

The price of soot per bushel is but 5d., and sometimes 4½d., but 5d. may be taken as an average. Now, 1,000,000 bushels of soot at 5d. will be found to yield £20,833, 6s. 8d. per annum."[1]

Section 19.—*Salt.*

Common salt has often been commended as a valuable manure, but has never been used in this way with such uniform success as to induce a general recourse to it. We have already spoken of it as forming a useful compound with lime and earth. It can also be used beneficially for the destruction of slugs, for which purpose it must be sown over the surface, at the rate of *four* or *five* bushels per acre, early in the morning, or on mild, moist days, when they are seen to be abroad. It is used also to destroy grubs and wireworm, for which purpose it is sown in considerable quantity on grass land some time before it is ploughed up. It can be used safely on light soils, but when clay predominates, it causes a hurtful wetness, and subsequent incrustation of the surface. Its application in its unmixed state as a manure is at best of doubtful benefit; but in combination with lime, soot, nitrate of soda, and perhaps also superphosphate of lime, it appears to exert a beneficial influence.

Section 20.—*Nitrate of Soda.*

Cubic saltpetre, or nitrate of soda, has now become one of our staple manures. The fertilising power of common saltpetre or nitrate of potass has been known from the earliest times, but its high price has hitherto hindered its use as a manure, except in the form in which it is obtained as refuse from the gunpowder mills. The cubic nitre is brought from Peru, where there are inexhaustible supplies of it. The principal deposits of nitrate of soda are in the plain of Tamarugal, at a distance of 18 miles from the coast. The beds are sometimes 7 or 8 feet in thickness, and from these it is quarried with ease. It is not found in a perfectly pure state, but contains a mixture of several substances, chiefly common salt. To fit it for certain uses in the arts, it is subjected to a process of purification by boiling and evaporation. But for its use as a manure this is altogether unnecessary, and the cost would be greatly lessened if the nitrate were imported as quarried. As cubic nitre and guano contain very nearly the same percentage of nitrogen (the element to which the fertilising power of all manures is mainly due), it may seem surprising that the former should ever be used in preference to the latter. In practice, however, it is found that when applied as a top-dressing in spring, the former frequently yields a better profit than the latter; and hence the importance to farmers of getting it at a more reasonable price. Nitrate of soda is used as a manure for grain and forage crops. It is now extensively used as a top-dressing for wheat. For this purpose it is applied at the rate of 84 lb per acre, in combination with 2 cwt. of salt. The nitre and salt are thoroughly mixed, and carefully sown, by hand, in two or three equal portions, at intervals of several weeks, beginning early in March, and finishing by the third week in April. If nitre alone is used, it has a tendency to produce over-luxuriance, and to render the crop liable to lodging and mildew. But the salt is found to correct this over-luxuriance, and a profitable increase of grain is thus obtained. Mr Pusey[2] informs us that an application of 42 lb of nitrate of soda and 84 lb of salt per acre, applied by him to ten acres of barley that had been injured by frost, had such an effect upon the crop, that he had *seven* bushels more grain per acre, and of better quality, than on part that was left undressed for comparison. These seven bushels per acre were attained by an outlay of 6s. 4d. only. This nitre is also applied with advantage to forage crops. Mr Hope, Fenton Barns, East Lothian, states that he finds the use of it as a top-dressing to clover, at the rate of one cwt. of nitrate and two of guano per acre, profitable. Its beneficial effects are most apparent when it is applied to light and sterile soils, or to such as have been exhausted by excessive cropping.

Section 21.—*Potash.*

Crude potash, or kainite, has of recent years been largely imported from Germany, and has been somewhat extensively used in combination with other manures for potatoes and other root crops—two cwt. per acre being a common rate for the potash.

Section 22.—*Artificial Manures.*

Besides those substances, the most important of which we have now enumerated, which are available as manure in their natural state, there are various chemical products, such as salts of ammonia, potash, and soda, copperas, sulphuric and muriatic acid, &c., which, in combination with lime, guano, night-soil, and other substances, are employed in the preparation of manures, with a special view to the requirements of particular crops. In some cases these preparations have been eminently successful, in others but doubtfully so. Many failures are probably due to the spuriousness of the article made use of; as it is known that enormous quantities of worthless rubbish have, of late years, been sold to farmers, under high sounding names, and at high prices, as special manures. We would recommend those who desire information regarding the preparation and use of such compounds to study the article on Agricultural Chemistry, by Mr Lawes of Rothamstead, in the *Journal of the Royal Agricultural Society of England* (vol. viii. p. 226); the accounts of experiments with special manures in the *Transactions of the Highland and Agricultural Society of Scotland;* and the articles relating to Agricultural Chemistry in *Morton's Cyclopædia.* Those who purchase manures of this kind ought to be very careful to insist in every instance upon the seller producing an analysis by some chemist of established character, and granting a written warranty that the article sold to them is at least equal to the value indicated by the analysis. Were all farmers to insist upon this mode of buying their manures, they would at once put an end to that wholesale system of fraud by which they have been so enormously cheated of late years.

In applying these concentrated manures, those only of a slowly operating character should be used in autumn or winter, and at that season should invariably be mixed with the soil. Those in which ammonia abounds should in spring also be mixed with the soil when crops to which they are applied are sown. When used for top-dressing growing crops they should be applied only in wet weather.

[1] *Farmers' Magazine* for March 1852, p. 254.

[2] *Journal of Royal Agricultural Society,* vol. xiii. p. 349.

CHAPTER XI.

CULTIVATED CROPS—GRAIN CROPS.

Pursuing the plan announced at the outset, we have now to speak of field crops, and shall begin with the cereal grasses, or white-corn crops, as they are usually called by farmers.

Section 1.—*Wheat.*

It is unnecessary to dwell upon the value of this grain to the farmer and to the community. It constitutes emphatically our bread-corn—our staff of life. While its increased consumption is, on the one hand, an indication of an improved style of living among the general population, its extended culture points, on the other, to an improving agriculture, as it is only on soils naturally fertile, or that have been made so by good farming, that it can be grown with success. Wheat is sown both in autumn and spring, from which circumstance attempts have been made to classify its varieties by ranging them under these two general heads. This distinction can only serve to mislead; for while it is true that there are varieties best adapted for autumn and for spring sowing respectively, it is also true that a majority of the kinds most esteemed in Britain admit of being sown at either season, and in practice are actually so treated. It is not our intention to present a list of the varieties of wheat cultivated in this country. These are very numerous already, and are constantly being augmented by the accidental discovery of new varieties, or by cross-impregnation artificially brought about for this purpose. The kinds at present in greatest repute in Scotland are the hardier *white wheats*, among which *Hunter's* white still retains the first place. There are many kinds which, in favourable seasons, produce a finer sample; but its hardiness, productiveness, and excellent milling qualities, render it a general favourite both with farmers and millers. Its most marked characteristic is, that in rubbing out a single ear, part of the grains are found to be opaque and white, and others flinty and reddish coloured, as if two kinds of wheat had been mixed together. Selections from Hunter's wheat have been made from time to time, and have obtained a measure of celebrity under various local names. The most esteemed of these is the *Hopeton* wheat. On very rich soils both these varieties have the fault of producing too much straw, and of being thereby liable to lodge. Hence, several new kinds with stiffer straw, and consequent lessened liability to this disaster, are now in request in situations where this evil is apprehended. *Fenton* wheat, possessing this quality in an eminent degree, and being at the same time very productive, and of fair quality, is at present extensively cultivated. It has the peculiarity of producing stems of unequal height from the same root, which gives a crop of it an unpromising appearance, but has perhaps to do with its productiveness. The *red-straw white* and *Piper's thick-set* have properties similar to the Fenton. Piper's had the repute of being the shortest and stiffest strawed wheat in cultivation, but after a brief popularity is now never heard of. The *red-chaff white* is productive, and yields grain of beautiful quality, but it requires good seasons, as it sheds its seeds easily and sprouts quickly in damp weather. The *Chiddam, Trump, white Kent*, and *Talavera*, have each their admirers, and are all good sorts in favourable seasons; but, in Scotland at least, their culture is attended with greater risk than the kinds previously named; they require frequent change of seed from a sunnier climate, and are only adapted for dry and fertile soils with a good exposure. A new sort, called *square-head*, has quite recently been introduced, and is reported to be so exceedingly prolific as to yield from six to eight bushels more per acre than any wheat previously in cultivation. As red wheats usually sell at from 2s. to 4s. less per quarter than white wheats of similar quality, they are less grown than heretofore. But being more hardy and less liable to mildew and sprouting than the finer white wheats, a recurrence of unfavourable seasons always leads to an increased cultivation of them. Some of these red wheats are, however, so productive that they are preferred in the best cultivated districts of England. *Spalding's prolific* holds a first place among these, being truly prolific, and producing grain of good quality. In Scotland it shows a tendency to produce a rough quality of grain. The *Northumberland red* and the *golden creeping* are there in estimation; the former being well adapted for spring sowing, and the latter for poor soils and exposed situations. Several new varieties of wheat have recently been introduced by Mr Patrick Sheriff of Haddington, formerly of Mungoswells. One is a large-grained red wheat, another somewhat resembles Hunter's in colour, and the third has grain of a pearly whiteness. They have all the peculiarity of being bearded. They are all true autumn wheats; but they seem also well adapted for spring sowing, as they ripen early. A red bearded variety, usually called *April wheat*, from its prospering most when sown in that month, and which indeed is a true summer wheat, is sometimes grown with advantage after turnips, when the season is too advanced for other sorts. But except upon poorish clay soils, it seems only doubtfully entitled to a preference over barley in such circumstances. The list now given could easily be extended; but it comprises the best varieties at present in use, and such as are suited to the most diversified soils, seasons, and situations in which wheat can be grown in this country. In regard to all of them it is reckoned advantageous to have recourse to frequent change of seed, and in doing this to give the preference to that which comes from a soil and climate better and earlier than those of the locality in which it is to be sown. Every farmer will find it worth his while to be at pains to find out from whence he can obtain a change of seed that takes well with his own farm, and having done so, to hold to that, and even to induce his correspondent to grow such sorts as he prefers, although he should have to pay him an extra price for doing so. An experienced farmer once remarked to the writer, that by changing his seed he got it for nothing; that is, his crop was more abundant by *at least* the quantity sown, from the single circumstance of a suitable change of seed. It is proper, however, to state, that this practice of changing the seed is founded more upon mere opinion than upon well-ascertained facts, and that in those instances where it has been followed by beneficial results nothing is known of the causes to which such success is due. It is much to be desired that our agricultural societies should address themselves to the thorough investigation of a question of such vital importance. In fixing upon the kind of wheat which he is to sow, the farmer will do well to look rather to productiveness than to fine quality. For however it may gratify his ambition to show the heaviest and prettiest sample in the market, and to obtain the highest price of the day, no excellence of quality can compensate for a deficiency of even a few bushels per acre in the yield. It is of importance, too, to have seed-corn free from the seeds of weeds and from other grains, and to see that it be true of its kind. Farmers who are systematically careful in these respects frequently obtain an extra price for their produce, by selling it for seed-corn to others; and even millers give a preference to such clean samples.

But there are seeds which no amount of care or accuracy in dressing can remove from seed-corn—viz., those of certain parasitical fungi, which must be got rid of by a different process. The havoc caused to wheat crops by bunt, blackball, or pepper-brand (*Uredo caries* or *Tilletia caries*), before the discovery of the mode of preventing it

by steeping the seed-corn in some acrid or caustic bath, was often ruinous. The plan at first most usually adopted was to immerse the seed-wheat in stale chamber-lie, and afterwards to dry it by mixture with quick-lime. This pickle, as it is called, is usually efficacious; but the lime vexes the eyes and excoriates the hands and face of the sower, or clogs the hopper of the sowing-machine, and has therefore been superseded by other substances. Blue vitriol (sulphate of copper) is as good as anything for this purpose, and is used in the following manner. A solution is prepared by dissolving powdered sulphate of copper in water, at the rate of two ounces to a pint for each bushel of wheat. The grain is emptied upon a floor; a little of it is shovelled to one side by one person, while another sprinkles the solution over it, and this process is continued until the whole quantity is gone over. The heap is then turned repeatedly by two persons working with shovels opposite to each other. After lying for a few minutes, the grain absorbs the moisture, and is ready for sowing either by hand or machine.

The season for wheat-sowing extends from September to April, but ordinarily that succeeds best which is committed to the ground during October and November. When summer-fallows exist the first sowings are usually made on them. It is desirable that the land neither be wet nor very dry when this takes place, so that the precise time of sowing is determined by the weather; but it is well to proceed as soon after 1st October, as the land is moist enough to insure a regular germination of the seed.

Over a large portion of England wheat is the crop usually sown after clover or one year's "seeds." In such cases the land is ploughed in the end of September, immediately harrowed, and wheat sown upon it by a drilling machine. On loose soils the land-presser is frequently used to consolidate the soil and to form a channel for the seed, which in such cases comes up in rows, although sown broadcast. It is more usual, however, first to level the pressed furrows by harrowing, and then to use the drill, by means of which various portable manures are frequently deposited along with the seed-corn. The sowing of wheat after clover or "seeds," as now described, is rarely practised in Scotland, where it so invariably fails as to show that it is unsuited to our northern climate. It is here not unusual, however, to plough up such land in July or August, and to prepare it for wheat-sowing by what is called *rag-fallowing*. After the first ploughing the land is harrowed lengthwise, so as to break and level the surface of the furrows and close the interstices without tearing up or exposing any green sward. It is then allowed to lie for ten or fourteen days to allow the herbage to die, which it soon does at this season when light is thus excluded from it. A cross ploughing is next given, followed by repeated grubbings, harrowing, and rollings, after which it is treated in all respects as a summer-fallow.

The fallow and clover leas being disposed of, the land from which potatoes, beans, pease, or vetches have been cleared off will next demand attention. When these crops have been carefully horse and hand hoed, all that is required is to clear off the haulm to plough and sow. If the land is not clean, recourse must be had to a short fallowing process before sowing wheat. For this purpose the surface is loosened by the broadshare and grubber, the weeds harrowed out and raked off, after which the land is ploughed and sown. On soils well adapted for the growth of beans and wheat, viz., those in which clay predominates, any lengthened process of autumn cultivation is necessarily attended with great hazard of being interrupted by rain, to the loss of seed-time altogether. Every pains should therefore be taken to have the land so cleaned beforehand that these unseasonable efforts may be dispensed with; and to have the sowing and harrowing to follow so closely upon the ploughing as to diminish to the utmost the risk of hindrance from wet weather. As the crops of mangolds, carrots, or turnips arrive at maturity, and are either removed to the store-heap or consumed by sheep where they grow, successive sowings of wheat can be made as the ploughing is accomplished and as the weather permits. It is to be noted, however, that it is only on soils naturally dry, or made so by thorough draining, and which are also clean and in a high state of fertility, that wheat-sowing can be continued with advantage during the months of December and January. If the whole of these conditions do not obtain, it is wiser to refrain until February or March. When these late winter sowings are made, it is of especial importance to sow close up to the ploughs daily, as a very slight fall of rain will, at this season, unfit the land for bearing the harrows. This sowing and harrowing, in detail, is the more easily managed, that in the circumstances cross-harrowing is neither necessary nor expedient. Under the most favourable conditions as to weather and drainage, soils with even a slight admixture of clay in their composition will at this season plough up somewhat clammy, so that cross-harrowing pulls the furrows too much about, and exposes the seed, instead of covering it more perfectly. Two double turns of the harrows *lengthwise* is as much as should be attempted at this season.

The sowing of *spring-wheat* is only expedient on dry and fertile soils with a good exposure. Unless the whole conditions are favourable, there is much risk of spring-sown wheat being too late to be properly ripened or well harvested. On the dry and fertile soils in the valley of the Tweed, where the entire fallow-break is sown with turnips, and where consequently it is difficult to get a large breadth cleared in time for sowing wheat in autumn, it is the practice to sow it largely in February and March, and frequently with good success. Many judicious farmers are, however, of opinion that, taking the average of a twenty years' lease, barley is a more remunerative crop than spring-sown wheat, even under circumstances most favourable to the latter. When it is resolved to try it, a very full allowance of seed should be given—not less than three bushels per acre, and 3½ will often be better. If the plants have room they will tiller; and thus the ripening of the crop is retarded, the risk of mildew increased, and the quality of the grain deteriorated. As much seed should therefore be sown as will yield plants enough to occupy the ground fully from the first, and thus remove the tendency to tillering. By such full seeding a fortnight is frequently gained in the ripening of the crop, and this frequently makes all the difference between a remunerative crop and a losing one.

Much controversy has taken place about the quantities of seed-wheat which should be used per acre. The advocates of thin seeding have been so unguarded and extravagant in their encomiums of their favourite method,—some of them insisting that anything more than a few quarts per acre does but waste seed and lessen the produce,—that many persons have been induced to depart from their usual practice to their serious cost. It is true that with land in a high state of fertility, and kept scrupulously clean by frequent hoeings, a full crop of wheat may be obtained from half a bushel of seed per acre, provided that it is sown in September, and deposited regularly over the surface. But what beyond a trifling saving of seed is gained by this practice? And at what cost and hazard is even this secured? It is a mere fallacy to tell us, as the advocates of excessively thin seeding so often do, that they obtain an increase of so many hundred-fold, whereas thick seeders cannot exceed from twelve to twenty fold, when after all the gross produce of the latter may exceed that of

the former by more than the quantity of seed saved, with less expense in culture, less risk from accidents and disease, an earlier harvest, and a better quality of grain. Such a crowding of the ground with plants as prevents the proper development of the ear is of course to be avoided; but the most experienced growers of wheat are convinced of the benefit of having the ground fully occupied at the time when active spring growth begins. This is secured by using two bushels per acre for the sowing made early in October, and by increasing this quantity at the rate of half a peck per week until three bushels is reached, which may be held as the maximum. Less than this should not be used from the middle of November to the end of the season. These are the quantities to be used in broad-cast sowing; when drilling or dibbling is resorted to, two-fifths less seed will suffice. In Scotland, at least, often repeated trials have shown that larger crops are obtained by broad-casting than by drilling. The latter mode is, however, to be preferred wherever the land is infested by annual weeds, which can then be got rid of by hoeing. When clover and grass-seeds are sown with the grain crop, it is believed also that they thrive better from the grain being sown in rows, probably because in this case light and air are less excluded from them. It is believed also that in highly-manured soils of a loose texture, grain deposited somewhat deeply in rows is less liable to lodge than when sown broad-cast and shallower. When drilling and hoeing are resorted to, the latter is effected most cheaply and effectively by using Garret's horse-hoe. The mere stirring of the soil is considered by many farmers to be so beneficial to the wheat crop that they use the horse-hoe irrespective of the presence of weeds. Others are of opinion that, apart from the destruction of weeds, hoeing is injurious to grain crops, alleging that the cutting of their surface roots weakens the stems and increases their liability to fall over. Carefully conducted experiments are required to settle this point. We have no personal experience bearing upon it beyond this, that we have repeatedly seen a wheat crop much benefited by mere harrowing in spring. It is always useful to roll wheat, and indeed all cereal crops, in order to facilitate the reaping process, although no other benefit should result from it. When the plants have been loosened by severe frosts, or are suffering from the attacks of the wire-worm, the use of Crosskill's roller is usually of great benefit to the crop.

A plan of growing wheat year after year on the same field without the use of manure was practised for a number of years by the late Rev. Mr Smith of Lois Weedon, Northamptonshire, and detailed by him in the pages of the *Royal Agricultural Society's Journal*, and in a pamphlet which has passed through many editions and had a very extensive circulation. His plan is to a certain extent a revival of that of Jethro Tull, but with this important difference, that whereas Tull occupied his ground with alternate double rows of wheat a foot apart, and vacant spaces, five feet wide, which were carefully cultivated by ploughings and horse-hoeings repeated at intervals from the springing of the wheat until midsummer, Mr Smith introduced two important elements in addition, viz., thorough draining, and trenching the vacant spaces in autumn, so as to bring portions of subsoil to the surface. A field treated on this system consists of alternate strips of wheat and bare fallow, which are made to exchange places year by year, so that each successive crop occupies a different site from its immediate predecessor. It has also the benefit of the fresh soil brought up by the previous autumn's double-digging, which is subsequently mellowed and pulverised by lengthened exposure to the atmosphere, and by frequent stirrings. The produce obtained by Mr Smith from his acre thus treated was very nearly 34 bushels each year for the first five years; but as his crops steadily improved, his average at the end of fourteen years was fully 36 bushels. Writing in July 1861, he said, "The growing crop for 1861, notwithstanding the frost, looks strong and well, with scarcely a gap. Thus year after year gives growing confidence in the scheme." On steam-power being introduced, Mr Smith became convinced of the practicability of carrying out his system with advantage on an entire farm. At first he restricted himself to the employment of manual labour, but he subsequently invented a set of implements for sowing, covering in, rolling, and hoeing his crops by horse labour. We give in his own words his directions for carrying out this system, what he believed to be the advantages of it, and the cost of thus cultivating an acre:—

"I suppose, at the outset, the land intended for wheat to be wheat land; having besides a fair depth of staple, and a subsoil, as will generally, though not universally be the case, of the same chemical composition with the surface. I suppose it dry, or drained three feet deep *at least;* well cleaned of weeds; the lands cast; and the whole tolerably level.

"1. First of all, then, plough the whole land, when dry, one inch deeper than the used staple. If it turn up cloddy, bring the clods down with the roller or the crusher. Let this be done, if possible, in August. Harrow deep, so as to get five or six inches of loose mould to admit the presser. Before sowing wait for rain. After the rain wait for a fine day or two to dry the surface. With this early commencement a week or two is of no material importance compared with that of ploughing dry and sowing wet.

"As early as possible, however, in September, get in your seed with the presser-drill, or with some implement which forms a firm-bedded channel in which to deposit the seed, grain by grain, a few inches apart. Cover over with the crusher or rough roller.

"2. When the lines of wheat appear above ground, guard against the rook, the lark, and the slug—a trite suggestion, but ever needful, especially here. And now, and at spring, and all through summer, watch for the weeds, and wage constant warfare against them. The battle may last for a year or two, or in some foul cases even more; but, in the end, the mastery, and its fruits, without fail, will be yours.

"3. The plant being now distinctly visible, dig the intervals two spits deep, increasing the depth, year after year, till they come to twenty or twenty-four inches. Bring up at first only four, or five, or six inches, according to the nature of the subsoil, whether tenacious, or loamy, or light. To bring up more at the outset would be *a wasteful and injurious expense.*

"The digging is done thus:—Before proceeding with the work, a few cuts are made within three inches of the wheat, the back of the spade being towards the rows. A few double spits, first of all, at the required depth, are then thrown out on the headland, and there left for the present. After this, as the digging proceeds, the staple is cast to the bottom, and the subsoil thrown gently on the top. This process is carried on throughout the whole interval; at the end of which interval, just so much space is left vacant as was occupied by the soil thrown out at the beginning of it. In commencing the second interval at that finished end, the earth is thrown out as at first, not on the headland, however, but into the vacant space of the first interval. And so on all over the acre.

"4. Late in winter, and early in spring, watch your opportunity, in dry weather, before the roots of the plant are laid bare, to press them with the crusher.

"5. In the spring and early summer stir the spaces between the rows as often as the surface becomes crusted over; and move the settled intervals four or five inches deep with the common scarifier, set first of all about twenty-eight inches wide, reducing the width till it come by degrees to twenty-four and eighteen inches. Continue the process, if possible, at the last-named width, up to the time of flowering in June.

"These operations are indispensable to full success, and happily can be carried on at little cost; for, while the intervals of each acre can be scarified in fifty minutes, the horse-hoe implement, covering two lands at once, can stir between the rows in twenty-five.

"6. Immediately the crop is carried, clean the intervals, and move them with the scarifier in order to *sow,* without delay, the shed grains. When these vegetate and come up into plant, move the intervals again five or six inches deep, and so destroy them. After that, level with the harrow implement, and the land is ready for the drill.

"If anything occur to prevent the sowing early in September, and to drive you to the end of October, set the drill for a thicker crop. But, if possible, sow early—for this reason. Tillered wheat has a bad name. But that has reference only to wheat which has tillered late in the spring. And certainly, in that case, there is the fear of danger to the crop, and danger to the sample. For

supposing no mildew to fall on it, even then the plant ripens unevenly; the early stems being ready for the sickle, while the late-grown shoots have scarcely lost their verdure. But if mildew come when the stem is soft, and succulent, and porous, instead of being, as it should be at that time, glazed and case-hardened against its attacks, the enemy enters in and checks the circulating sap; and the end is, blackened straw, light ears, and shrivelled grain. Therefore, sow early. Let the plant tiller before winter. Give every stem an equal start at spring; and then, with a strict adherence to rule, there need be no alarm as to the result, subject only to those visitations from which no wheat, on any system, in the same description of soil, and under the same climate, is secure."—(See pamphlet, *Word in Season*, p. 36.)

"The advantages of the system of corn-growing which I have described are principally these:—First, while one crop of wheat is growing, the unsown intervals of the acre are being fallowed and prepared for another. This the farmer well knows to be of infinite moment, meeting, as it does, one of the greatest difficulties he has to contend with. Next, upon this half-portion of the acre, tilled as I describe, there is a yield equal to average crops on a whole acre. Then, for half the portion of an acre, there is, of course, only half the labour and half the expense of an entire acre required for cultivation. And, lastly, the hand-labour required finds constant employment for the poor."—(*Ibid.*, p. 17.)

"After harrowing, and cleaning, and levelling the whole, I marked out the channels for the seed with my *presser implement*, which is drawn with one horse, and presses two lands at once. My scheme of implements, to be complete, embraced a drill, which was to act immediately behind the presser-wheels, and to drop seed by seed into the hard channels. The spindle of the presser was to turn the drill-wheels, and the boxes were to be made removable. Being unable to accomplish this in time for this year's sowing, I had the seed, as heretofore, dropped by hands, and covered over by rollers.

"These rollers form the *roller implement* in the same frame, and are managed thus: the three-wheeled pressers are removed from their sockets, and in their place two rough rollers, formed of several wheels on the self-cleaning principle, are introduced, and cover over two lands at once.

"The portion of the field thus seeded will lie in this firm but rough state till spring time. Then, when the rollers have been applied again to keep the roots of the plant well in their place, they too will be removed from the frame, and light wheels and hoes will be attached, forming the *horse-hoe implement*, for hoeing and stirring between the wheat.

"There is yet one other use for the implement frame. The intervals of the wheat having been trenched in autumn, and well and frequently stirred by the common scarifier at spring, are shut out by the wide-spreading wheat-plant in June from all further processes till the crop is cut and carried. They are then to be moved and levelled by the common one-horse scarifier for seed-time. After this will follow the harrow. The hoes will be removed from the frame, and two small harrows will be attached, to cover two lands at once; and with this implement the horse will walk on the stubble-land, between what before were the intervals; and the cycle of operations is now complete.

"In all these operations (excepting in that of scarifying) the sown lands, and lands about to be made ready for sowing, are untouched by the foot of man or horse.

"The time occupied in scarifying the land is about an hour the acre; in heavily pressing the channels for the seed, half an hour; in the other operations about 20 or 25 minutes."—(Pp. 25, 26.)

"The presser-drill, spoken of in p. 25, is completed, and I now sow the four acres in 90 minutes, timed by watch; being at the rate of 18 or 20 acres a day in a day of 8 hours, with a horse of average power and speed.

"It has been thought advisable to keep the drill in its own frame,—devoting another frame to the roller-wheels or crusher, the hoes, the scarifiers, and harrows, all of which are made removable, and which, with the exception of the spade, the hand-hoe, and the common scarifier for stirring the intervals, perform the whole cycle of operations for cultivating the land for wheat."—(Pp. 33, 34.)

"I have only to show now, by my fresh balance-sheet, how with suitable implements, on wheat-land, the whole scheme I propose is economical, as well as easy and expeditious.

	£	s.	d.
"One double digging in autumn	£1	10	0
Three stirrings with scarifier at spring (6d.)	0	3	0
One ditto with scarifier and harrow implement, before sowing	0	1	0
Two pecks of seed (5s. the bushel)	0	2	6
Pressing and drilling	0	1	0
Rough rolling	0	0	6
Four hoeings between wheat with horse-shoe implement (6d.)	0	2	0
Bird-keeping	0	2	0
Carried forward	£2	2	0

	£	s.	d.
Brought forward	£2	2	0
All the operations from reaping to marketing	1	2	0
Rates, taxes, and interest	0	10	0
Total amount of outlay	£3	14	0

"The produce, supposing it equal to that of former years, in round numbers, would be:—

	£	s.	d.
"Four quarters and two bushels of wheat (at 40s.)	£8	10	0
One ton and 12 cwt. of straw (at £2 the ton)	3	4	0
	£11	14	0
Deduct outlay	3	14	0
Total amount of profit	£8	0	0"

—(*Ibid.*, p. 30.)

Particular attention was directed to this system of wheat culture by a lecture on Tull's husbandry, delivered by Professor Way, at a council meeting of the Royal Agricultural Society of England, and by the animated discussion which followed; when several gentlemen who had visited Mr Smith's farm bore testimony to the continued excellence of his crops, and intimated that they and others had begun to test the system upon their own farms. If such a practice can indeed be pursued on the generality of clay-soils, then the puzzling problem of how to cultivate them with a profit is solved at once. It is not to be thought that practical farmers would regard otherwise than with incredulity a system which so flatly contradicts all existing theory and practice. The facts submitted to them by Mr Smith being beyond challenge, they would naturally imagine there must be some peculiarity in the soil at Lois Weedon which enabled it to sustain such heavy and continued demands on its fertility; and that the issue, there and elsewhere, must eventually be utter sterility. For our own part, believing that we have exceeding much to learn in every department of agriculture, we cannot thus summarily dispose of these facts. We simply accept them as true, and leave the exposition of them to *experience*, whose verdict we await with much interest.

But Mr Smith is not the only person who has furnished us with information regarding the continuous growth of wheat for a series of years on the same soil. Mr Lawes, at Rothamstead, in Herts, so well known by his interesting papers on agricultural chemistry in the *Royal Agricultural Society's Journal*, has furnished some facts in connection with the culture of wheat on clay soils to which farmers were little prepared to give credence. Mr Caird, who visited Rothamstead early in 1851, thus refers to the subject in his valuable work:—

"On a soil of heavy loam, on which sheep cannot be fed on turnips, 4, 5, and 6 feet above the chalk, and therefore uninfluenced by it, except in so far as it is thereby naturally drained, *ten* crops of wheat have been taken in succession, one portion always without any manure whatever, and the rest with a variety of manure, the effects of which have been carefully observed. The seed is of the red cluster variety, drilled uniformly in rows at 8 inches apart, and two bushels to the acre, hand-hoed twice in spring, and kept perfectly free from weeds. When the crop is removed the land is scarified with Bentall's skimmer, all weeds are removed, it is ploughed once, and the seed for the next crop is then drilled in. During the ten years, the land, in a natural state, without manure, has produced a uniform average of 16 bushels of wheat an acre, with 100 lb. of straw per bushel of wheat, the actual quantity varying with the change of seasons between 14 and 20 bushels. The repetition of the crop has made no diminution or change in the uniformity of the average, and the conclusion seems to be established, that if the land is kept clean, and worked at proper seasons, it is impossible to exhaust this soil below the power of producing 16 bushels of wheat every year.

"But this natural produce may be doubled by the application of certain manures. Of these, Mr Lawes's experiments led him to conclude that ammonia is the essential requisite. His conclusions are almost uniform, that no organic matter affects the produce of wheat, except in so far as it yields ammonia; and that the whole of the organic matter of the corn crop is taken from the atmosphere by the medium of ammonia. There is a constant loss of ammonia going on by expiration, so that a larger quantity must be supplied than is contained in the crop. For practical purposes, 5 lb. of

ammonia is found to produce a bushel of wheat, and the cheapest form of ammonia at present being Peruvian guano, 1 cwt. of that substance may be calculated to give 4 bushels of wheat. The natural produce of 16 bushels an acre may therefore be doubled by an application of 4 cwt. of Peruvian guano. To this, however, there is a limit—climate. Ammonia gives growth, but it depends on climate whether that produce is straw or corn. In a wet, cold summer a heavy application of ammonia produces an undue development of the circulating condition of the plant, the crop is laid, and the farmer's hopes are disappointed. Seven of corn to ten of straw is usually the most productive crop; five to ten seldom yields well. The prudent farmer will therefore regulate his application of ammonia with a reference to the average character of the climate in which his farm is situated.

"The practical conclusion at which we arrive is this, that in the cultivation of a clay-land farm, of similar quality of soil to that of Mr Lawes, there is no other restriction necessary than to keep the land clean; that while it is very possible to reduce the land by weeds, it is impossible to *exhaust* it (to a certain point it may be *reduced*) by cleanly cultivated corn corps; that it is an ascertained fact that wheat may be taken on soils of this description (provided they are manured) year after year, with no other limit than the necessity for cleaning the land, and that may best be accomplished by an occasional green crop—turnip or mangold, as best suits—at great intervals, the straw being brought to the most rotten state, and applied in the greatest possible quantity to insure a good crop, which will clean the land well. If these conclusions are satisfactorily proved, the present mode of cultivating heavy clays may be greatly changed, and the owners and occupiers of such soils be better compensated in their cultivation than they have of late had reason to anticipate."—(Caird's *English Agriculture*, in 1850 and 1851, pp. 460–462.) [1]

It is certainly curious to observe, that the addition of four cwt. of guano brings up the produce of Mr Lawes's acre from its average annual rate of sixteen bushels, under its reduced normal state, to very nearly the same as Rev. Mr Smith's acre under his system of alternate strips of corn and summer fallow.

From information carefully gathered, Mr Caird gives it as his opinion, that the average produce of wheat per acre in 26 of the 32 counties of England visited by him is 26⅔ bushels, or 14 per cent. higher than it was estimated at in the same counties by Arthur Young 80 years before. Were the country generally anything like as well cultivated as particular farms that are to be met with in all parts of it, we should have the present average increased by at least eight bushels per acre. 63 ℔ per bushel is a weight indicating a good quality of grain. A good crop of wheat will yield a ton of grain and about two tons of straw per acre.

Besides its uses on the farm, wheat straw, in certain limited districts in the south of England, is an article of some value, as the raw material of a not unimportant native manufacture, namely, *Straw-Plait*. The first straws used for this purpose in this country were grown in the neighbourhood of Luton in Bedfordshire. This town is still the principal seat of the straw trade and straw bonnet manufacture, and the district around still produces the finest quality of straws; but straw-growing is now also carried on in parts of Hertfordshire, Buckinghamshire, Oxfordshire, and Berkshire. Light, rich soils are best adapted for this purpose. The kinds of wheat grown with this view are the Red Lammas and the Chiddam. A bright, clean, tough straw being required, it is necessary to begin reaping before the flag of the straw falls. If the straw is exposed to rain, it becomes rusted or spotted; if to very hot and dry weather, it gets sunburnt and brittle. The utmost care and energy must, therefore, be used to get the crop dried, carried, and stacked as quickly as possible. In favourable seasons an acre of wheat will yield (besides the grain) from 15 cwt. to a ton of cut straws, of the value of £6 to £8 per ton, clear of all expenses. The farmer sells his straw to a class of men called straw-factors, who draw and cut the straws in his barn. The drawing and cutting-off of the ears being there performed, the factors remove the straw to their own premises. There it undergoes a farther cutting, is exposed to the fumes of sulphur, assorted into proper lengths, and made up into marketable bunches of various sizes and qualities. These bunches are disposed of to the plaiters at the various markets of the district. About 50,000 females and boys are engaged in plaiting. No plait is made in factories, the work being performed by the wives and children of agricultural labourers in their own cottages, where it is carried on all the year except in harvest. The straw trade, in its various departments, is of considerable importance and is steadily increasing. The gross returns are supposed not to fall short of £1,250,000 per annum.

There is now also a small demand for wheat straw for the manufacture of paper.

Section 2.—Barley.

In Great Britain barley is the grain crop which ranks next in importance to wheat, both in an agricultural and commercial point of view. Its use as bread-corn is confined to portions of the lowlands of Scotland, where unleavened cakes, or "bannocks o' barley meal," still constitute the daily bread of the peasantry. It is more largely used in preparing the "barley broth" so much relished by all classes in Scotland. To fit the grain for this purpose, it is prepared by a peculiar kind of mill, originally introduced from Holland by Fletcher of Saltoun, in which a thick cylinder of gritty sandstone is made to revolve rapidly within a case of perforated sheet-iron. The barley is introduced betwixt the stone and its case, and there subjected to violent rubbing, until first its husk and then its outer coatings are removed. It is, however, in the production of malt liquor and ardent spirits, and in the fattening of live stock, that our barley crops are chiefly consumed. We have no doubt that it would be better for the whole community if this grain were more largely used in the form of butcher-meat and greatly less in that of beer or whisky. It has been customary for farmers to look upon distillation as beneficial to them from the ready market which it affords for barley, and more especially for the lighter qualities of this and other grain crops. But this is a very short-sighted view of the matter; for careful calculation shows that when the labouring man spends a shilling in the dram-shop, not more than a penny of it goes for the agricultural produce (barley) from which the gin or whisky is made; whereas, when he spends the same sum with the butcher or baker, nearly the whole amount goes for the raw material, and only a fraction for the tradesman's profits. And not only so, but the man who spends a part of his wages upon strong drink diminishes, both directly and indirectly, his ability to buy wholesome food and good clothing; so that, apart from the moral and social bearings of this question, it can abundantly be shown that whisky or beer is the very worst form for the farmer in which his grain can be consumed. Were the £50,000,000 at present annually spent in Great Britain upon ardent spirits (not to speak of beer), employed in purchasing bread, meat, dairy produce, vegetables, woollen and linen clothing, farmers would, on the one hand, be relieved from oppressive rates, and, on the other, have such an increased demand for their staple products as would far more than compensate for the closing of what is at present the chief outlet for their barley.

There are many varieties of barley in cultivation, and some of them are known by different names in different districts. Those most esteemed at present in Berwickshire and neighbouring counties are the *Chevalier*, the *Annat*, and the *common-early long-eared*. The chevalier produces the finest and heaviest grain, weighing usually from 54 ℔ to 56 ℔ per bushel, and is in high estimation with maltsters.

---

[1] Mr Lawes continues these experiments of growing successive crops of wheat year after year on the same site, with no material change in the results after a trial of thirty years.

It is also tall and stout in the straw, which is less liable to lodge than that of the common barley; and when this accident does happen, it has the valuable property of not producing aftershoots or greens. It requires about fourteen days longer than the common-early to reach maturity, but as it admits of being sown earlier than the latter sort, this is in practice no drawback to it. The Annat barley resembles the chevalier in its leading features, but is yellower in its complexion, and not quite so round in the grain. It ripens a few days earlier than the chevalier, and in our own experience is more productive. The common-early is more liable than those just noticed to suffer from over-luxuriance. It is generally used for the latest sowings on those portions of land from which the turnip crop has been longest in being removed.

In the elevated or northern parts of the kingdom, four-rowed barley, usually called *bere* or *bigg*, is cultivated, as it is more hardy, and ripens earlier than the two-rowed variety. A new variety, called Victoria bere, is said to be so productive, and to yield such a heavy sample, as to be worthy of cultivation even in lowland districts.

Barley delights in a warm, friable soil, and thrives best when the seed is deposited rather deeply in a tilthy bed. Being the grain crop best adapted for succeeding turnips that have been consumed by sheep-folding, advantage must be taken of favouring weather to plough up the land in successive portions as the sheep-fold is shifted. So much of it as is ploughed before 1st February will usually get so mellowed by the weather as to be easily brought into suitable condition for receiving the seed. In Scotland the usual practice is to sow broadcast on this stale furrow, and to cover the seed by simple harrowing. A better way is first to level the surface by a stroke of the harrows, and then to form it into ribs *twelve* inches apart by such an implement as has been described when speaking of Tennant's grubber. Over this corrugated surface the seed is sown broadcast, and covered by another turn of the harrows. The ribbing loosens the soil, gives the seed a uniform and sufficient covering, and deposits it in rows. The only advantage of such ribbing over drilling is, that the soil is better stirred, and the seed deposited more deeply, and less crowded than is done by the ordinary drills. It is certainly of great advantage to have the seed-corn deposited in narrow lines, so far as the working of the horse-hoe is concerned; but we are convinced that stiffer stems, larger ears, a more abundant yield, and a brighter sample, are likely to be obtained when the seed is loosely scattered in a channel three or four inches wide than when crowded into a narrow line. This grain is now sown considerably earlier than heretofore. When the soil is enriched by plentiful manuring, its temperature raised by thorough draining, and the climate and exposure favourable, it should be sown as early in March as possible, and will often do remarkably well although sown in February. This early sowing counteracts that tendency to over-luxuriance by which the crop is so often ruined in fertile soils. It is chiefly owing to this early sowing (although aided by the use of hummelling machinery) that the average weight of barley is so much greater now than it was thirty years ago. From 54 lb to 56 lb per bushel is now about the average weight in well-cultivated districts; while 57 lb and 58 lb is by no means rare. The produce per acre ranges from 30 to 60 bushels, 36 bushels being about the average. The quantity of seed used per acre is from 2½ to 3 bushels for broadcast sowing, and about a third less when drilled. As already remarked in regard to wheat, it is well, as the season advances, to avoid, by a fuller allowance of seed, the temptation to excessive tillering, and consequent unequal and later ripening. A good crop of barley yields about 1 ton each per acre of grain and straw.

Section 3.—Oats.

Over a large portion of England oats are grown only as provender for horses, for which purpose they are fully ascertained to be superior to all other grains. Except, therefore, on fen-lands and recently-reclaimed muiry soils, the cultivation of oats in South Britain bears a small proportion to the other cereals. It is in Scotland, "the land o' cakes," that this grain is most esteemed and most extensively cultivated. Considerably more than half of the annual grain crops of Scotland consists, in fact, of oats. The important item which oatmeal porridge forms in the diet of her peasantry, and of the children of her other classes, has something to do with this extensive culture of the oat; but it arises mainly from its peculiar adaptation to her humid climate. As with the other cereals, there are very numerous varieties of the oat in cultivation. In Messrs Lawson's *Synopsis of the Vegetable Products of Scotland*, it is said (Div. i. p. 80), "Our collection comprises nearly sixty varieties, about thirty of which are grown in Scotland; but of these not more than twelve are in general cultivation. These twelve varieties, enumerated in the order of their general cultivation, are, the Potato, Hopetoun, Sandy, Early-Angus, Late-Angus, Grey-Angus, Blainslie, Berlie, Dun, Friesland, Black Tartarian, and Barbachlaw." The first four kinds in this list are those chiefly cultivated on the best class of soils. It is to the produce of these that the highest market prices usually have reference. The weight per bushel of these sorts usually runs from 42 lb to 46 lb. From 50 to 60 bushels per acre is a usual yield of oats. The two last named kinds are chiefly esteemed for their large produce, and adaptation to inferior soils; but being of coarse quality, they are chiefly used for provender. A variety which stands the winter is now frequently grown in England, for the double purpose of first yielding a seasonable supply of green food to ewes and lambs in early spring, and afterwards producing a crop of grain. It has already been stated that in Scotland wheat does not prosper when sown after clover or pasture; but with the oat it is quite the reverse, as it never grows better than on land newly broken up from grass. It is, accordingly, almost invariably sown at this stage of the rotation. The land is ploughed in December or January, beginning with the strongest soil, or that which has lain longest in grass, that it may have the longest exposure to the mellowing influences of wintry weather. In March or April the oats are sown broadcast on this first ploughing, and covered in by repeated harrowings. These are given lengthwise until the furrows are well broken down, for if the harrows are worked across the ridges before this is effected, they catch hold of the edges of the slices, and, partially lifting them, permit the seed-corn to fall to the bottom, where it is lost altogether. As it is only when a free tilth is obtained that the crop can be expected to prosper, care must be taken to plough early and somewhat deeply, laying the furrows over with a rectangular shoulder, to sow when the land is in that state of dryness that admits of its crumbling readily when trode upon, and then to use the harrows until they move smoothly and freely in the loose soil, two or three inches deep. The Norwegian harrow is an important auxiliary to the common ones in obtaining this result. When wild mustard and other annual weeds abound, it is advisable to drill the crop and to use the horse-hoe. When the land is clean, the general belief in Scotland is that the largest crops are obtained by sowing broadcast. When the latter plan of sowing is adopted, from 4 to 6 bushels per acre is the quantity of seed used. The latter quantity is required in the case of the Hopetoun and other large-grained varieties. The condition of the soil as to richness and friability must also be taken into account in deter-

mining the quantity of seed to be used. When it is in high heart and likely to harrow kindly, a less quantity will suffice than under opposite conditions. In breaking up a tough old sward, even 6 bushels per acre may be too little to sow. The following very interesting experiment bearing on this point was made in the county of Fife:—"Mr Gulland, Wemyss, offered a sweepstakes in 1850, that 4 bushels of oats, sown per Scotch acre, in poor land, would yield a better produce than 8 bushels sown under similar conditions. The late Mr Hill, maintaining the contrary, accepted the sweepstakes, and a number of others took up the same. Experiments were made by Mr Dingwall, Ramornie, and Mr Buist, Hattonhill. . . . . :—

In Mr Buist's experiments,
"4 bush. sown yielded 28 bush. per acre, 34 lb per bush.
8 bush. sown yielded 36 ,, ,, 34¼ lb ,,

"In Mr Dingwall's experiments,
"4 bush. sown yielded 45 bush. per acre, 38¼ lb per bush.
8 bush. sown yielded 49 ,, ,, 39 lb ,, "[1]

The advocates for thin seeding will of course regard even the least of these quantities as foolishly redundant. It is quite true, that if the land is in good heart, the crop will ultimately stand close on the ground from a very small seeding; but it will take two or three weeks longer to do this than if the land had been fully stocked with plants from the first, by giving it seed enough. In our precarious climate, where a late harvest and bad crops usually go together, it is of the utmost importance to secure early, uniform, and perfect ripening; and as liberal seeding tends directly to promote such a result, practical farmers will do well to take care how they omit such a simple means of attaining so important an end. We believe that it is on the principle now indicated that the superior result, both as respects quantity and quality of produce, in the double-seeded lots in the experiments now cited, is to be explained.

As with wheat, the vigour and productiveness of the oat is much enhanced by frequent change of seed. Our agricultural authorities usually assert that the change should, if possible, always be from an earlier climate and better soil. This is undoubtedly true as regards high-lying districts; but with a good soil and climate we have always seen the best results with seed from a later district. A homely old couplet tersely expresses the experience of our ancestors in this matter of the changing of seed-corn by directing us to procure—

"Oats from the hills, bere from the sea,
Gude wheat and pease wherever they be."

On poor hard soils it is usually remunerative to apply a cwt. of guano per acre to the oat crop, sowing it broadcast, and harrowing it in along with the seed. As much additional produce is thus ordinarily obtained as more than pays for the manure, and the land is, in all respects, left in better condition for the succeeding green crop. In the case both of very light and strong clay soils, we have obtained excellent results by applying a liberal dressing of farm yard dung in autumn to grass-land about to be broken up for oats. By using in this way the dung produced during the summer months, we have obtained abundant crops of oats from portions of land which, but for this, would have yielded poorly; and, at the same time, by applying the bulky manure at this stage of the rotation, instead of directly for the succeeding green crop, an important saving of time and labour has been effected, as we shall have occasion to notice when treating of turnip-culture.

When the young oat plants have pushed their second leaf, it is always beneficial to use the roller, as it helps to protect the crop from the evil effects of drought, and facilitates the reaping of it. The oat frequently suffers much from a disease called "segging" or "tulip root," which appears to be caused by the presence of a maggot in the pith of the stems close to the ground. On land which is subject to this disease it is advisable not to sow early. A dressing of lime is also believed to be serviceable as a preventative. On muiry soils this crop is also not unfrequently lost by what is called "*slaying*." This seems to result from the occurrence of frosty nights late in spring, when the crop is in its young stage, which, when grown on such soils, it cannot withstand. The application of large dressings of lime to light muiry soils greatly aggravates this tendency to *slaying* in the oat crop. The only effectual remedy is to improve the texture of the soil by a good coating of clay. Oats yield about 1 ton of grain and 1½ ton of straw per acre.

Section 4.—Rye.

The extensive cultivation of this grain in any country being alike indicative of a low state of agriculture, and of a poor style of living among its peasantry, it must be regarded as a happy circumstance that it has become nearly obsolete in Great Britain. It is still occasionally met with in some of our poorest sandy soils, and patches are occasionally grown elsewhere for the sake of the straw, which is in estimation for thatching, for making bee-hives, and for stuffing horse-collars. Its cultivation as a catch crop, to furnish early food for sheep in spring, is on the increase.

Section 5.—LEGUMINOUS CROPS—*Beans.*

The only members of this family statedly cultivated for their grain are beans and pease. Before the introduction of clover and turnips these legumes occupied a more important place in the estimation of the husbandman than they have done since. Indeed, in many districts naturally well adapted for the culture of turnips, that of beans and pease was for a time all but abandoned. Recently, however, increasing precariousness in the growth of clover, and even of turnips, where they have been sown on the same ground every fourth year for a lengthened period, has compelled farmers to return to the culture of beans and pease for the mere purpose of prolonging the intervals in the periodic recurrence of the former crops. But it is found, in regard to the bean itself, in districts where it has long occupied a stated place in rotations of six or seven years, that its average produce gradually diminishes. We have thus an additional illustration of the importance of introducing as great a variety of crops as possible into our field culture. It is on this principle that beans and pease are now again extensively cultivated on dry friable soils. Winter beans, or pease of some early variety, are generally preferred in such cases. The grain of these legumes, though partially used for human food, is chiefly consumed by horses and by fattening cattle and sheep. Being highly nutritious, they are well adapted for this purpose. By growing beans on a limited portion of the land assigned to cattle crops, a larger weight of beef and mutton can be produced from a given number of acres, than by occupying them wholly with roots, forage, and pasturage. Several varieties of field beans are cultivated in Great Britain, such as the *common horse bean*, the *tick*, the *Heligoland*, and the *winter bean*. The latter was introduced into England about the year 1825, and there rises steadily in estimation. It has been tried in many parts of Scotland, and proves quite hardy, but is objected to from the exceeding shortness of its straw. But for this, it is a valuable acquisition, as it ripens so much earlier than the spring-sown varieties. Beans should never be sown on land that is foul. By diligent horse and hand hoeing, land that is clean to begin with can be kept so under beans, and left in fine condition for carrying a white

[1] *Agricultural Gazette*, 20th November 1852.

corn crop; but in opposite circumstances it is sure to get into utter confusion. It is found advisable, therefore, to take beans after the white crop that has succeeded roots or a bare fallow. In Berwickshire, where a five-years' course, consisting of turnips, wheat, or barley, two years' seeds, and oats, has long prevailed, beans are now not unfrequently introduced by substituting them for the second year's grass. A four-years' course with beans instead of a portion of the seeds is certainly preferable. In cultivating this crop the land is ploughed with a deep furrow in autumn, a dressing of dung being first spread over the surface and turned in by the plough. As early in March as the state of the soil admits, it is stirred by the grubber and harrowed. The seeds are then deposited either in narrow rows 14 inches, or in wider rows 27 inches apart. The latter width has long been preferred in Scotland, because of its admitting of the free use of the plough and the drill-grubber, in addition to the hoe, during the early stages of the plant's growth, and also from a belief that the free entrance of light and air, of which the wide rows admits, increases the productiveness of the crop. We shall describe both modes of culture, and then state the grounds upon which, after long sharing in the opinion just noted, and following that practice, we now give a decided preference to sowing in narrow rows. In sowing at the wider intervals, the soil, having been prepared as already stated, is formed, by a single turn of the common plough, into shallow drills 27 inches apart. Ten or twelve such drills being formed to begin with, the seed is scattered broadcast, at the rate of 3 bushels per acre, by a sower who takes in six of these drills at a time, and gives them a double cast, or by a drilling-machine, which sows three rows at once. The beans either roll into the hollows as they fall, or are turned in by the ploughs, which now proceed to open each a fresh drill, in going down the one side of the working interval, and to cover in a seeded one in returning on the other side. If tares are cultivated on the farm, it is usual to sow a small quantity (say a peck per acre) amongst the beans, on which they are borne up, and so ripen their seeds better, and yield more abundantly, than when trailing on the ground. When the crop comes to be thrashed the tares are easily separated from the beans by sifting. Ten days or so after sowing, the drills are partially levelled by a turn of the chain harrow; and if the land is cloddy, it is smoothed by a light roller. If showers occur when the bean plants are appearing above ground, or shortly after, the common harrows may be used again with the best effect in pulverising the soil and destroying newly-sprung weeds. A horse and hand hoeing is then given, and is repeated if weeds again appear. When the plants have got about 6 inches high it is beneficial to stir the soil deeply betwixt the rows by using Tennant's grubber, drawn by a pair of horses. For this purpose the tines are set so close together as to clear the rows of beans, and the horses are yoked to it by a main tree, long enough to allow the horses to work abreast in the rows on either side of the one operated upon. The soil is thus worked thoroughly to the depth of 6 or 8 inches, without reversing the surface and exposing it to drought, or risk of throwing it upon the plants. Just before the blooms appear some farmers pass a bulking-plough betwixt the rows, working it very shallow, and so as merely to move the surface soil towards the plants. This may do good, but a deep earthing up is hurtful. When the blooms open all operations should cease, as otherwise much mischief may be done. Such an amount of culture as has now been described may be thought needlessly costly and laborious, but unless a bean crop is kept clean, it had better not be sown. And it is to be remembered that the benefit of this careful tillage is not confined to it, but will be equally shared in by the wheat crop that follows. The culture of winter beans differs only in this, that they require to be sown as early in autumn as the removal of the preceding grain crop admits of. When it is determined to sow in 14-inch rows, the seeds are deposited by any of the corn drilling-machines in common use, set for the specified width of rows, or (which we prefer) the soil is formed into narrow ribs or drills by means of the one-horse plough, the seeds are scattered broadcast by hand or machine over this corrugated surface, and they are covered by a double turn of the common harrows, and rolled by a light roller. As soon as the bean plants appear, care must be taken to keep down weeds by diligent hoeing. Two good hoeings will usually suffice, for by the time that the second is accomplished, the crop will speedily so close in as to render any further hoeing impracticable and unnecessary. After repeated trials of these two modes of cultivation, made alongside of each other, we have found that the produce from the narrow rows has been at the rate of from 4 to 6 bushels more per acre than that from the wide rows, and that the soil has been left decidedly cleaner after the former than after the latter mode. It is certainly somewhat startling to find results so opposed as these are to preconceived opinion and approved practice. And yet, when the matter is well considered, it becomes obvious enough why it should be so. The wide rows admit of a most effective process of tillage and hoeing up to the time when the beans come into bloom, when, however, it must wholly cease. But when farther culture is precluded, the need for it by no means ceases, seeing that the rows of bean plants usually remain sufficiently apart to admit of the continued growth of weeds during the long period which intervenes betwixt the blooming and the ripening of the crop. And hence it happens—especially if the spring prove cold and parching—that although the wide-rowed beans have been kept scrupulously clean up to the time of blooming, their upright habit of growth renders it impossible that they can so close in upon the wide space betwixt the rows, as to preoccupy and overshadow the ground sufficiently to keep it clean during the long period that the crop must necessarily be left to its own resources. By sowing in narrow rows the crop is soon in a condition to defend itself against weeds and drought, and hence the saving of labour, the more bulky crops, and the cleaner stubble, which result from sowing beans at 14 rather than 27 inch intervals.

In Scotland the haulm of beans is esteemed an excellent fodder for horses and other live stock, whereas in England it is thought unfit for such a use. The reason of this appears to be, that in the southern counties beans are allowed to stand until the leaf is gone and the stems blackened before reaping; whereas in Scotland they are reaped so soon as the eye of the grain gets black. When well got, the juices of the plant are thus, to some extent, retained in the haulm, which in consequence is much relished by live stock, and yields a wholesome and nutritious fodder. A good crop of beans yields about 1 ton of grain and 1½ ton of straw per acre.

Section 6.—Pease.

Pease are sown in circumstances similar to those just detailed, but they are better adapted than beans to light soils. They too are best cultivated in rows of such a width as to admit of horse-hoeing. The early stage at which they fall over, and forbid further culture, renders it even more needful than in the case of beans to sow them only on land already clean. If annual weeds can be kept in check until the pease once get a close cover, they then occupy the ground so completely that nothing else can live under them; and the ground, after their removal, is found

in the choicest condition. A thin crop of pease should never be allowed to stand, as the land is sure to get perfectly wild. The difficulty of getting this crop well harvested renders it peculiarly advisable to sow only the early varieties

Section 7.—Other Crops.

The cereals and legumes now enumerated constitute the staple grain-crops of Great Britain. Others are grown occasionally, but more for curiosity than profit. Zealous attempts were made by the late William Cobbet to introduce *maize* or *Indian corn* as one of our regular crops. It has been conclusively proved that none of its varieties yet tried can be ripened in the ordinary seasons of this country. It has indeed been suggested that it might form a useful addition to our garden vegetables,—using it, as it is done in America, by cooking the unripe cobs, and also that we might grow it beneficially as a forage crop. *Lentiles* have recently been grown in different parts of the country; but both of these grains can be imported of better quality, and at less cost, than they can be grown at home.

There is great inducement to agriculturists to endeavour more earnestly to obtain improved varieties of grain by cross-impregnation of existing ones. Something has already been accomplished in this direction, but only enough to show what encouragement there is to persevere. Whenever the same skill and perseverance are directed to the improvement of field crops that our gardeners are constantly exerting, with such astonishing results, on fruits, flowers, and vegetables, we may anticipate a great increase of produce, not only from the discovery of more fruitful varieties, but of such as possess a special adaptation to every diversity in the soil and climate of our territory.

Section 8.—Harvesting of Grain Crops, and preparing them for Market.

Several distinct modes of reaping grain are in use. The most ancient, and still the most common, is by the sickle or reaping-hook, which is used either with a smooth or serrated edge. The latter was at one time preferred, as by it the work was performed most accurately. The smooth-edged instrument is, however, now the favourite, as it requires less exertion to use it, and the reaper can, in consequence, get through more work in a day; and also because in using it the stalks are less compressed, and consequently dry faster when made into sheaves. In some parts of England the crops are reaped in a method called *fagging* or *bagging*. The cutting instrument used is heavier, straighter, and broader in the blade than the common reaping-hook. The workman uses it with a slashing stroke, and gathers the cut corn as he proceeds by means of a hooked stick held in his left hand. It is a similar process to the mode of reaping with the Hainault scythe—an instrument which has been tried in this country, but never adopted to any extent. The common scythe, especially with that form of handle known as the Aberdeen handle or *sned*, is very extensively used for reaping grain in all parts of the kingdom. Indeed, the practice of mowing grain has been increasing of late years, and would extend more rapidly but for the greater difficulty of finding good mowers than good reapers. A greater amount of dexterity is required to cut grain well by the scythe than by the sickle. The difficulty lies not in making smooth and clean stubble, but in so laying the swathe as to admit of the corn being sheaved accurately. When the mower lays his swathe at right angles to his line of progress, and the gatherer is skilful and careful, corn may be handled as neatly in reaping by the scythe as by the sickle. When the crops are not much laid or twisted, mowing is somewhat the cheapest of these modes of reaping. Its chief recommendation, however, is that mown sheaves dry most quickly, and suffer least from a drenching rain. This arises from the stalks being less handled, and so forming an open sheaf, through which the wind penetrates freely. Tightly bound sheaves are always difficult to dry.

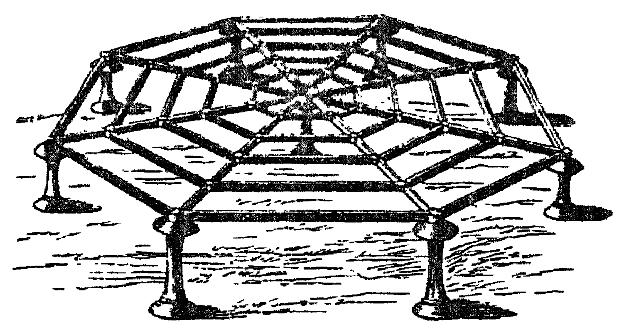
In Berwickshire and adjoining counties the reaping of the crops has hitherto been accomplished by employing, at day's wages, such a number of reapers as suffices to cut down the crops on each farm in from twelve to twenty days. The rate of wages paid to reapers for a number of years has ranged from 2s. 6d. to 3s. 6d. each *per diem*, with victuals in addition, costing about *eightpence* for each person. In marshalling the band, two reapers are placed on each ridge of 15 or 18 feet in breadth, with a binder to each *four* reapers, and a steward, or the farmer in person, to superintend the whole. When the crop is of average bulk, and lies favourably for reaping, each *bandwin*, or set of *four* reapers and a binder, clear *two* acres in a day of ten hours, but $1\frac{1}{4}$ to $1\frac{1}{2}$ acre only, if it is bulky and lodged. The cost of reaping by this method is therefore from 10s. to 15s. per acre. With a reaping-machine cutting say six acres *per diem*, and requiring in all ten persons (five men and five women or stout lads) to attend to and clear up after it, at an average wage, including victuals, of 3s. each, and allowing 3s. *per diem* to cover tear and wear, and interest on its prime cost, there seems a reasonable prospect of a goodly portion of our future crops being reaped for about 6s. per acre. The labour of the horses employed in working the reaper is not included in this estimate, as at this season they would otherwise be idle, and yet eating nearly as much food as when at work. There would thus be a saving in actual outlay of about 5s. per acre. But this is the least important view of the matter. On a Berwickshire farm producing 200 acres of crop, there are usually at least six pairs of horses kept, with a resident population sufficient to yield about thirty persons (including women and youths) available for harvest labour. The stated forces of such a farm will therefore suffice to man *three* reaping-machines, which, if the weather is favourable, and the crops standing erect or lying in one direction, will cut down the crop in about ten days. When portions of the crop are much lodged and twisted, it becomes necessary to employ part of the labourers in clearing out such portions by the scythe or sickle. It is often possible to manage these awkward-lying portions by setting one or more men, each with a stout staff, to raise up the crop and lay it towards the machine. When two or more machines are used on the same farm, it is best to work them together by cutting the whole length or width of the field in whichever direction the general lay of the crop admits of them working to most advantage. As each machine completes its cut, it returns empty to the side from which it started; and they follow each other at such an interval as gives time to the lifters and binders, who are placed equidistant along the whole line, to keep the course clear. In such cases a man is usually employed to sharpen the spare knives, to assist in changing them from time to time, and to attend to the oiling and trimming of the whole machinery. It is good economy to have a spare machine at hand ready to put in the place of one that may be disabled by some breakage, and thus avoid interruption to the urgent work of reaping while the damage is being repaired. Great progress has been made in recent years in working these machines skilfully and systematically; they are in general use in all well-cultivated districts, and the time appears to be at hand when the whole grain crops of the country will be reaped by means of them.

It is now agreed on all hands that grain should be reaped before it becomes what is called *dead* ripe. In the case of wheat and oats, when the grains have ceased to yield a

milky fluid on being pressed under the thumb-nail, and when the ears and a few inches of the stem immediately under them have become yellow, the sooner they are reaped the better. Barley requires to be somewhat more matured. Unless the pink stripes on the husk have disappeared, and the grain has acquired a firm substance, it will shrink in drying, and be deficient both in weight and colour. When allowed to stand till it gets curved in the neck, the straw of barley becomes so brittle that many ears break short off in the reaping, and it then suffers even more than other grain crops under a shaking wind.

It is of great consequence to see that corn is dry when it is tied up in sheaves, that these are not too tightly bound, and that every sheaf is kept constantly on foot. From the increased demand for harvest labourers, and the rapidity with which operations must be carried forward, stooking is not now performed with the same accuracy that it was wont to be. There is therefore the greater need for employing a person to review the stooks daily, and keep every sheaf erect. It was formerly the practice in Scotland to set up oats and barley in full stooks of twelve sheaves each, viz., five pairs and two hood-sheaves. These hood-sheaves are an excellent defence when wet weather sets in, but they retard the drying of the corn in fine weather, and there are now few binders who can set them up so as to stand securely. It is better, therefore, to aim at rapid drying, and for this purpose to have the sheaves small individually, and to set but *four* or *six* of them together. Large sheaves are worse to dry than small ones, not only from their greater bulk, but from their being almost inevitably tighter bound. The utmost vigilance is required on the part of farmers to avoid this fault. Beans and pease are reaped by the sickle. The former are usually not bound into sheaves at once, but left prostrate in handfuls for a few days until they have withered a little. But it is on the whole safer to stook them as they are reaped. They are then sheaved and bound with ties of twisted straw, which must be provided beforehand. In stacking beans, the tops of the sheaves are kept outwards, as by this means fewer pods are exposed to the weather, or to the depredations of fowls, &c., than when the butts are to the outside. Pease are rolled into wisps as they are reaped, and afterwards turned daily until they are fit to carry. When stacked, they must instantly be thatched, as they take in wet like a sponge. It requires no little discrimination to know when sheaves are dry enough to keep in a stack. The farmer finds it for his profit to consult his most intelligent and experienced labourers on this point. On thrusting the hand into a sheaf sufficiently dried, there is a lightness and kindliness to the touch not easily mistaken when once understood. Whenever this is ascertained, the crop is carried with the utmost possible dispatch. This is best accomplished by using one-horse carts, and by building the sheaves into round stacks of *ten* or *twelve* loads each. Very large stacks are for ostentation, not for profit. The labour of pitching up the sheaves to them is needlessly great; corn is much sooner in a state to keep in small stacks than in large ones, and sooner gets into condition for market; the crop is more accessible for thrashing in *ten* load quantities than in huge ricks; and the crop of different fields and kinds of grain more easily kept separate. While naming ten or twelve loads as a convenient quantity to put together in each stack, let it be observed that this assumes the sheaves to be in a thoroughly dry condition; for in wet seasons it frequently happens that the sheaves have a sufficient degree of dryness to keep safely in stacks of five or six loads each, although they will certainly heat if double these quantities are put together. Judicious farmers therefore accommodate the size of their stacks to the condition of the sheaves, and are more concerned to get their crops secured rapidly and safely than to have their stacks of uniform size. For the same reasons, it is often expedient to stack portions of the crop either in the field where it grew or at some convenient site nearer than the homestead, but on the way towards it, and where two carts will suffice to keep each stacker in work. An incidental benefit from having the stacks in detached groups is, that it lessens the risk from fire.

It is always desirable to have the stacks built upon frames or stools elevated 18 or 20 inches from the ground. Besides the security from vermin thus attained, there is a free admission of air to every part, particularly when aided by a triangle of rough timber in the centre, which speedily insures thorough dryness in the whole stack. When stacks are built upon the ground with a mere bedding of straw under them, the grain from the basement tiers of sheaves is often lighter by several pounds per bushel than that from the rest of it. A farmer who has his rick-yard fully furnished with these frames can often carry his crop without risk—when, if built on the ground, it would inevitably heat—and have the grain in condition for market earlier by months than in the latter case. As the stacks are built,



Young's Stack-Stool.

they are thatched without delay. For this purpose, careful farmers provide beforehand ample stores of thatch and straw ropes. The thatch is not elaborately drawn, but merely straightened a little as it falls from the thrashing-mill, tied into large bundles, and built up into stacks, where it gets compressed, and so lies more evenly than if used direct from the mill. A good coating of such thatch secured by straw ropes, interlacing each other in chequers, forms a secure and cheap covering, easily put on by ordinary farm labourers, and possesses, with all its roughness, an air of unpretending rustic neatness which harmonises well with surrounding objects, and which we greatly prefer to the elaborate ricks of the southern counties with their shaved sides, combed thatch, and weather-cock a-peak. Apart from its cost, the shaving of stacks is objectionable, as they then suffer more from a beating rain or snow-drift than when the natural roughness is left upon them, on the same principle that a coarse, shaggy topcoat shoots off wet better than a smooth broadcloth. A stout two-ply cord made of cocoa-nut fibre, or coir, is coming into use as a substitute for straw ropes in the thatching of stacks.

With proper machinery propelled by steam or water, the thrashing and dressing of grain is a simple and inexpensive process. As grain is now universally sold with a reference to its weight per bushel, its relative value depends much upon its dryness and thorough freedom from chaff, dust, light grain, and seeds of weeds. Farmers who are systematically careful in the cultivation, harvesting, thrashing, and dressing of their crops, can always command the best prices of the day. In preparing a parcel of grain for market, it is a good plan to measure a few sacks very carefully, ascertain the average weight of these, and then fill every remaining sack to that weight exactly.

CHAPTER XII.

CULTIVATED CROPS—ROOT CROPS.

Section 1.—*Potato.*

The events of late years render it necessary to regard this root somewhat differently than was warranted by its previous history. Its value as an article of food, relished alike by prince and peasant, its easy culture, its adaptation to a very wide diversity of soil and climate, and the largeness of its produce, justly entitled it to the high esteem in which it was universally held. Like many other good gifts, it was, however, grossly abused, and diverted from its legitimate use; and advantage was taken of its amazing productive powers to elevate it from the place of an agreeable, wholesome addition to the daily food of the community to that of "the staff of life." In Ireland and the Highlands of Scotland, the people, already in a painfully degraded condition, and contented with the potato as their sole food all the year round, took occasion, from its very productiveness, under the rudest culture, to subdivide their lands, and marry prematurely, with reckless improvidence, and amid an ever-deepening degradation. We know now, from the utter prostration and helplessness into which this wretched population was at once thrown by the memorable potato disease, the terrible penalty which this abuse of "a good gift" has brought directly on the miserable sufferers, and indirectly on the whole community. It will be well if the stern lesson, enforced by famine and pestilence, have the effect of leading to a better social condition. Viewed in this light, the potato disease may yet prove a blessing to the nation. Its continued prevalence, although in a mitigated form, cannot well be regarded otherwise, when we remember the frantic eagerness with which the Irish peasantry replanted their favourite root on the first indication of its returning vigour, and the desperate energy with which they cling to it under repeated disappointments. Apart from this speciality, the precarious health of this important esculent is much to be regretted. It seems contrary to analogy to suppose that it is likely either to be entirely lost or to manifest a permanent liability to disease. It seems more natural to suppose that by-and-by the disease will disappear, or that some efficient remedy for it will be discovered. Railways afford great facilities for transporting this bulky commodity at little expense to great distances, and thus render the market for it available to a wider district. Apart from disease, this facility of transport would naturally insure its more extended cultivation. This enlarged cultivation of a crop which, to be grown successfully, requires a soil rich in fertilising matters, has moreover been rendered practicable by the facilities which the farmer now has of obtaining guano and other portable manures.

The varieties of the potato, whether for garden or field culture, are exceedingly numerous, and admit of endless increase by propagating from seeds. It would serve no useful purpose to enumerate here even a selection from the sorts in use in different parts of the country. In Messrs Lawson's *Synopsis of the Vegetable Products of Scotland* a description of 175 kinds is given, to which the reader is referred for particulars. When the crop is grown for cattle food, bulk of produce will be the primary consideration; but for sale or family use, flavour, keeping quality, and handsome appearance, will be particularly attended to. Exemption from disease is now a momentous consideration, whatever the use for which it is grown. There is this difficulty, however, connected with selections on the score of healthiness, that while in each season since the disease broke out certain varieties have escaped, it is observed from year to year that the exempted list varies, certain kinds that had been previously healthy becoming as obnoxious to disease as any, and others in a great measure escaping that had suffered much before. Indeed, certain parties, from observing that diseased tubers left in the ground have produced healthy plants in the following season, have been induced purposely to plant diseased potatoes, and with good results. This, however, is probably due to the mere fact of their being kept in the earth.

In field culture the potato is frequently grown on a portion of the fallow break; but its appropriate place in the rotation is that usually assigned to beans, with which, in an agricultural point of view, it has many features in common, and in lieu of which it may with advantage be cultivated. As the potato requires to be planted as early in spring as the weather will admit of, thus leaving little opportunity for cleaning the land, and as its mode of growth forbids any effective removal of root-weeds by after culture, it is peculiarly necessary to have the land devoted to this crop cleaned in autumn. Winter dunging facilitates the planting, and is otherwise beneficial to the crop by producing that loose and mellow condition of the soil in which the potato delights. The quality of the crop is also believed to be better when the dung is thoroughly incorporated with the soil, than when it is applied in the drill at the time of planting. A liberal application of manure is necessary if a full crop is expected. The rank growth thus induced renders it, however, more obnoxious to the blight, and hence at present it is more prudent to aim rather at a sound crop than an abundant one, and for this purpose to stint the manure. When it is applied at the time of planting, the mode of procedure is the same as that which will presently be described in the section on turnip culture. The potato sets are prepared a few days before they are expected to be needed. Tubers about the size of an egg do well to be planted whole; and it is a good plan to select these when harvesting the crop, and to store them by themselves, that they may be ready for use without further labour. The larger tubers are cut into pieces having at least one sound eye in each, although two are better. It is of great consequence to have seed-potatoes stored in a cool and dry pit, so that if possible they may be prepared for planting before they have begun to shoot. If there has been any heating in the pit, the potatoes are found to be covered by a rank crop of shoots, which are necessarily rubbed off, and thus the most vigorous eyes are lost, and much of the substance which should have nourished the young plant is utterly wasted. A sufficient number of dormant eyes are no doubt left, but from the comparatively exhausted state of the tubers, these produce stems of a weaker and more watery character, and more liable to disease than those first protruded. To avoid these evils, gardeners are at pains to invigorate their seed potatoes and husband their whole powers for early and vigorous growth by *greening* them in autumn, storing them in a cool place with a current of air passing through it, and then in early spring exposing them to light on a floor, whence they are carefully removed and planted with their short *green* shoots unbroken. Neither the *greening* nor the sprouting under cover and in the light can ordinarily be practised on the scale on which the field culture of the potato is conducted. But the important feature in it, viz., so treating potatoes intended for seed that the crop shall be produced from the first and most vigorous shoots, and that these shall obtain the full benefit of the natural pabulum stored up for their use in the parent tuber, should be carefully considered and imitated if possible in field culture.

The report of the meeting of the Edinburgh Botanical Society, on 8th January 1852, bears that "Professor Simpson communicated the results of some experiments made by himself and Mr Stewart relative to the growth of alpine plants after having been kept artificially covered

with snow in an ice-house for many months. Seeds and plants when kept in this way during winter, and then brought into the warm air of summer, germinate and grow with great rapidity. Mr Stewart had also made experiments with animals, and he found that the chrysalis so treated produced a moth in eleven days after being brought into the atmosphere, while another chrysalis of the same moth did not do so for three or four months after. In arctic regions the rapid growth of plants during the short summer was well known. Professor Simpson alluded to the importance of similar experiments being made on the different kinds of grain. He referred to the rapidity of harvest in Canada and other countries where the cold lasted for many months, and he was disposed to think that if grain was kept in ice-houses during the winter, and sown in spring, there might be an acceleration of the harvest."

The suggestion for the treatment of seed corn is certainly deserving of trial; but the known difficulty of hindering the premature germination of potato sets in the ordinary method of storing them seems to point to them as the peculiarly appropriate subjects of such an experiment.

Potato drills should not be less than 30 inches wide, nor the sets less than 10 or 12 inches apart in the rows. The usual practice is to take the sets to the field in sacks, which are set down at convenient distances for replenishing the baskets or aprons of the planters. When a large breadth is to be planted, a better way is to have the sets in carts, one of which is moved slowly along in front of the planters. A person is seated in the cart, who has by him several spare baskets which he keeps ready filled, and which are handed to the planters in exchange for empty ones as often as required. This greatly economises the time of the planters, and admits of a greater amount of work being accomplished by them in a day. Single-bout drills are quite sufficient, so far as the success of the crop is concerned. So soon as the young potato plants are fairly above ground, the drill-grubber should be set to work and followed up without delay by hand-hoeing. Mr Wallace, North Berwick Mains, a most successful cultivator of potatoes, has for many years taken off all the shoots, save one, from the potato sets as they appear above ground, and the prunings are used in filling up blanks; the result has been that the produce of the solitary stem is both larger and of more equal size and quality than when the shoots are all left. A turn of the horse-hoe and another hand-hoeing after a short interval are usually required, after which the common practice is to earth up the rows by the double mould-board ploughs. There is reason to believe that this latter practice usually does harm rather than good. It no doubt prevents the uppermost tubers from getting greened by exposure to the light, but it is believed that the injury inflicted on the roots which spread into the intervals betwixt the rows far more than counterbalances any benefits that result, or have been supposed to result, from this earthing up. After the plants are a foot high, a slight stirring of the surface to keep down weeds is all the culture that is admissible consistently with the well-doing of the crop.

When the crop is matured, which is known by the decay of the tops and the firmness of the epidermis when the tubers are forcibly rubbed by the thumb, advantage is taken of every dry day in harvesting the crop. With small plots, the fork is certainly the most efficient implement for raising the tubers; but on the large scale, when expedition is of great consequence, they are always unearthed by the double mould-board plough. Alternate rows are split open in the first instance, and then the intervening ones, as the produce of the first is gathered. When a convenient breadth has thus been cleared, a turn of the harrows is given to uncover such tubers as have been hid from the gleaners at the first going over. This work is now very generally accomplished by means of a bulking-plough divested of its wings, and having attached to its sole a piece of iron terminating in radiating prongs. This being worked directly under the row of potato plants, unearths the tubers, and spreads them on the surface by one operation. The potatoes are gathered into baskets, from which they are emptied into carts and conveyed at once to some dry piece of ground, where they are piled up in long narrow heaps and immediately thatched with straw. The base of the heaps should not exceed a yard in width, and should be raised above the surface level rather than sunk below it, as is very usually done. As the dangers to be guarded against are *heating* and *frost*, measures must be taken with an eye to both. The crop being put together in as dry and clean a state as possible, a good covering of straw is put on, and coated over two or three inches thick with earth, care being taken to leave a chimney every two yards along the ridge. By thus keeping the heaps dry and secure from frost, it is usually possible, even yet, to preserve potatoes in good condition till spring. Such diseased ones as have been picked out at the gathering of the crop can be used for feeding cattle or pigs. The fact that pigs fatten apparently as well on diseased potatoes when cooked by steaming or boiling, as on sound ones, is certainly a very important mitigation of this dreaded calamity. There are several varieties of the potato, such as "yams," "lumpers," "mangel-wurzel potato," &c., which, although unfit for human food, are much relished by cattle, and which, from their abundant produce, healthiness, and great fattening quality, are well deserving of being more generally cultivated for the purpose of being used in combination with turnips and other substances in the fattening of cattle. The turnip crop of recent years has been nearly as much diseased as the potato crop, and as one remedy against "fingers-and-toes" in the former is to let longer intervals of time intervene before their recurrence in the same field, and as it has been ascertained that an acre each of beans, potatoes, and turnips will produce more beef than three acres of turnips alone, it is worthy the consideration of those concerned whether it would not be prudent to substitute a crop of these coarser potatoes for a portion of their turnip crop on fields or parts of fields that have borne diseased turnips in previous rotations. Eight tons per acre is a good crop of potatoes.

Section 2.—Turnips.

The introduction of turnips as a field crop constitutes one of the most marked epochs in British agriculture. To the present day no better criterion exists by which to estimate its state in any district, or the skill of individual farmers, than the measure of success with which this or other root crops are cultivated. We have already, in our section upon fallowing, described in detail the process of preparing the soil for drilled green crops. Referring the reader to what is there said, we now proceed with our description of turnip culture.

Previous to the introduction of bone-dust and guano, farm-yard dung formed, in the majority of cases, the only available manure for the turnip crop. It was almost invariably formed into heaps in the field to which it was to be applied, and repeatedly turned, as great stress was laid on having it well rotted. The introduction of these invaluable portable manures has, however, not only immensely extended the culture of the turnip, but has materially modified the course of procedure. On the first introduction of bone-dust the practice was to use the fold-yard dung as far as it would go, and to apply bone-dust alone, in quantities of from sixteen to twenty bushels per acre, to the remainder of the crop. Guano, too, for a time was used to some extent on the same principle; but now it is

most satisfactorily proved that whereas very good crops of turnips can be obtained by manuring either with dung alone, at the rate of from fifteen to twenty tons per acre, or bones alone, at the rate of sixteen to twenty bushels, or guano alone, at the rate of three or four cwt., much *better* crops can be obtained by applying to each acre its proportion of each of these kinds and quantities of manures. A portion of the bones is now usually applied in the form of superphosphate of lime; and as this substance, and also guano, have a remarkable power of stimulating the growth of the turnip in its earliest stage, forcing it to the state fit for thinning from ten to fourteen days earlier than heretofore, there is now no occasion for the dung being in the advanced state of decomposition that was formerly found necessary. When farm-yard dung alone was used, it behoved to be in a soluble state, ready to furnish nourishment to the plant from the beginning. But in bringing it to that state a considerable loss is sustained by fermentation, and its bulk is so much reduced that it becomes difficult to distribute evenly the allowance which would be available for each acre, in order to give the whole crop a share of it. This, however, it is most desirable to do, as good farm-yard manure contains in itself the whole elements required by the crop; and hence an additional reason for the plans of applying farm-yard dung which have already been noticed. If that made during the previous summer has been applied in autumn to the lea before ploughing for oats, as far as it will go, and another portion of the contemplated turnip break dunged before the winter furrow, with all that has been made up to that time, and the future accumulations up to April formed into heaps, to be applied in the drills for the latest sowings, the manures produced on the farm may be made to go over nearly the whole breadth under root crops.

In proceeding to sow those portions that were dunged before the oat crop and on the stubble, all that is required is to form the drills, and apply the guano or bones, or mixture of both, by hand. In doing this, ten or twelve drills are set out the evening before, that all may be ready for a good start. The light manure is taken to the field in carts, which are unyoked at convenient distances for replenishing the aprons of the young persons (one for each plough) or the machine by which it is distributed along the drills. The sowers of the manure being started on the outside drills, the ploughmen proceed to open fresh ones inside in going, and to cover in the manure by reversing the first formed ridgelets as they return. The seed machine, sowing two rows at a time, follows close up to the ploughs, and thus the work goes rapidly on, each plough getting over from 2½ to 3 acres a-day. When farm-yard dung is applied at the time of sowing, the process is the same, except that the drills must be opened somewhat deeper, and that the dung-carts, followed by an adequate number of spreaders, precede the sowers of the light manures. In filling the dung-carts, one able-bodied labourer is required for each plough employed in drilling; and where these amount to three, six spreaders are required to distribute it evenly along the drills. In some districts the double-breasted plough is used in forming the drills and covering in the dung. In the hands of a skilful ploughman that implement does certainly make neater work to look at; but so far as the success of the crop is concerned, the common swing-plough is preferable, for in covering in with it the earth is made to run over the top of the ridgelet, by which means the clods fall into the hollow, and the finest of the mould is left on the top, where the seed is to be deposited. With the double mould-board this cannot so well be done, and the consequence is, that a groove is formed on the top of the ridgelet, in which the small dry clods, carried up by the tail of the mould-board, are left, forming the worst possible bed for the seed. In parching weather it is usual to pass a light roller over the drills immediately after sowing, to retain the moisture and insure germination. The seed is deposited near the surface, half an inch of mould being a sufficient covering. The quantity sown is 2 ℔ per acre of globe or yellow turnip seeds, and 3 to 4 ℔ of swedes. Care must be taken that the seed is fresh, so as to have a vigorous and thick plant. Thick sowing increases the difficulty of thinning out the plants, but it hastens their growth, and diminishes the risk of failure from the depredations of the turnip beetle. The time of sowing in the south of Scotland extends from the beginning to the end of May for swedes, and thence to the middle of June for yellows and globes. A partial sowing of yellow or globe is, however, made by careful stock-masters before sowing the swedes, to be ready for use by the end of August or beginning of September, when pasturage fails. Sowings of early varieties, such as the stubble turnip and certain yellow kinds, are also made after winter tares or other catch crops, until the middle of July; but in Scotland they cannot be sown later than this with advantage, unless for the production of a crop of seed. The average weight per acre of swedes may be stated at 18 tons, and of turnips at 22 tons, but double these rates have occasionally been obtained. Recent experiments go to show that with liberal manuring and early sowing, the weight of the crop is considerably increased by thinning out the plants at wider intervals than has hitherto been customary. The usual practice in Scotland has been to sow in ridgelets 27 inches apart, with 9 or 10 inches betwixt the plants. Recent experiments establish the fact that, with 15 inches from plant to plant, much larger bulbs and a greater acreable produce are obtained. As it is ascertained that in the case of swedes the largest bulbs are also the best in quality, it is of the greater consequence to allow them ample room.

The thinning is commenced as soon as the rough leaf is fairly developed. Previous to this operation the horse-hoe is worked betwixt the rows for the double purpose of destroying weeds and facilitating the operation of thinning. This operation is sometimes still farther facilitated by using Huckvale's machine, which slaps out the rows so as to leave tufts of plants at regular distances apart. The *singling* of the plants is performed by the hand-hoe. The young persons by whom this work is usually performed advance in *echelon* with their backs to the untouched work, the steadiest and most expert worker leading the band. This arrangement insures a uniform rate of progress, saves the finished work from being trodden upon, and keeps the workers closely under the eye of the steward. This thinning of the rows, so as to leave single plants at regular intervals of 12 to 15 inches apart, is accomplished by an alternate thrusting and drawing motion of the hoe, which a little practice enables the workers to perform with such precision that very rarely do they either make a gap or leave double plants, and still more rarely do they require to stoop down to disentangle them with their fingers. Three of these workers can usually thin an acre in a day. With ordinary care on the part of the overseer, there is no great difficulty in getting the plants left single at proper intervals; but it is very difficult to get the hoers trained to select and leave only the stoutest plants. And yet so important is this, that, all other things being equal, a difference of two to three tons per acre in the rate of produce has been ascertained to result on comparing rows that had been thinned by a person who took pains to select and leave the best plants, with others on which they had been left indiscriminately. When the plants have rallied after the thinning, and begun to grow rapidly, the usual practice has been to turn a furrow from either side

of them into the middle of the interval by a one-horse plough, and then to level this down by a turn of the horse-hoe. A great improvement on this practice is to use Tennant's grubber instead, adjusted for drill work in the manner already described. By thus using a strong implement drawn by two horses, the soil in the intervals betwixt the rows can be stirred a foot deep if required, without any risk of hurting the young plants, and this, too, is accomplished by a single operation. A second hand-hoeing is then given, which usually completes the after culture.

The nature of the soil will generally determine the mode of consuming the crop. On all loose, dry soils, feeding off by sheep is the most profitable plan; whereas on deep, strong loams, it is advisable to withdraw the whole produce, and have it eaten by cattle, as, unless in very favourable weather, when even a fourth is fed off by sheep, the extra manuring does not compensate to the after crops for the injury which they usually sustain from the treading and poaching. On the poorest class of light soils the whole crop should, if possible, be consumed where it grows by sheep; but on those of a better description, a third, a half, or two-thirds may be withdrawn for the feeding of cattle, according to circumstances. Whatever the proportion left on the ground, care is to be taken to regulate the intervals so as to distribute the treading and droppings of the sheep as equally as possible over the field.

The management of the turnip crop so as that it may be supplied to the live stock in the best possible condition during the entire season, is a point of the greatest importance. The portion that is to be used as cattle food is removed from the ground as soon as the crop is sufficiently matured, and before the time when drenching rains and severe frosts may ordinarily be looked for. The best way of preserving turnips is by storing in broad flat heaps, not exceeding 20 inches deep, on some dry and sheltered situation, open to the sun, and covering them with a good coating of straw. It takes less labour to put them together in this way, and less straw to cover them; and being less exposed to frost and parching winds, they retain their juices much better than when stored in long narrow heaps. The pulling of swedes preparatory to storing is much facilitated by passing under them a sharp share, and so cutting across the tap-roots without displacing the bulbs. The thatch of the corn-stacks that are thrashed in autumn is usually reserved for covering turnip heaps. After 1st November it is well to make diligent use of every favourable hour in thus securing the turnip crop.

The portion to be fed off by sheep must necessarily be treated in a different manner. What is to be used after Christmas can be very readily defended against frost by earthing up in the drills with the common plough. But as what is to be consumed by the young sheep must be pulled and trimmed at any rate, in order to be sliced, the best way is to throw the turnips into heaps at regular distances, and cover them with a thin coating of earth. By this means the turnips are kept from running to stems, and the sheep get them clean and fresh, whatever the state of the weather.[1] The same end is secured by opening a trench by a bout of the common plough, into which the turnips from two drills on either side are laid in regular order with their tops uppermost, and the earth turned over upon them by reversing the course of the plough. When wanted for use they are again unearthed by means of the plough. The feeding qualities of turnips are so seriously impaired by exposure to frost, even when they escape actual destruction, that the expense of securing them by one or other of these methods is always amply repaid. In very mild winters, again, storing is equally effective in preventing the virtues both of the turnips and the soil from being wasted by the pushing of the seed stems.

The turnip is liable in the early stages of its growth to the attacks of various insects. The most formidable of these enemies is the *turnip beetle*, which frequently settles upon the plants as soon as they appear above ground in such numbers as totally to destroy the whole of them. The best way of guarding against these nimble adversaries is to endeavour, by careful preparation of the soil, liberal manuring, and thick seeding, to secure a thick plant and rapid growth; for whenever the rough leaf is expanded the risk from this quarter is over. From time to time the young turnip plants are assailed by the larvæ of certain butterflies and moths, which sometimes appear in such numbers as to cause serious alarm, but ordinarily their attacks occasion but a slight check to the growth of the crop.

A far more formidable evil is the disease called "fingers and toes," which, although long known, seems to be steadily extending, and has been wider spread and more virulent since 1851 than in previous years. This truly formidable disease sometimes shows itself by the time that the plants are ready for thinning, but more usually it is about the stage when the second hoeing is given that unmistakable indications of its presence are observed. The crop appears in high health, and is making rapid growth, when suddenly, under hot sunshine, numbers of the plants are seen to droop with flaccid leaves; and examination being made, it is found that the disease has already made serious progress. In some cases it is chiefly confined to the tap-root, which is distorted with knobby excrescences. In others, the roots present a thickened, palmated appearance, giving rise to the popular name for the disease, "fingers and toes;" while in others the lateral roots expand into glandular-looking tubers, which frequently appear partially above ground at distances of several inches from the central stem. For a time all these forms of the excrescences present a smooth healthy looking skin, yielding no trace of the presence of insects of any kind, either externally or internally. By-and-by the skin cracks over the excrescences, which speedily assume a gangrenous appearance. Indeed, the whole symptoms present a striking analogy to cancer in the animal system. By the time that the healthy plants are approaching near to maturity, the most diseased ones have usually lost all resemblance to turnips, and there remains on the land a substance like rotten fungus. In very bad cases whole acres together are found in this state, with here and there a sickly distorted turnip still showing a few green leaves. At other times a few only of the plants are wholly destroyed; the field, to a casual observer, looking not much amiss, though a closer inspection proves that the general crop is of stunted growth, with few plants entirely free from the disease. Such partially diseased roots are not absolutely rejected by sheep, but they are evidently unpalatable and innutritious, while the crop as a whole is more speedily consumed than its general appearance would lead one to expect. When this disease appears on farms that have previously been exempt from it, it is usually confined for a year or two to small patches, which, however, in the absence of remedial measures, steadily and rapidly extend, not only on the recurrence of a turnip crop on the same fields, but over the other parts of the farm. Indeed, there are not wanting indications of its being propagated by contagion; as, for instance, when tainted roots are carted into pastures, and the disease shows itself most in those places where they have been consumed, when, in course of rotation, the field comes afterwards to bear a turnip crop. When they are consumed by cattle in fold-yards, the dung

[1] During the unusually wet winter of 1852–53 a large quantity of turnips and swedes intended for cattle food was stored in this way. The trimming and storing was carried on every dry day, and the carting postponed until the occurrence of frost or drought admitted of its being done without injury to the land.

may be the medium of contamination, on the supposition that this conjecture is well-founded. Ploughing land in a wet state evidently aggravates the disease. We know of one instance where a strip down the middle of a field was ploughed in autumn while soaked by rain, on which wet ploughed portion the turnips were evidently more diseased than over the rest of the field. In another instance which came under our personal observation, a ditch running along part of the top of a field of upwards of 50 acres, was scoured in spring, and the mud spread back over the headland. The whole field was, in the same season, sown with turnips, which proved an excellent crop, entirely free from "fingers and toes," with the exception of that portion of headland on which the mud was spread, where every plant was diseased. Although wholly in the dark as to the nature and propagation of this disease, it is well to know that the judicious application of lime is a certain remedy. In order, however, to its efficacy, it must be applied in a *powdery state* after the autumn ploughing, and immediately incorporated with the soil by harrowing; or else, as a compost with earth, spread on the lea before breaking up for oats. We know from experience that a very moderate dose (say four tons of unslaked shells to the acre) applied in this way will suffice to prevent the disease. It is on light soils that its ravages are most frequently experienced, and to these heavy doses of lime are unsuitable. Indeed, whether for promoting the general fertility of soils, or for warding off the attacks of this disease, moderate applications of lime every *twelve* years or so seem preferable to heavier dressings at longer intervals. The name "fingers and toes" is not unfrequently applied to a distinct disease to which the turnip, in common with the cabbage and other coleworts, is liable—namely *anbury* or club root. When the knobby excrescence which is found on plants affected by anbury is broken up, it is found to encase a white maggot, whose presence is the obvious cause of the mischief. We have seen young cabbages which had begun to droop from clubbing, when pulled up, freed from the parasite, and replanted, regain healthy growth and come to prosperous maturity. In the case of the "finger and toe," the most careful investigation, aided by the microscope, has hitherto failed to detect any insect cause for this disastrous malady.

Section 3.—*Mangel-Wurzel.*

This root has been steadily rising in estimation of late years. It is peculiarly adapted for those southern parts of England where the climate is too hot and dry for the successful cultivation of the turnip. A competent authority declares that it is there easier to obtain 30 tons of mangold than 20 tons of swedes, and that it is not at all unusual to find individual roots upwards of 20 ℔ in weight. In Scotland it is just the reverse, it being comparatively easy to grow a good crop of swedes, but very difficult to obtain 20 tons of mangold. This plant is very susceptible of injury from frost, and hence in the short summer of Scotland it can neither be sown so early nor left in the ground so late as would be requisite for its mature growth. These difficulties may possibly be got over either by the selection of hardier varieties or by more skilful cultivation. Its feeding quality is said to be nearly equal to that of the swede; it is much relished by live stock—pigs especially doing remarkably well upon it; and it has the very important property of keeping in good condition till midsummer if required. Indeed, it is only after it has been some months in the store heap that it becomes a palatable and safe food for cattle. It is, moreover, exempt from the attacks of the turnip beetle. On all these accounts, therefore, it is peculiarly valuable in those parts of Great Britain where the summer is usually hot and dry—conditions of climate which are favourable to the mangold and peculiarly unfavourable to the turnip.

Up to the act of depositing the seed, the processes of preparation for mangold are identical with those described for the turnip; winter dunging being even more appropriate for the former than for the latter. The ridgelets being formed 28 inches apart, and charged with a liberal allowance of dung and guano, the seeds are deposited along the top, at the rate of about 4 ℔ per acre. The common drilling machines are easily fitted for sowing its large rough seeds, which should be sown from the 10th to the 25th April. The after culture is also identical with that of the turnip. The plants are thinned out at distances of not less than 15 inches apart. Transplanting can be used for filling up of gaps with more certainty of success than in the case of swedes. But we find it much more economical to avoid such gaps by sowing a little swede seed along with the mangold. Several varieties of the plant are cultivated—those in best repute being the *orange globe*, the *long yellow*, and the *long red*. This crop requires a heavier dressing of manure than the turnip to grow it in perfection, and is much benefited by having salt mixed with the manure at the rate of 2 or 3 cwt. per acre. The crop requires to be secured in store heaps as early in autumn as possible, as it is easily injured by frost. The following graphic description of this process is by Mr Morton of Whitfield :—

"The mode of harvesting our root crop which we have adopted for several years is this : We let the lifting, cutting off the leaves and the roots, and putting the roots into the cart—at so much per acre, according to the weight of the crop—to one man, who gets other men to join with him in the work and share in the profits : and the arrangement I require to be adopted is, that the one-horse carts, which I employ to haul the roots, shall be constantly employed, and I require from 16 to 20 loads or tons of roots to be filled hourly. The number of carts required is according to the distance of the field from the store ; thus the distance from the middle of the field to the store being 15 chains, four carts are required ; 22 chains require five carts ; and 30 chains require seven carts.

"*The mode of lifting the roots.*—Five men are employed to pull up the roots ; each man pulls up two rows ; standing between the rows, he takes with his left hand a root from the row on his left side, and with his right hand a root from the row on his right side, and pulling both up at the same time, places them side by side across the row where he pulled up the roots with his right hand, so as to have the tops lying in the space between the two rows he has pulled up ; the next man takes the two rows at the right hand of the last two rows we have just described, and he, with each of his hands, pulls up a row, and places them on the line of the row which he has pulled up with his left hand, with the root end lying towards the root end of the first row, so that we have now four rows of roots lying close together in two rows, side by side, with their leaves on the outside of each of these rows, and the roots of each row nearly touching each other ; and every four rows, when growing, are thus, when pulled, laid in two rows, root to root, occupying not more than 27 inches. Now, as the next four rows are lifted in the same way, and placed in like manner, we have a space unoccupied of three times 27 inches, or 6 feet 9 inches between each double row of roots, for the cart to go between them (viz., this double row of bulbs after they have had the leaves and roots cut off), to carry off the bulbs to the store. After the five men who are pulling the roots there follow ten women or boys, with knives made of pieces of old scythes, who, with repeated blows, cut off the leaves and roots without ever moving one of them with their hands ; this is constant but not hard work, and it requires ten active women or boys to keep up with the five men pulling.

"Immediately on the heels of the cutters follow the carts between the two double rows of bulbs as they lie, having their leaves and roots cut off ; and a man, one of the principals of the gang, and nine young active boys and girls, throw up the bulbs as fast as they can into the cart, the man speaking to the horse to move forward or stop as they clear the ground ; when one cart is full, an empty one has been brought by one of the boys who drive the carts, and placed immediately behind the full one ; so that, as he moves off with the full cart, the man calls the horse with the empty cart to move forward, and they proceed to throw the roots into the cart as fast as they did into the one that has just gone off the field.

"The pulling of the roots and the filling of the carts being the principal work, one of the leaders is in each of these departments of

the work; so that, by his example, he shows those with him how he wishes them to work, and thus the work proceeds with the utmost regularity and despatch; 20 cart-loads are hourly filled in the fields and delivered in the store; 180 to 182 loads of 22 cwt. and 23 cwt. each in a day of nine hours; thus a cart-load is filled every three minutes by 10 pairs of hands, which are pulled by five pairs of hands, and the leaves and roots cut off by 10 pairs of hands —in all 25 pairs of hands, men, women, and boys. This has been repeatedly done in a day.

"The stores are made of posts and rails, enclosing a space 9 feet apart and 4½ feet high, and of any length, if the space will admit, and as near to where they are to be consumed as possible. The posts are 5 feet apart, let into the ground 18 inches, and 4½ feet above, with five rails above, 4 or 5 inches wide, nailed to the inside of the posts; and each of these stores is 3 feet apart. I have 14 of them, about 70 feet long each, which is sufficient to store from 1000 to 1200 tons of bulbs."

The heaps are carefully thatched, and the spaces betwixt them filled with straw to keep out frost.

It is believed that in many cases crops of turnip and mangold could be more cheaply stored by means of the portable railway than by carts, and with less injury to the land. This is especially the case with clay soils and in wet seasons. In using it, eight drills of roots are trimmed and laid in two rows, as Mr Morton describes; the rails are shifted between the pairs of rows in succession; and the roots are pitched into light trucks, which a man pushes before him to the headland, where the contents are discharged by tipping. Being there heaped up and thatched, the roots are carted to the homestead as required.

Section 4.—Carrot.

This root, though so deservedly esteemed and universally grown in gardens, has not hitherto attained to general cultivation as a field crop. This is owing chiefly to certain practical difficulties attending its culture on a larger scale. Its light feathery seeds cannot easily be sown so as to secure their regular germination; the tardy growth of the young plants, and the difficulty of discriminating between them and weeds makes the thinning a troublesome affair; the harvesting of the crop is comparatively expensive; and it is only on sandy and light loamy soils, or those of a peaty character, that it can be grown successfully. The increasing precariousness in the growth of potatoes, turnips, and clover, and the consequent necessity for a greater variety of green crops, entitle the carrot to increased attention as a field crop. Its intrinsic qualities are, however, very valuable, especially since the introduction of the white Belgian variety. On light soils it is alleged that larger crops of carrots can be obtained than of turnips, and with less exhaustion of their fertility, which is explained as arising from the greater depth to which the carrots descend for their nourishment. This root is eaten with avidity by all kinds of farm stock. Horses, in particular, are very fond of it, and can be kept in working condition with a considerably smaller ration of oats when 20 ℔ of carrots are given to them daily. It can also be readily kept to an advanced period of spring when stored with ordinary care.

The mode of culture is very similar to that already described for mangel-wurzel. A usual practice is to prepare the seed for sowing by mixing it with moist sand, and turning the mass repeatedly for several days until germination begins, when it is sown by hand at the rate of 6 ℔ per acre of the dry seeds, in a seam opened by the coulters of the corn or turnip drill, according as it is wished to have it on the flat or on ridgelets. Some prefer merely to rub the mixture of seeds and sand or mould betwixt the palms, until the seeds are thoroughly separated from each other, and so divested of their hairs as, when mixed with sand, to run from a drilling machine. It is of the utmost importance to secure seeds of the previous year's growth, as if older their germination cannot be depended upon. Much care is also needed in saving the seed only from selected roots, as carrots have a decided tendency to degenerate. The white Belgian variety is certainly the best for farm use, not only from the weight of crop, but from its growing more rapidly in its earliest stage than other approved sorts, and showing a broader and deeper coloured leaf, which can more easily be discriminated from weeds, and thus admitting of the earlier use of the hoe. When the sowing and first hoeing and thinning of the crop are got over successfully, the after culture of the crop is very simple; all that is needed being the occasional use of the horse and hand hoe to keep down weeds. The fork must be used in lifting the crop. The greens are then cut off and given to young stock or cows, and the roots stored in long narrow heaps, exactly as mangold. Fifteen tons per acre is an average crop, although on suitable soils, with liberal manuring and skilful cultivation, double the weight is sometimes obtained. Those who intend to cultivate this crop statedly will do well to raise their own seeds from carefully-selected roots. Unless genuine and fresh seed is sown, failure and disappointment can scarcely be avoided.

Section 5.—Parsnip.

This plant bears so close a resemblance to the carrot, and its culture and uses are so similar, that they need not be repeated. It can, however, be cultivated successfully over a much wider range of soils than the carrot, and, unlike it, rather prefers those in which clay predominates. It is grown extensively and with great success in the Channel Islands. The cows there, fed on parsnips and hay, yield butter little inferior, either in colour or flavour, to that produced from pasture. About 10 ℔ of seed are required per acre. It requires, like that of the carrot, to be steeped before sowing, to hasten germination, and the same care is needed to have it fresh and genuine. It should be sown in April. The roots, when matured, are stored like carrots

Section 6.—Jerusalem Artichoke.

This root, although decidedly inferior to the potato in flavour, is yet deserving of cultivation. It grows freely in inferior soils, is easily propagated from the tubers, and requires little attention in its cultivation. When once established in the soil, it will produce abundant crops for successive years on the same spot. It is sometimes planted in woods to yield shelter for game, for which purpose it is admirably fitted, as it grows freely under the shade of trees, and yields both food and covert. In properly-fenced woods it might yield abundant and suitable food for hogs, which could there root it at their pleasure, without damage to anything. Where they had mast along with these juicy tubers, they would undoubtedly thrive apace. After they had grubbed up what they could get, enough would be left to reproduce a crop for successive seasons. Such a use of this esculent seems well deserving of careful trial.

CROPS ANALOGOUS TO DRILLED ROOT CROPS.

(*Sections* 7, 8, 9.)

There are several crops which, under a strict classification, should be noticed among forage crops rather than here, but which, in an agricultural point of view, are so closely analogous to drilled root crops that we regard this as the suitable place in which to notice them.

Section 7.—Cabbage.

On strong rich soils large crops of very nutritious food for sheep or cattle, and of a kind very acceptable to them, are obtained from the field culture of the Drumhead cabbage. A seed-bed is prepared in a garden, orchard, or other sheltered situation, about the second week in August, either by sowing in rows 12 inches apart, and thinning the plants

about 3 inches in the rows, or broadcast in beds. As early in spring as the land on which the crop is to be grown is dry enough for being worked, let it be thoroughly and deeply stirred by one or more turns of the grubber. Assuming that a liberal dressing of dung has been put into it at the autumn ploughing, 3 or 4 cwt. of guano are now scattered evenly over the surface and ploughed in by a deep square furrow. A lot of plants being brought from the seed-bed, a band of planters, each provided with a dibble and a piece of rod 27 inches long, proceed to insert a row of plants the length of the rods apart in each third plough-seam, the result of which is that the plants stand in regular rows 27 inches apart every way, and can afterwards be kept clean by horse and hand hoeing like any other drilled green crop. Cabbages are much in repute with breeders of rams and prize sheep, which fatten rapidly on this food. Cabbages are usually drawn off and given to sheep on their pastures, or to cattle in byres and yards; but they are also fed off, where they grow, by sheep, in the same way as turnips. It is an exhausting crop when wholly drawn off, and on this account is sometimes grown with advantage on spots greatly enriched by irrigation with sewage or otherwise, and where the succeeding grain crop is expected to suffer from over-luxuriance, the cabbages being grown, as the phrase goes, to "take the shine out of it." In favourable circumstances, from 30 to 40 tons per acre of this nutritious crop may be obtained. From what has been said it is evidently not adapted for extensive field culture; but on most farms a few acres might be grown annually with great advantage. It is a peculiarly suitable food for either sheep or cattle during the autumnal transition from grass to turnips.

Section 8.—*Rape.*

This plant is peculiarly adapted for peaty soils, and is accordingly a favourite crop in the fen lands of England, and on recently reclaimed mosses and moors elsewhere. Its growth is greatly stimulated by the ashes resulting from the practice of paring and burning. In these cases it is sown broadcast; but when such soils are brought into a regular course of tillage, it is drilled, and otherwise treated in the same manner as turnips. As we shall consider its culture under the head of "Oil-producing Plants" (chap. xiv. sec. 5), we shall only say further here, that its highly nutritious leaves and stems are usually consumed by folding sheep upon it where it grows, and that there is no green food upon which they fatten faster. Occasionally it is carried to the homestead, and used with other forage in carrying out the system of soiling cattle.

Section 9.—*Kohl-Rabi.*

This plant has been frequently recommended to the notice of farmers of late years. Like mangold, it is better adapted than the turnip for strong soils and dry and warm climates. It may be either sown on drills in the same manner as the turnip, or sown in a seed-bed and afterwards transplanted. The latter plan is expensive, if it is desired to cultivate the crops to any extent; but is commendable for providing a supply of plants to make good deficiencies in the rows of other crops, or when a small quantity only is wanted. By sowing a plot of ground in March in some sheltered corner, and transplanting the crop early in May, it is more likely to prosper than in any other way. Cattle and sheep are fond of it, and it is said not to impart any unpleasant flavour to milk. We have seen a few trials of it in Scotland as a field crop; but, from whatever cause, the weight of food produced per acre was greatly less than from the mangolds and swedes growing alongside of it. For further information about this plant, the reader is referred to the *Book of the Farm*, vol. ii. p. 87; Hewlett Davis's *Farming Essays*, p. 90; Lawson's *Synopsis of the Vegetable Products of Scotland*, div. ii. p. 109. Lawson says that the pulp or flesh of kohl has the same taste as the leaves of the cabbage, and hence its adaptation as food for milch cows.

CHAPTER XIII.

CULTIVATED CROPS.—HERBAGE AND FORAGE CROPS.

Section 1.—*Grasses, &c.*

Under this general heading we propose to include what we have to say concerning the grasses, whether natural or cultivated, and those other crops which are grown expressly for the sake of the cattle food yielded by their leaves and stems. This kind of farm produce is either consumed where it grows by depasturing with live stock, or mown and given to them in a green state under cover, or dried and stored for after use. It thus embraces the cultivation of these crops, and their disposal, whether by grazing, soiling, or haymaking. Following this method, we shall first of all briefly describe the cultivation of those pasture and forage crops which are of best repute in British husbandry.

Tillage lands are now everywhere cropped according to some settled rotation, in which the well-recognised principles of the alternate husbandry are carried out according to the actual circumstances of each locality. With rare exceptions, such lands at stated intervals bear a crop of the clovers or cultivated grasses. As these are usually sown in mixture, especially when intended for pasturage, the resulting crop is technically called "seeds." As it is of importance to have the land clean and in good heart when such crops are sown, they usually follow the grain crop which immediately succeeds the fallowing process. Being for the most part of a lower habit of growth, these can be sown and grown along with white corn crops without injury to either. When the latter are harvested, the former, being already established in the soil, at once occupy it, and grow apace. By this arrangement there is therefore secured an important saving both of time and tillage. Barley being the crop amongst which the seeds of the clovers and grasses are most frequently sown, and amongst which, upon the whole, they thrive best, it is customary to sow these small seeds at the same time as the barley, and to cover them in with a single stroke of the common harrows. This is erroneous practice, both as regards the time and manner of sowing these small seeds. We have already mentioned, in the proper place, that barley should be sown as early in March as possible. Now, if the clovers, &c., are sown as early as this, they are almost certain to get so forward as both to rob the barley of its due share of nourishment, and, when it is reaped, to bulk so largely in the sheaves as to retard their drying, and aggravate the risk of their being ill harvested. It is found, too, that if there be plants enough, the clovers stand the winter better, and ultimately yield a better crop, when, at the reaping of the grain crop, they are puny-looking than when they are very strong. It is better, therefore, to delay the sowing of the small seeds till the end of April or beginning of May. As to the manner of covering them in, we have to remark that the smallness of these seeds and their mode of germinating alike require that they receive only the very slightest covering of soil. This important fact is so well illustrated in the following table, which exhibits the results of some carefully-conducted experiments, reported to the Highland Society by Mr Stirling of Glenbervie, that we shall here quote it:—

"Column I. contains the scientific names.
Column II. contains the average weight of the seeds per bushel in pounds.

Column III. contains the average number of seeds in one ounce.
Column IV. shows, in inches, the depth of cover at which the greatest number of seeds brairded.
Column V. shows, in inches, the depth of cover at which only about half the number of seeds brairded.
Column VI. shows, in inches, the least depth of cover at which none of the seeds brairded.

I.	II.	III.	IV.	V.	VI.
Agrostis stolonifera,	13	500,000	0 to ¼	¼ to ¾	1
vulgaris,	12	425,000	...	..	.
Aira cæspitosa,	14	132,000	0 to ¼	¾ to 1	2¼
Alopecurus pratensis,	5	76,000	0 to ¼	1 to 1¼	2¼
Anthoxanthum odoratum,	6	71,000	0 to ¼	1 to 1¼	2
Arrhenatherum avenaceum,	7	21,000	½ to ¾	1¼ to 1¾	4
Brachypodium sylvaticum,	10	15,500	0 to ¼	½ to ¾	2
Cynosurus cristatus,	26	28,000	.	.	..
Dactylis glomerata,	12	40,000	0 to ¼	¾ to 1	2¼
glomerata *gigantea*,	10	34,000	...	.	..
Elymus arenarius,	11	2,320	1 to 1½	2 to 2½	5
geniculatus,	12	2,300	...	..	...
Festuca duriuscula,	10	39,000	0 to ¼	¾ to 1	2¼
elatior,	14	20,500	0 to ¼	1 to 1¼	2¾
elatior *gigantea*,	13	17,500	0 to ¼	1¼ to 1½	3
heterophylla,	12	33,000	0 to ¼	1 to 1¼	2¼
gigantea,	16	8,600	...	..	..
ovina,	14	64,000	0 to ¼	¾ to 1	2
ovina *tenuifolia*,	15	80,000	..	..	...
pratensis,	14	26,000	0 to ½	¾ to 1	2½
pratensis *loliacea*,	15	24,700	...	...	..
rubra,	10	39,000	..	.	...
Glyceria aquatica,	13	58,000	¼ to ½	¾ to 1	2¼
fluitans,	15	33,000	.	..	...
Holcus lanatus,	7	95,000	¼ to ½	¾ to 1	2½
mollis,	6	85,000	...	...	...
Lolium italicum,	15	27,000	0 to ½	1 to 1¼	3¼
perenne,	18–30	15,000	¼ to ½	1¼ to 1¾	3½
Milium effusum,	25	80,000	¼ to ½	1 to ¼	2¾
Phalaris arundinacea,	48	42,000	...	...	...
Phleum pratense,	44	74,000	0 to ¼	¾ to 1	2
Poa nemoralis,	15	173,000	...	...	...
nemoralis *sempervirens*,	15½	133,000	0 to ¼	¼ to ½	1
pratensis,	13	243,000	..	...	..
trivialis,	15	217,000	0 to ¼	½ to ¾	1½
Psamma arundinacea,	15	10,000	½ to 1	1½ to 1¾	4
Trisetum flavescens,	5½	118,000	0 to ¼	¾ to 1	2
Achillea Millefolium,	30	200,000	¼ to ½	½ to ¾	1½
Cichorium Intybus (chicory),	32	21,000	...	..	...
Lotus corniculatus,	62	28,000	0 to ¼	¼ to ½	1½
major,	64	51,000	...	...	...
Medicago lupulina,	63	16,000	0 to ¼	¾ to 1	1½
sativa,	60	12,600	...	...	...
Onobrychis sativa,	26	1,280	¾ to 1	2 to 2¼	4¼
Petroselinum sativum,	41	12,800	..	...	...
Plantago lanceolata,	52	15,600	¼ to ½	1¼ to 1½	2½
Poterium Sanguisorba (burnet),	25	3,320	¼ to ¾	1½ to 1¾	4
Trifolium filiforme,	65	54,000	0 to ¼	¼ to ½	1¼
hybridum,	63	45,000	0 to ¼	½ to ¾	1½
pratense,	64	16,000	0 to ½	1¼ to 1½	2
pratense *perenne*,	64	16,000	0 to ½	1¼ to 1½	2
repens,	65	32,000	0 to ¼	½ to ¾	1½

"The results in the three last columns of the preceding table were obtained by sowing the seed in finely-sifted dark loam, which was kept moist throughout the process of germination, to which is attributable the circumstance of so many of the sorts vegetating best (as shown in Column IV.) without covering, and under full exposure to the light. The combination of such favourable circumstances of soil and moisture can, however, seldom be calculated upon in field sowing, therefore a covering of mould for the seeds, however slight, is always advisable. But it will be seen, by the results in Column VI., that a great number of seeds must be inevitably lost from over-depth of covering, unless the ground be in all cases carefully prepared and pulverised before sowing either the *natural* or *artificial* grasses."[1]

From this it is evident that to scatter these tiny seeds over a cloddy surface, and then to harrow it, may more aptly be called burying than sowing them. The following is a more rational mode of proceeding:—When these seeds are to be sown among winter wheat, it is expedient to begin by using the horse-hoe (supposing the wheat to have been drilled), as well to loosen the surface and produce a kindly bed for the seeds as to destroy weeds. In the case of broadcasted wheat, a turn of the harrows secures the same end. In the case of the more recently sown barley all that is needed is to smooth the surface with the one-horse roller. Over the ground thus prepared the small seeds are distributed by a broadcast sowing-machine, which covers at once a space of 15 or 18 feet in width. The covering is then effected by simply rolling with the smooth roller, or by dragging over the surface the chain-harrow, which may either be attached to the sowing-machine or to a separate frame; or by using Cambridge's or Crosskill's roller, with a very light chain harrow attached to it. On clay soils the chain-web is to be preferred; but on loose soils Crosskill's roller imparts a beneficial firmness, and, with its tail-piece of chain-web to fill up the indentations, gives an accuracy of finish which rivals the neatness of a newly-raked garden plot. We have long regarded this covering in of grass seeds as the most important use to which Crosskill's valuable implement is put. The only drawback to it is, that it makes a heavy demand on the horse-power of the farm at a pressing season. As it can only be worked in dry weather, it is advisable, when the land is in trim, to work it double tides by means of a relay of horses. This mode of procedure is alike applicable to the sowing of mixed clovers and grasses, and to that of the clovers alone, and is the course usually pursued in sowing for one or two years' "seeds."

When it is intended to lay down arable land to grass for several years, or to restore it to permanent pasture or meadow, it is always advisable to sow the seeds without a corn crop. This doubtless involves an additional cost at the outset, but it is usually more than repaid by the enhanced value of the pasture thus obtained. To grow the grasses well, the soil should be pulverised to the depth of 3 or 4 inches only, and be full of manure near the surface. There is no better way of securing these conditions than by first consuming a crop of turnips on the ground by sheep folding, and then pulverising the surface by means of the grubber, harrow, and roller, *without ploughing it*.

Much diversity of practice exists in regard to the kinds and quantities of seeds used in sowing down with a grain crop. In Scotland from 2 to 4 pecks of ryegrass seeds, with from 10 to 14 ℔ of those of red, white, alsike, and yellow clovers, in about equal proportions, is a common allowance for an acre. A pound or two of field parsley is occasionally added, or rather is substituted for an equal weight of clover seeds. The natural grasses are seldom sown, and only when the land is to be laid to permanent pasture. In England ryegrass is in much less repute than in Scotland, the clovers being there very generally sown unmixed, and always in larger quantities than we have just named—20 ℔ per acre being a common allowance. There can be little doubt that both these plans are faulty.

When a good natural pasture is carefully examined, it is found to consist of an amazing number of different grasses and other plants. Not only does a natural pasture contain a great variety of herbage at any one time, but it has its plants which replace each other at different seasons; and some also which are prominent only in wet years and others in dry ones. The provision thus made for affording at all times such a variety of food as is at once grateful and wholesome to the animals which browse on it, and for keeping the ground fully occupied under every diversity of seasons and weather, is truly admirable, and the study of it well

[1] Morton's *Cyclopædia of Agriculture*—article "Grasses," vol. i. p. 999.

fitted to interest and instruct the husbandman. The importance of this subject is beginning to be appreciated by agriculturists; as one proof of which we now see our leading seedsmen regularly advertising for sale an extensive list of grasses and other pasture plants. Most of them also, for the guidance of their customers, point out the kinds and quantities per acre which are appropriate for diversity of soils and other circumstances. We refer, as an example of this, to the manual of Messrs Lawson of Edinburgh, who have devoted much attention to this subject.

The following Tables will be found useful:—

"I.—For Alternate Husbandry.

	For 1 year's Hay.	For 1 year's Hay and 1 year's Pasture.	For 1 year's Hay and 2 years' Pasture.
	lb	lb	lb
Lolium italicum	9	9	9
perenne	18	18	18
Dactylis glomerata	—	2	2
Phleum pratense	1	2	2
Medicago lupulina	—	1	1
Trifolium hybridum	1	2	2
pratense	8	4	2
pratense perenne	—	2	4
repens	2	4	4
	39	44	44

"For sheep pastures it will often be found advantageous to add from 2 to 4 lb per acre of *parsley* seed to the above mixtures; and for pastures in certain upland districts established practice will justify the introduction of an additional pound or two of yellow clover (*Medicago lupulina*), together with from 2 to 3 lb of ribgrass (*Plantago lanceolata*). And for very heavy as well as for peaty soils, 1 to 1½ lb of *Phleum pratense* may be added advantageously, both for hay and pasture.

"II.—For Permanent Pasture, No. I.

	lb
Alopecurus pratensis	2
Dactylis glomerata	6
Festuca duriuscula	2
elatior	2
pratensis	2
Lolium italicum	6
perenne	8
Phleum pratense	2
Poa nemoralis sempervirens	2
trivialis	3
Medicago lupulina	1
Trifolium pratense	1
perenne	3
repens	6
	46

"In certain cases the following additions to Table II. may be made—namely, 1 to 2 lb each of *Festuca rubra* and *Poa pratensis* on dry sandy soils; 1 lb of *Achillea Millefolium*, and 1 to 2 lb of *Petroselinum sativum* in sheep pastures; 2 lb chicory (*Cichorium Intybus*) in cattle pastures, 6 or 10 lb of *Onobrychis sativa* and 4 to 6 lb of *Poterium Sanguisorba* (burnet) in dry calcareous soils. When a crop of hay is taken the first year, both the ryegrasses (*Lolium*) may be increased by a third; and 2 lb of *Trifolium pratense* added. Also ½ to 1 lb per acre of *Anthoxanthum odoratum* when occasional crops of hay are to be taken." [1]

When land has been thus sown for a permanent pasture, care should be taken not to allow a sheep to set foot upon it for the first two years, for if these industrious nibblers are allowed to crop the tender clover seedlings before they are fully established in the soil, they are certain to remove the crown from most of them, and thus ruin the pasture at the very outset. Innumerable instances of failure in the attempt to obtain good permanent pastures are entirely owing to this premature grazing by sheep. The first growth should therefore be mown, care being taken to do so before any of the grasses have flowered. Then roll repeatedly, and stock with young cattle only until the second season is over.

Having described the means to be used for obtaining good pastures, let us now consider how to use them profitably. The art of grazing embraces the practical solution of two important problems, viz., 1*st*, How to obtain the greatest amount and best quality of herbage from any given pasture; and 2*d*, How to consume this herbage by live stock so as to make the most of it. The grazier has ever to keep in view what is best for his land and what is best for his stock; and must take his measures throughout the entire season with an eye to both these objects. As regards the first of them, experience yields the following maxims for his guidance:—

Never to stock his pastures in spring until genial weather is fairly established.

Never to allow the grasses to run to seed, nor parts of a field to be eaten bare, and others to get rank and coarse.

Duly to spread about the droppings of the cattle, to remove stagnant water, and to extirpate tall weeds.

Some time about midsummer to make a point of having the pasture eaten so close that no dead herbage or "foggage" shall be left on any part of it.

In what more immediately concerns the welfare of the live stock he is in like manner taught in stocking his pastures—

To adapt the stock, as regards breed, size, condition, and numbers, to the actual capabilities of the pasturage.

To secure to the stock at all times a full bite of clean, fresh-grown, succulent herbage.

In moving stock from field to field to take care that it be a change to better fare—not to worse.

Pasturage consists either of natural herbage or of "seeds." In the south-eastern counties of Scotland there is little good old grass; all the really fertile soils being employed in arable husbandry, with the exception of small portions around the mansions of landowners. The pasturage consists, therefore, for the most part of the cultivated clovers and grasses. Comparatively few cattle are there fattened on grass; the object of graziers being rather to stock their pastures with young and growing animals, and to get them into forward condition for being afterwards fattened upon turnips. The grazing season is there also much shorter than in England, old grass seldom affording a full bite for a well-conditioned bullock before the middle of May, or later than the middle of September. It is quite otherwise in England, various parts of which abound with old grass lands of the very richest description, on which oxen of the largest size can be fattened rapidly. These, in many cases, admit of being stocked towards the end of April, and under judicious management continue to yield excellent pasturage for half the year. When stocked with cattle in fresh condition, two sets or "runs" are not unfrequently fattened in such pastures in the same season. These grass-fed cattle begin to come to market early in July, and for four or five months thereafter constitute the chief supplies of beef in our markets.

Cattle already well-fleshed are alone suitable for turning into these rich old pastures. When this is attended to, and care taken not to over-stock the pastures until they yield a full bite, the progress of the oxen will usually be very rapid. It is now customary to hasten this progress by giving about 4 lb of oilcake to each beast daily. The dust and crumbs being sifted out, the bits of cake are strewn upon the clean sward, from whence they are quickly and carefully gleaned by the cattle. This is usually a profitable practice. It brings the beasts forward rapidly, improves their appearance and handling, and, besides enriching the land, admits of about *twelve* per cent. more numbers being fed upon a given acreage. These choice old pastures are usually occupied in combination with others of inferior quality. The most forward lot of cattle having been fattened and sold off from the former,

[1] Morton's *Cyclopædia of Agriculture*—article "Grasses," vol. i. p. 1000

they are ready to receive a fresh stock. If it is contemplated to get them also fattened before the expiry of the season, they are not put on the best land instantly on the first lot being sold; but a crowd of sheep or store-beasts being turned upon it for a few days, the existing herbage is cleared off, and the pasture (*Anglice*) "laid in" or (*Scottice*) "hained," until a fresh clean growth fits it for receiving a suitable number of the best cattle from the other pastures. It is inexpedient to graze sheep promiscuously with cattle on these best lands, as they pick out the sweetest of the herbage, and so retard the fattening of the oxen. Neither do we approve of having horses among such cattle; not so much from their interfering with their pasturage as from the disturbance which they usually cause by galloping about. This does not apply to the draught-horses of a farm, which are usually too tired and hungry when turned out from the yoke to mind anything but food and rest, but it is better thrift to soil *them;* and frolicsome, mischievous colts are unsuitable companions for sedate, portly oxen. In favourable seasons, the grass often grows more rapidly than an ordinary stocking of cattle can consume it, in which case they select the best places, and allow the herbage on some parts to get rank and coarse. If these rank places are neglected until the herbage gets dry and withered, the finer plants die out, the coarser-growing grasses usurp the ground, and the pasturage is injured for future years. To check this evil in time, these neglected places should be mown, and the grass either brought to the homestead for soiling, or left to dry where it grew; in which state the cattle will eat up most of it, and be the better for it, especially if their bowels are unduly relaxed by the succulence of the growing herbage. The remarks now made apply equally to all old pastures employed for the fattening of cattle, although not of the first quality. All that is required is, to observe a due proportion between the capabilities of the pasturage and the breed and size of the cattle. A pasture that will fatten a fifty-stone ox may be quite inadequate for one of seventy, and the hardy Galloway or West Highlander will thrive apace where the heavier and daintier shorthorn could barely subsist.

With the exception of the best class of rich old pastures, grass is usually consumed to greater profit by a mixed stock of sheep and store cattle than by one kind of animals only. This holds true both as regards the natural herbage of pastures or water meadows, and cultivated grasses, clovers, or sainfoin. When old pastures and mixed "seeds" are grazed chiefly by sheep, the same rules apply that have already been noticed in connection with cattle. The herbage should if possible be fully established in a growing state, and so far advanced as to afford a full bite, before the pasture is stocked in spring. If the sheep are turned into it prematurely, their close nibbling hinders the plants from ever getting into a state of rapid growth and productiveness, and the necessity imposed upon the stock of roaming over the whole field, and keeping long afoot before they can glean enough to appease their appetite, is prejudicial alike to them and to their pasture. The prudent grazier endeavours to avoid these evils by having stores of swedes or mangolds to last until the full time at which he may reckon on having good pasturage. In distributing the flocks to different fields, the best pasturage is allotted to those that are in most forward condition. It is advantageous to have the pastures so subdivided that one portion may be double stocked while another is rested. By frequently removing the stock from the one portion to the other the herbage of each by turns gets time to grow and freshen, and is more relished by the sheep, and more wholesome than when the whole is tainted by their uninterrupted occupation of it. In the case of clover, trefoil, sainfoin, and water-meadows, this principle is yet more fully carried out by folding the flock and giving them a fresh piece daily. The crop is thus eaten close off at once in daily portions, and the plants being immediately thereafter left undisturbed, and receiving over the whole area their due share of the excrements of the flock, grow again more rapidly than when subjected to constant browsing under a system of promiscuous grazing. This plan of folding sheep upon such crops has the same advantages to recommend it as soiling, only that it is cheaper to shift the fold daily than to mow and cart home the forage and carry back the manure. In the case of water-meadows it is the practice to irrigate them afresh as each crop of grass is fed off. This is attended with considerable risk of the sheep getting tainted with rot, which must be guarded against as much as possible. In the first place, it is well to give them a daily allowance of bran, beans, or cake, and salt; and besides this, to put on this land only such sheep as are nearly ready for the butcher. They will thus fatten very rapidly, and be slaughtered before there is time for harm to ensue.

The modes of grazing which we have now described are appropriate for sheep in forward condition. The poorer pastures are usually stocked with nursing ewes and lean sheep bought in from higher grazings. Lambs, both before and after weaning, require clean pastures, and of course frequent changes. If kept on tainted pastures, they are certain to become subject to diarrhœa, to be stinted in their growth, and to have their constitution so weakened that many of them will die when afterwards put upon turnips. To avoid these evils, they must be frequently moved from field to field. A sufficient number of store cattle must be grazed along with them, to eat up the tall herbage and rank patches avoided by the sheep. After the lambs are weaned, the ewes require to fare rather poorly for a time, and can thus be made use of to eat up the worst pasturage, and the leavings of the young and fattening sheep. When the latter, with the approach of autumn, are put upon aftermath, clover stubbles, rape, cabbages, or turnips, their previous pastures should in succession be thickly stocked by the ewes and other store stock, so as to be eaten bare and then left to freshen and get ready for the ewes by rutting-time, when they require better food. In depasturing sheep on poor soils it is usually highly advantageous to give them a daily allowance of grain or cake in troughs, which must be shifted daily, so as to distribute the manure regularly over the land. By means of this auxiliary food sheep can be fattened on land the herbage of which would not alone suffice for the purpose. It admits also of a larger number of sheep being kept per acre, and of the pasturage being fed off more closely than could otherwise be done. The produce of poor siliceous soils, both in grass and after crops, is much increased by the additional manuring and treading which the consumption of such extraneous food upon them occasions.

It is always advantageous to have pastures provided with a shed, under which the stock can find shelter from sudden storms, or from the attacks of insects and the scorching rays of the summer's sun. When such sheds are regularly strewed with dried peat or burnt clay, much valuable compost for top-dressing the pasture can be obtained. The dung of the cattle, thus secured and applied, benefits the pastures more than that which is dropped upon it by the animals. Such clots require to be spread about from time to time.

The temperate climate of Britain is so peculiarly favourable to the growth of the grasses and other pasture plants, and to the keeping of live stock with safety in the open fields for a large part of the year, that the practice of consuming these crops by depasturing, as already described, has hitherto been decidedly preferred to soiling One con-

sequence of this is, that forage crops have been comparatively neglected. There is now, however, a growing conviction among agriculturists that it is more convenient to keep neat cattle and horses, during summer, in yards or loose boxes, and to feed them with succulent forage, mown and brought to them daily as it is needed, than to turn them adrift to browse in the fields. The pasturing plan is preferred by many because it involves the least labour, and is alleged to be more healthful to the animals. In behalf of the soiling plan it is urged that a given space of ground under green crop keeps nearly twice as much stock, when its produce is mown and consumed elsewhere, than when it is constantly nibbled and trodden upon; that housed cattle being exempted from the vicissitudes of the weather, the attacks of insects, mutual disturbance, and the labour of gathering their food, eat less and yet fatten more rapidly than they do at pasture; that more good is gotten of their excrements when mixed with litter and trodden down under cover, than when dropped about in the open fields; and that land from which a green crop has been mown, when ploughed up, is freer of weeds and (other things being equal) bears a better corn-crop than that which has been pastured. It is a further recommendation to the soiling plan that it admits of oilcake or meal being administered along with green food with a precision and economy that is unattainable in the pasture fields. There being so many and such cogent reasons in favour of the practice of soiling, we may warrantably anticipate that it will in future be much more generally adopted. It is proper, however, to notice that the success of this system is absolutely dependent on the following conditions:—The green food must be mown and brought home at least *twice* a-day, owing to the rapidity with which it ferments when put together; it must be given to the stock not less than *four* times daily, and only in such quantity at each feed as they can eat clean up in the interval betwixt meals; they must have constant and ample supplies of pure water and of fresh litter; and, in particular, matters must be so arranged that there shall be an unfailing supply of green forage of the best quality through the entire season. This is accomplished either by successive cuttings of one kind of crop from the same ground—as of irrigated meadow or Italian ryegrass—or by a combination of such crops as naturally come to maturity in succession, or are made to do so by a sequence of sowings. From what has been said it is obvious that soiling can only be carried out successfully with a moderately good soil and climate, a liberal use of manure, and skill and foresight on the part of the farmer. With these, however, its results will usually be highly satisfactory. It is peculiarly adapted for clay soils, on which the culture of root crops is attended with much difficulty, and where there is, therefore, abundance of litter for use in summer, and much need for the soiling system to get it converted into good manure.

Section 2.—Natural Meadow Grass.

In proceeding to notice the crops most usually cultivated in Britain for green forage we shall begin with *natural meadow grass.* In the south-western parts of England abundant crops of grass are obtained by irrigation with water alone. Our remarks will here, however, be restricted to those situations where sewage from towns or villages is available. Wherever a few scores of human families are congregated together, and have their dwellings properly drained and supplied with water, there is an opportunity for manuring a considerable extent of meadow with the sewage-water accruing from them throughout the year. The celebrated meadows in the environs of Edinburgh are interesting illustrations of the value of such water for irrigating purposes, and of the astonishing bulk of rich herbage which can be obtained in the course of a year from an acre of land thus treated. From the thickness of the crop in these meadows, and the rank luxuriance of its growth, the grass must be cut before it exceeds *ten* inches in height, as otherwise the bottom gets blanched and the grass rots out. The mowing begins usually in April and continues till November, so that by fitly proportioning the head of stock to the extent of meadow, and having the latter arranged in plots to be mown in regular succession, soiling can be practised throughout the season by the produce of the meadow alone. This practice is necessarily limited to situations where sewage-water is available. The following excerpts from a paper read before the Royal Scottish Society of Arts in January 1867 *On the Collection, Removal, and Disposal of the Refuse of the City of Edinburgh*, by Charles Macpherson, C.E., burgh engineer, to which the society's silver medal was awarded, will explain this system and exhibit its results:—

"The waters of the Craigentinny Burn, the Lochrin Burn, the Jordan Burn, and the Broughton Burn, are used in irrigating part of the lands adjoining the course of the respective streams. The waters of the Craigentinny Burn are used for irrigating about 250 acres; Lochrin Burn, about 70 acres; Jordan Burn, about 11 acres; and Broughton Burn, about 5 acres—being 336 acres in all irrigated by the water flowing in these four natural outlets for the drainage of Edinburgh.

"The area within the city draining towards the Craigentinny Burn—to the meadows irrigated by the waters of which I shall confine these remarks—is about one square mile and a half in extent. From this district there flows about 20 cubic feet of spring-water per minute; the surplus rainfall being the non-absorbed portion of 24 inches per annum; and the sewage from a population of 95,589 persons, according to the census of 1861, with a water supply of say 25 gallons per head. Of this population about 60,000 have the use of water-closets; and excrementitious matter from about 15,000 or 20,000 of the remainder finds its way to the sewers connected with the burn at the rate of about 265 feet per minute of sewage.

"Various kinds of soil are irrigated. The subsoil of the part of the meadows nearest the city is peat, with loam over it near the course of the burn; while to the northward it is naturally sand, but the sand has been taken away, and the ground made up with rubbish of buildings, &c., dressed off with soil. Further down the course of the stream the soil is reddish clay, or loamy clay, or sandy clay; while at the part of the Figgate Whins adjoining the sea-shore it is pure sand, with a coating of rich loam, varying from 1 inch to 4 or 5 inches deep, entirely derived from repeated applications of the sewage, no soil having been ever spread over the sand. The deeper soil is nearest the channels for conveying the sewage to the land. The meadows on the farm of Lochend, at Restalrig, and at Craigentinny, have a slope transversely to the course of the stream, varying from the steepest part, 1 in 25, which is of small extent, to about 1 in 50, which is the slope of the greatest part of these meadows. The Figgate Whins were artificially levelled to allow of irrigation.

"It is important to remark that the land (except the sand at the Figgate Whins) has been drained thoroughly to a depth of 4 feet below the surface. It was found that with shallower drains the sewage was drawn off by the drain, leaving the lower part of the ground without irrigation. At the Figgate Whins the sewage soaks into the sand, and oozes out upon the sea-shore.

"The kinds of grasses grown are Italian ryegrass and meadow grass. The ryegrass requires to be resown every third year; but the meadow grass has not required resowing, not even on the Figgate Whins, which were sown about forty years ago, when the ground was first irrigated. Opinions differ as to which grass is best adapted for the purpose; but ryegrass seems to produce the heavier crops. The irrigated ground is let off in small plots or squares for the season to the highest bidder. The grass is cut by the tenant as required, so that the annual yield of any particular plot has never been accurately ascertained; but an average crop is considered to be from 30 to 40 tons per acre, in four cuttings. The first cutting takes place at the beginning of April, and the last at the end of September, the let of the ground expiring at 1st October. The time of cutting the intermediate crops depends upon the wants of the tenant.

"The whole grass is eaten by about 3100 cows—the number previous to the cattle plague—in Edinburgh, Newhaven, Leith, and Portobello; but after the fourth crop is cut, sheep are turned on some parts of the ground about the beginning of November, and remain for about a fortnight, should the weather be favourable. The sheep do not seem to thrive, however, although the food is plentiful. The grass has been found most suitable for feeding cows—the attempts to use it for feeding other animals having been found not to answer, and

the cost of converting it into hay being proved to be such as to render the process unprofitable.

"The price paid for the plots varies considerably, the best being known to bring £40 per acre, while others are as low as £15 or £20. Last season, owing to the cattle plague, the former high prices could not be obtained. The best land produces the heaviest crop; but on the Figgate Whins, mere irrigated sand, the first crop is earlier in the season—a matter of such consequence that, although the annual yield is less, the rent paid for these plots is about as high as for the plots producing the heavier crop. The rental of the Figgate Whins previous to the irrigation was, I have been informed, about 20s. per acre; while, when irrigated, parts have been let for some years at £40 per acre. The only works having been the levelling of the sandy hillocks and formation of channels for the sewage—neither of them very costly operations—and the annual outlay being small, the increased annual value of that land may be stated at not much less than the difference between the two sums.

"It might be an interesting speculation to consider how far the cost of the works necessary for collecting and removing the sewage from the district of the city draining towards Craigentinny might have been defrayed by the advance of rent obtained by the disposal of the sewage in irrigating the land along the course of the stream. The cost of the whole sewerage works (including many of the branch drains) constructed within the district in the city which is drained to the Craigentinny Burn, may be stated at £96,000. Assuming that the annual rent of the 250 acres irrigated was £5 per acre on an average previous to being laid out for irrigation, while the rent was raised to £25, then the difference, £20 per acre, is the annual value of the irrigation. There being 250 acres, gives £5000 as the return, or upwards of 5 per cent. on the cost of the sewers.

"The produce of the various irrigated meadows round Edinburgh is sufficient to supply the present demand for grass; necessitating any further application of the sewage to some other kind of crop, unless a more extensive market is obtained for the grass produced."

Section 3.—Italian Ryegrass.

Italian ryegrass can be cultivated over as wide a range of soils and climate as any forage crop which we possess, and its value for soiling is every day getting to be more generally appreciated. When first introduced, and indeed until very recently, it was chiefly sown in mixture with other grasses and clovers for pasturage, a purpose to which it is well adapted from its early and rapid growth in spring. Its true function, however, is to produce green food for soiling, for which purpose it is probably unrivalled. It is in connection with the system of irrigation with liquid manure that its astonishing powers have been most fully developed. When grown for this purpose it is sown in April, on land that has borne a grain crop after turnips or summer fallow. If sown *with* a grain crop as thickly as is requisite, it grows to nearly the height of the grain, and both are injured. A liberal dressing of farm-yard dung is spread upon the stubble in autumn, and immediately ploughed in. In the end of March or beginning of April the land is prepared for the seed by being stirred with the grubber and then well harrowed. The seed, at the rate of 4 bushels per acre, is then sown in the way already described for clover and grass seeds. When the liquid manure system is practised, the crop is watered as soon as the young plants are about an inch high, and so rapid is its growth in favourable circumstances that a cutting of 10 tons per acre has in some cases been obtained six weeks after sowing. When there is no provision for supplying liquid manure, a top-dressing of guano, nitrate of soda, soot, or the first two articles mixed, is applied by hand-sowing, care being taken to give this dressing when rain seems at hand or has just fallen. A similar top-dressing is repeated after each cutting, by which means three cuttings are ordinarily obtained from the same space in one season. A very great quantity of stock can thus be supported from a very limited extent of ground. This grass is also found to be very grateful to the palates of horses, cattle, and sheep, which all thrive upon it. Though so very succulent, it does not produce purging in the animals fed upon it. It is peculiarly suitable feeding for milch cows, as appears from the published account at Canning Park. Such results as those obtained by Mr Kennedy and others are not to be expected unless under similar conditions; but on good loams, clean and in good heart, and under such treatment as is described at the beginning of this section, as large crops of this grass as of red clover may be reckoned on, with at least equal feeding powers, and with a degree of certainty which the farmer cannot now entertain in regard to the latter crop. If it is regularly mown when the ear begins to show, and care taken never to allow the seed to form, it is fully ascertained that this grass will grow abundantly for a second year, with the advantage of being ready for use very much earlier than in its first season. It is sometimes sown in autumn, but those who have had the fullest experience in its cultivation give a decided preference to spring sowing, either after a grain crop which has followed a green crop or fallow, or at once after turnips. It is of great importance to get fresh and genuine seed. That directly imported from Italy yields the best crop when otherwise good. As a proof of the fondness of sheep for this grass, it has been observed that when it had been sown in mixture with red clover and cut for hay, sheep, on being turned into the aftermath, eat down the Italian ryegrass in preference to the clover.

Section 4.—Crimson Clover.

Crimson clover, though not hardy enough to withstand the climate of Scotland in ordinary winters, is a most valuable forage crop in England. It is sown as quickly as possible after the removal of a grain crop at the rate of 18 ℔ to 20 ℔ per acre. It is found to succeed better when only the surface of the soil is stirred by the scarifier and harrow than when a ploughing is given. It grows rapidly in spring, and yields an abundant crop of green food, peculiarly palatable to live stock. It is also suitable for making into hay. Only one cutting, however, can be obtained, as it does not shoot again after being mown.

Section 5.—Red Clover.

This plant, either sown alone or in mixture with ryegrass, has for a long time formed the staple crop for soiling; and so long as it grew freely, its power of shooting up again after repeated mowings, the bulk of crop thus obtained, its palatableness to stock and feeding qualities, the great range of soils and climate in which it grows, and its fitness either for pasturage or soiling, well entitled it to this preference. Except on certain rich calcareous clay soils, it has now, however, become an exceedingly precarious crop. The seed, when genuine, which unfortunately is very often not the case, germinates as freely as ever, and no greater difficulty than heretofore is experienced in having a full plant during autumn and the greater part of winter; but over most part of the country, the farmer, after having his hopes raised by seeing a thick cover of vigorous-looking clover plants over his field, finds to his dismay, by March or April, that they have either entirely disappeared, or are found only in capricious patches here and there over the field. No satisfactory explanation of this clover failure has yet been given, nor any certain remedy, of a kind to be applied to the soil, discovered. One important fact is, however, now well established, viz., that when the cropping of the land is so managed that clover does not recur at shorter intervals than eight years, it grows with much of its pristine vigour. The knowledge of this fact now determines many farmers in varying their rotation so as to secure this important end. At one time there was a somewhat prevalent belief that the introduction of beans into the rotation had a specific influence of a beneficial kind on the clover when it came next to be sown; but the true explanation seems to be, that the beans operate favourably only by the incidental circumstance of almost neces-

early lengthening the interval betwixt the recurrences of clover.

When the four-course rotation is followed, no better plan of managing this process has been yet suggested than to sow beans, pease, potatoes, or tares, instead of clover, for one round, making the rotation one of eight years instead of four. The mechanical condition of the soil seems to have something to do with the success or failure of the clover crop. We have often noticed that head-lands, or the converging line of wheel tracks near a gateway at which the preceding root crop had been carted from a field, have had a good take of clover, when on the field generally it had failed. In the same way a field that has been much poached by sheep while consuming turnips upon it, and which has afterwards been ploughed up in an unkindly state, will have the clover prosper upon it, when it fails in other cases where the soil appears in far better condition. If red clover can be again made a safe crop, it will be a boon indeed to agriculture. Its seeds are usually sown along with a grain crop, any time from 1st February to May, at the rate of 12 ℔ to 20 ℔ per acre when not combined with other clovers or grasses.

Italian ryegrass and red clover are now frequently sown in mixture for soiling, and succeed admirably. It is, however, a wiser course to sow them separately, as by substituting the Italian ryegrass for clover, for a single rotation, the farmer not only gets a crop of forage as valuable in all respects, but is enabled, if he choose, to prolong the interval betwixt the sowings of clover to twelve years, by sowing, as already recommended, pulse the first round, Italian ryegrass the second, and clover the third.

These two crops, then, are those on which the arable-land farmer mainly relies for green forage. To have them good, he must be prepared to make a liberal application of manure. Good farm-yard dung may be applied with advantage either in autumn or spring, taking care to cart it upon the land only when it is dry enough to admit of this being done without injury. It must also be spread very evenly so soon as emptied from the carts. But it is usually more expedient to use either guano, nitrate of soda, or soot, for this purpose, at the rates respectively of 2 cwt., 1 cwt., and 20 bushels. If two or more of these substances are used, the quantities of each will be altered in proportion. They are best also to be applied in two or three portions at intervals of fourteen to twenty days, beginning towards the end of December, and only when rain seems imminent or has just fallen.

When manure is broadcast over a young clover field, and presently after washed in by rain, the effect is identical with that of first dissolving it in water, and then distributing the dilution over the surface, with this difference, namely, that the first plan costs only the price of the guano, &c., and is available at any time and to every one, whereas the latter implies the construction of tanks and costly machinery.

Section 6.—Vetches.

Vetches are another very valuable forage crop. Being indigenous to Britain, and not fastidious in regard to soil, they can be cultivated successfully under a great diversity of circumstances, and are well adapted for poor soils. By combining the winter and spring varieties, and making several sowings of each in its season at intervals of two or three weeks, it is practicable to have them fit for use from May till October, and thus to carry out a system of soiling by means of vetches alone. But it is usually more expedient to use them in combination with grass and clover, beginning with the first cutting of the latter in May, taking the winter vetches in June, recurring to the Italian ryegrass or clover as the second cutting is ready, and afterwards bringing the spring vetches into use. Each crop can thus be used when in its best state for cattle food, and so as gratefully to vary their dietary.

Winter Vetches.—There is no botanical difference between winter and spring vetches, and the seeds being identical in appearance, caution is required in purchasing seed to get it of the right sort. Seed grown in England is found the most suitable for sowing in Scotland, as it vegetates more quickly, and produces a more vigorous plant than that which is home-grown. As the great inducement to cultivate this crop is the obtaining of a supply of nutritious green food which shall be ready for use about the 1st May, and so as to fill up the gap which is apt to occur betwixt the root crops of the previous autumn and the ordinary summer food, whether for grazing or soiling, it is of the utmost importance to treat it in such a way that it may be ready for use by the time mentioned. To secure this, winter tares should be sown in August if possible, but always as soon as the land can be cleared of the preceding crop. They may yield a good crop though sown in October, but in this case will probably be very little in advance of early-sown spring vetches, and possess little, if any, advantage over them in any respect. The land on which they are sown should be dry and well sheltered, clean, and in good heart, and be further enriched by ploughing into it from 12 to 15 loads of farm-yard manure. Not less than 3½ bushels of seed per acre should be sown, to which some think it beneficial to add half a bushel of wheat. Rye is frequently used for this purpose, but it gets reedy in the stems, and is rejected by the stock. Winter beans are better than either. The land having been ploughed rather deeply, and well harrowed, it is found advantageous to deposit the seed in rows, either by a drilling-machine or by ribbing. The latter is the best practice, and the ribs should be at least a foot apart and rather deep, that the roots may be well developed before top-growth takes place. As soon in spring as the state of the land and weather admits of it, the crop should be hoed betwixt the drills, a top-dressing at the rate of 40 bushels of soot or 2 cwt. of guano per acre applied by sowing broadcast, and the roller then used for the double purpose of smoothing the surface so as to admit of the free use of the scythe, and of pressing down the plants which may have been loosened by frost. It is thus by early sowing, thick seeding, and liberal manuring, that this crop is to be forced to an early and abundant maturity. May and June are the months in which winter vetches are used to advantage. A second growth will be produced from the roots if the crop is allowed to stand; but it is much better practice to plough up the land as the crop is cleared, and to sow turnips upon it. After a full crop of vetches, land is usually in a good state for a succeeding crop. When the whole process has been well managed, the gross amount of cattle food yielded by a crop of winter vetches, and the turnip crop by which it is followed in the same summer, will be found considerably to exceed what could be obtained from the fullest crop of turnips alone, grown on similar soil, and with the same quantity of manure. It is vain to sow this crop where game abounds.

Spring Vetches, if sown about the 1st of March, will be ready for use by 1st July, when the winter vetches are just cleared off. To obtain the full benefit of this crop, the land on which it is sown must be clean, and to keep it so a much fuller allowance of seed is required than is usually given in Scotland. When the crop is as thick set as it should be, the tendrils interwine, and the ground is covered by a solid mass of herbage, under which no weed can live. To secure this, not less than 4 bushels of seed per acre should be used if sown broadcast, or 3 bushels if in drills. The latter plan, if followed by hoeing, is certainly

the best; for if the weeds are kept in check until the crop is fairly established, they have no chance of getting up afterwards. With a thin crop of vetches, on the other hand, the land is so certain to get foul, that they should at once be ploughed down, and something else put in their place. As vetches are in the best state for use when the seeds begin to form in the pods, repeated sowings are made at intervals of three weeks, beginning by the end of February, or as early in March as the season admits, and continuing till May. The usual practice in Scotland has been to sow vetches on part of the oat break, once ploughed from lea. Sometimes this does very well, but a far better plan is to omit sowing clover and grass seeds on part of the land occupied by wheat or barley after turnips, and having ploughed that portion in the autumn to occupy it with vetches, putting them *instead of "seeds"* for one revolution of the course.

When vetches are grown on poor soils, the most profitable way of using them is by folding sheep upon them, a practice very suitable also for clays, upon which a root crop cannot safely be consumed in this way. A different course must, however, be adopted from that followed when turnips are so disposed of. When sheep are turned in upon a piece of tares, a large portion of the food is trodden down and wasted. Cutting the vetches and putting them into racks does not much mend the matter, as much is still pulled out and wasted, and the manure unequally distributed over the land. To avoid those evils, hurdles with vertical spars, betwixt which the sheep can reach with head and neck, are now used. These are set close up to the growing crop along a considerable stretch, and shifted forward as the sheep eat up what is within their reach. This requires the constant attention of the shepherd, but the labour is repaid by the saving of the food, which being always fresh and clean, does the sheep more good. A modification of this plan is to use the same kind of hurdles, but instead of shifting them as just described, to mow a swathe parallel to them, and fork this forward within reach of the sheep as required, repeating this as often during the day as is found necessary, and at night moving the sheep close up to the growing crop, so that they may lie for the next twenty-four hours on the space which has yielded food for the past day. During the night they have such pickings as have been left on the recently-mown space, and so much of the growing crop as they can get at through the spars. There is less labour by this last mode than the other, and having practised it for many years we know that it answers well. This folding upon vetches is suitable either for finishing off for market sheep that are in forward condition, or for recently-weaned lambs, which, after five or six weeks' folding on this clean, nutritious herbage, are found to take on more readily to eat turnips, and to thrive better upon them, than if they had been kept upon the pastures all the autumn. Sheep folded upon vetches must have water always at command, otherwise they will not prosper.

As spring-sown vetches are in perfection at the season when pastures usually get dry and scanty, a common practice is to cart them on to grass land and spread them out in wisps, to be eaten by the sheep or cattle. It is, however, much better either to have them eaten by sheep where they grow, or to cart them to the homestead.

Section 7.—*Beans.*

The common field bean has not hitherto been recognised as an available *forage* plant. Mr Mechi has, we believe, the merit of first showing its great value for this purpose. In the hot dry summer of 1868, when pastures utterly failed, and men were at their wits' end how to keep their stock in life, he had recourse to his bean crop, then at its full growth, and its green pods filled with soft pulse. His plan of using it was, to mow the needed quantity daily, pass it through a chaff-cutter, and then send it out in troughs to his sheep in their pastures, and to his cattle in their stalls. The quantity of green food per acre yielded by a full crop of beans when used in this way is very great, and probably exceeds that of any other crop we grow. As Mr Mechi observed, on first announcing his practice, "no farmer need to be at a loss for food for his live stock who has a crop of beans at command." We know that many farmers availed themselves of this seasonable hint with the very best results. That pre-eminently successful grazier, Mr William M'Combie, M.P., Tillyfour, has, in his instructive pamphlet, shown how useful it is to have a few acres of mixed beans, peas, and tares ready to give to cattle in forward condition in the month of August, by laying down to them daily on their pastures a supply of this very palatable and nourishing forage. By this expedient they make rapid progress at a season when they would lose the condition they had already gained if left dependent on the then failing pasturage. We can testify from experience that we never have our cattle make such rapid progress on any kind of food as when thus supplied with green pulse on autumn pastures.

Section 8.—*Mustard.*

After a crop of vetches has been consumed, if the season is too far advanced to admit of turnips being sown, it is not unusual to take a crop of white mustard or crimson clover.

By means of the crops now enumerated, the practice of soiling can be carried out in all cases where it is practicable.

There are other valuable crops of this kind, several of which we shall now describe; but their culture is either limited by their requirements in regard to soil and climate, or attended with too great expense to admit of their competing with those already described.

Section 9.—*Sainfoin.*

This very important forage plant would be well entitled to a more prominent place in our list but for the circumstance that it is only on dry calcareous soils that its excellences are fully developed; and to these, accordingly, its culture may be said to be confined. In all the chalk districts of England sainfoin occupies an important place in the rotation of crops. Referring to the chalky downs round Ilsley in Berks, Mr Caird says:—"About a tenth part of the land is kept under sainfoin, in which it remains for four years, being each year cut for hay, of which it gives an excellent crop. A farmer having 40 acres of sainfoin sows out 10 acres and breaks up 10 acres annually. This goes regularly over the whole farm, the sainfoin not returning on the same field for considerable intervals, and when its turn comes round the field receives a rest of four years from the routine of cultivation. It is then ploughed up in spring, and sown with oats on one furrow, the crop of which is generally excellent, as much as 80 bushels an acre not being uncommon."[1] The seed, at the rate of 4 bushels per acre, is drilled in immediately after barley or oats has been sown, working the drill at right angles to its course when it deposited the grain. It is frequently pastured for one or more years before being mown either for green forage or for hay. It is sometimes allowed to stand for eight or ten years, but the plan described in the above quotation is the more approved one. A variety called *giant sainfoin* has been introduced by Mr Hart of Ashwell, Herts. As compared with the common sort it is more rapid in its growth in

[1] Caird's *English Agriculture*, p. 114.

spring, and still more so after the first and second cuttings. Three cuttings for hay, and one of these ripening the seed, have been yielded by it in one year, and a good eddish after all. The yield from it in the first year after sowing is large in comparison with the common sainfoin, from its attaining maturity much sooner; but for the same reason it is thought judicious to break it up after three years, while still in vigour.

Section 10.—*Lucerne.*

Lucerne is much cultivated as a forage crop in France and other parts of the continent of Europe, but has never come into general use in Britain. It is, however, frequently met with in small patches in districts where the soil is very light, with *a dry subsoil.* Its thick tap-roots penetrate very deeply into the soil; and if a good cover is once obtained, the plants will continue to yield abundant cuttings of herbage for eight or ten years, provided they are statedly top-dressed and kept free from perennial weeds. In cultivating lucerne, the ground must first be thoroughly cleaned, and put into good heart by consuming a turnip crop upon it with sheep. In March or April, the surface-soil having first been brought to a fine tilth, the seed, at the rate of 10 ℔ per acre, is sown in rows 15 to 18 inches apart. As soon as the plants appear they must be freed from weeds by careful hoeing and hand-weeding, repeated as occasion requires. Little produce is obtained from them the first season, and not a very heavy cutting the second; but by the third year two or more abundant crops of herbage will be produced, peculiarly suitable for horse-feed. It is the slow growth of the plants at first, and the difficulty of keeping them free from weeds on those dry soils which alone are adapted for growing lucerne, that have deterred farmers from growing it more extensively than has hitherto been done. We have grown it successfully in Berwickshire on a muiry soil resting on sandstone rock, in an exposed situation, at an elevation of 400 feet. The time to cut it is, as with clover and sainfoin, when it is in full flower.

Section 11.—*Chicory, &c.*

Chicory, burnet, cow-parsnip, and *prickly comfrey,* all known to be palatable to cattle and yielding a large bulk of produce, have probably been less carefully experimented with than their merits deserve. Although they have long figured in such notices as the present, or in occasional paragraphs in agricultural periodicals, they have never yet, that we are aware of, been subjected to such a trial as either conclusively to establish their claim to more extended culture, or to justify the neglect which they have hitherto experienced.

Section 12.—*Gorse or Whin.*

Notwithstanding its formidable spines, the young shoots of this hardy evergreen yield a palatable and nutritious winter forage for horses and cattle. To fit it for this purpose it must be chopped and bruised to destroy the spines. This is sometimes done in a primitive and laborious way by laying the gorse upon a block of wood and beating it with a mallet, flat at one end and armed with crossed knife-edges at the other, by the alternate use of which it is bruised and chopped. There are now a variety of machines by which this is done rapidly and efficiently, and which are in use where this kind of forage is used to any extent. The agricultural value of this plant has often been over-rated by theoretical writers. In the case of very poor, dry soils, it does, however, yield much valuable food at a season when green forage is not otherwise to be had. It is on this account of importance to dairymen; and to them it has this further recommendation, that cows fed upon it give much rich milk, which is free from any unpleasant flavour. To turn it to good account, it must be sown in drills, kept clean by hoeing, and treated as a regular green crop. If sown in March, on land fitly prepared and afterwards duly cared for, it is ready for use in the autumn of the following year. A succession of cuttings of proper age is obtained for several years from the same field. It is cut by a short stout scythe, and must be brought from the field daily; for when put in a heap after being chopped and bruised it heats rapidly. It is given to horses and cows in combination with chopped hay or straw. An acre will produce about 2000 faggots of green two-year-old gorse, weighing 20 ℔ each.

This plant is invaluable in mountain sheep-walks. The rounded form of the furze bushes that are met with in such situations shows how diligently the annual growth, as far as it is accessible, is nibbled by the sheep. The food and shelter afforded to them in snow-storms by clusters of such bushes is of such importance that the wonder is our sheep farmers do not bestow more pains to have it in adequate quantity. Young plants of whin are so kept down by the sheep that they can seldom attain to a profitable size unless protected by a fence for a few years.

Section 13.—*Tussac Grass.*

The tussac grass of the Falkland Islands has of late years attracted considerable attention as a forage plant. From its gigantic growth, even in those ungenial regions, and the extraordinary relish manifested for it by horses and cattle, sanguine hopes were entertained that it was to prove a truly valuable addition to our present list of forage plants; but the attempts hitherto made to introduce it in Britain have not been of a very encouraging kind. The only successful cases have been in the Orkneys and in Lewis. Messrs Lawson of Edinburgh, who have given much attention to it, say—"Our own experience leads to the conclusion, that localities within influence of the sea spray, the soil being of a peaty nature, are without doubt the best adapted for the growth of the tussac; and in such places it is likely to be of great service, as few other nutritive grasses will exist there. In our own experimental grounds it does not thrive well; which may perhaps be accounted for by the nature of the soil, which is light and dry. Regarding its value as a forage plant, we have before us an analysis made, at our request, by Professor Johnston, the results of which show that 'the tussac grass ought to be very nutritive.' Propagation, in the absence of seed, is easily effected, under favourable circumstances, by subdivision of the roots."

We have thus noticed all the more important of our forage crops of ascertained value. Additions will probably be made to them from time to time, especially from the increased attention now bestowed on green crops of all kinds. It has lately been suggested that maize and also lupins, although unfit for our climate as grain crops, might with advantage be tried as forage plants. Both are successfully grown for this purpose in Germany. Being unable to withstand frost, they should be sown not earlier than May. The maize requires a deep rich soil; the lupins again are said to do best on light siliceous soils. Both should be sown in rows 15 to 18 inches apart, and seeded at the rate of 2 bushels per acre. A trial which we made with lupins (both the blue and the yellow sorts) in 1858, on a light moorland, proved a total failure.

Section 14.—*Haymaking.*

Having spoken of the cultivation and use in a green state of herbage and forage crops, it remains to describe the process by which they are preserved for use in a dry state, or *made into hay.* On every farm a supply of good

hay, adequate to the wants of its own live stock, is, or at least ought to be, statedly provided. This is no doubt an expensive kind of food, but on the other hand it is highly nutritious, and conduces much to the healthfulness of the animals fed upon it. Many a valuable farm horse is annually sacrificed to a false economy in feeding him solely on innutritious straw or ill-gotten hay. The owners of such stock would do well to consider that the death of a horse yearly, and the impaired health and condition of the whole stud, more than counterbalance any saving that can be effected by using bad fodder instead of good. But the great consumption of hay is by the numerous horses constantly required in this country for other purposes than farm labour. In the vicinity of towns hay is therefore a staple agricultural product, and haymaking an important branch of rural economy. It is one in the practice of which English farmers generally excel their brethren north of the Tweed. In the counties near the metropolis, in particular, this process is conducted with admirable skill.

In converting the grasses and forage plants into hay, the object is to get quit of the water which they contain, amounting to nearly *two-thirds* of their weight, with the least possible loss of their nutritive qualities. In order to this the crops must be mown at that stage of their growth when the greatest weight of produce with the maximum of nutritive value can be obtained; and then it is necessary so to conduct the drying process that the inspissated juices shall not be washed out and lost by external wetting. A simple and sufficiently accurate rule for determining the first point is to mow when the plants are in full flower. If this stage is exceeded, both the quality of the hay and the amount of the foggage or aftermath are seriously impaired. It follows from this that mowing should be commenced somewhat earlier than the stage indicated, otherwise, before the whole can be cut the last portion will have exceeded the proper degree of ripeness. By cutting a part too soon a slight loss of weight is incurred, which, however, is compensated for by a better aftermath; whereas if part is allowed to mature the seeds, there is a loss of weight, quality, and aftermath. Haymaking, to be done well, must be done quickly, and in order to this a full supply of labourers is indispensable. As a good mower can cut on an average an acre in a day, as many must be engaged as can overtake the extent of crop while it is in the best state for cutting. It is of great importance, too, to have the grass cut close to the ground. A loss of from 5 to 10 per cent. on the gross produce is frequently incurred by unskilful or careless mowers leaving the sward too high. Now that efficient mowing-machines can be had, this work can be performed with a celerity and accuracy hitherto unattainable. To admit of accurate and expeditious mowing, whether by scythe or machine, care must be taken, at the proper season, to remove all stones and other obstructions, and to make the surface smooth by rolling.

Confining our attention, in the first place, to natural meadow grass, let us glance at the process as conducted by those who are most proficient in it. The mowers having commenced their work at sunrise, the haymakers, in the proportion of two men and three women to each mower, so soon as the dew is off, shake out the swathes evenly over the whole ground, until they have overtaken as much as they can get into cocks the same day. This quantity they now turn and toss about as frequently as possible, getting it, before evening, either into a compact windrow, or forming it into very small cocks. Next day these cocks are again opened out, and as much more of the grass in swathe as can be overtaken, all of which is anew subjected to the same repeated turnings, and again, as evening approaches, secured from dew and rain by windrowing and cocking; that which is driest being put into larger cocks than on the previous day. If the weather is hot and parching, that which was first cut is by the fourth day ready for the stack, and is immediately carried. A large rick-cloth is drawn over the incipient stack until more hay is in condition to be added to it, and then, if weather favour, the whole process, from mowing to stacking, for a time goes on simultaneously, and is speedily completed. As the building of the stack proceeds, its sides are, by pulling, freed from loose hay, and straightened; and when completed it is thatched with the least possible delay. If the weather prove showery, the grass is left untouched in the swathe until it begins to get yellow on the under side, in which case it is usually turned over without opening out until weather again favour. To produce fine hay, care must be taken to secure from dew or rain by cocking before nightfall all that has been spread out during the day—never to touch it until dew or wet is off—to shake all out so thoroughly as that the whole may be dried alike —and never to suffer it, after being tedded out, to lie so long as to get scorched on one side. When these operations are conducted successfully, the hay is of a fine light-green colour, delightfully fragrant, and retains its nutritious matter unimpaired. To accomplish this in our variable climate much skill and energy, and an ample command of labour, are necessary.

The cost and labour of this process are now, indeed, much reduced by the use of machinery, consisting of mower, tedder, and rake, by means of which a man and pair of horses can do the work of ten scythemen, and another man and horse can toss, turn, and draw into windrows as much grass as could be overtaken in the same time by fifteen people. The hay-tedder, moreover, shakes out the grass more thoroughly than it can be done by hand. After the hay is gathered into rows, horse labour is also sometimes employed to collect it into heaps by means of a sweep, that is, a piece of plank with a rope attached to each end of it, by which a horse draws it along *on edge*, while two lads hold it down, and the hay is thus pushed forward in successive portions, which are then by hand labour made into orderly cocks. The yield of meadow hay ranges from 1 to 2 tons per acre, and the cost of making it is about 10s. per ton. In London hay is brought to market in trusses, each weighing 56 lb, 36 of which are called a load. In cutting up a stack these trusses are removed from it in compact cubes, which are then neatly secured by bands of twisted hay.

In converting the cultivated forage crops, such as clover (either pure or mixed with ryegrass), sainfoin, lucerne, or vetches, into hay, the procedure varies considerably from that pursued with the natural grasses. A considerable part of these plants consists of broad tender leaves, which, when scorched by the sun, become so dry and brittle that, on the least rough handling, they fly into dust, and are totally lost. These crops, therefore, do not admit of being shaken asunder and tossed about like the natural grasses, a circumstance which unfortunately forbids the use of the tedding-machine in getting them. The swathes are accordingly left untouched until they have got slightly withered on the upper side, after which they are turned several times with as little breaking up as possible; made up first into small cocks, opened out again, gently turned, and made into larger cocks, which as speedily as possible are carried and stacked. These crops can be stacked with safety in a very green state by mixing with them frequent layers of clean dry straw, by which the redundant juices are absorbed, and injurious heating prevented. The straw thus impregnated acquires a flavour which renders it palatable to cattle; but it is advisable, when this practice is adopted, to cut the whole into chaff before using it as fodder.

When it is desired to save the seeds of Italian or common ryegrass, the crop, after being mown, is allowed to lie for a day or two in swathe, and is then neatly gathered into sheaves, bound, and stooked, precisely like a crop of oats. When sufficiently dried, the seed is either thrashed out in the field, the straw stacked like other hay, and the seed spread thinly over a granary floor, and turned several times daily until it is dry enough to keep in a bin or in sacks; or the sheaves are built into small round stacks, which stand until the seed is wanted, when it is thrashed out by machinery like grain.

Of late years we have frequently secured considerable quantities of useful hay by mowing seeds that had been pastured by sheep in the early part of the season. In July we run the mowing-machines over such fields, taking care to set the cutting-bar high enough to leave the fresh-grown herbage untouched, and to remove only that of older and taller growth. The mown stuff is left untouched for two or three days; is then drawn together by the horse rake, and put into cocks for a short time, or carted at once to the rick-yard as weather permits. In this way much herbage that would otherwise go to waste is converted into useful winter fodder, and a fresh-grown clean pasture secured for lambs or other stock.

CHAPTER XIV.

CULTIVATED CROPS—CROPS OF LIMITED CULTIVATION.

Under this head we shall notice a variety of crops which, however valuable in themselves, and important to the farmers of particular localities, are, from one cause or other, not adapted for general cultivation.

Section 1.—*Flax.*

Flax is probably the most important of these crops. Indeed, from the rapid growth of our linen trade, the growing demand for linseed and its products, and the fitness of the soil and climate for the successful growth of flax, it is not without cause that its more extended cultivation has been so strenuously urged upon our farmers, and that influential societies have been organised for the express purpose of promoting this object. Viewed merely as an agricultural crop, the cultivation of flax is exceedingly simple, and could be practised as readily and extensively as that of the cereal crops. The difficulty is, that before it can be disposed of to any advantage, it must undergo a process of partial manufacture; thus there is required not only an abundant supply of cheap labour, but such an amount of skill and personal superintendence on the part of the farmer as is incompatible with due attention to corn and cattle husbandry. If a ready and remunerative market were available for the fibre in its simple form of flax straw, this, in combination with the value of the seed for cattle feeding, would at once hold out sufficient motive to our farmers to grow it statedly and to any required extent. Until this is the case, its culture cannot extend in the corn-growing districts of Great Britain. In Ireland and parts of the Highlands of Scotland, where there is a redundant population much in want of such employment as the flax crop furnishes, and where the climate is suited for its growth, it is highly desirable that its culture should extend, and probable that it will do so. Flax prospers most when grown upon land of firm texture resting upon a moist subsoil. It does well to succeed oats or potatoes, as it requires the soil to be in fresh condition without being too rich. Lands newly broken up from pasture suit it well, as these are generally freer from weeds than those that have been long under tillage. It is usually inexpedient to apply manure directly to the flax crop, as the tendency of this is to produce over-luxuriance, and thereby to mar the quality of the fibre, on which its value chiefly depends. For the same reason it must be thickly seeded, the effect of this being to produce tall slender stems, free from branches. The land having been ploughed in autumn, is prepared for sowing by working it with the grubber, harrow, and roller, until a fine tilth is obtained. On the smooth surface the seed is sown broadcast by hand or machine, at the rate of 3 bushels per acre, and covered in the same manner as clover seeds. It is advisable immediately to hand-rake it with common hay-rakes, and thus to remove all stones and clods, and to secure a uniform close cover of plants. When these are about 3 inches long the crop must be carefully hand-weeded. This is a tedious and expensive process, and hence the importance of sowing the crop on land as free as possible from weeds of all kinds. To obtain flax of the very finest quality the crop must be pulled as soon as the flowers fall, but in the improved modes of steeping, whether by Schenck's or Watt's patent, the value of the fibre is not diminished by allowing the seeds to mature. It must not, however, be allowed to become dead ripe, but should be pulled whenever the seeds appear, on opening the capsule, to be slightly brown-coloured. The pulling requires to be managed with much care. It is performed by men or women, who seize a small quantity with both hands and pull it by a slight jerking effort. The important point to be attended to is to keep the butts even as successive quantities are seized and twitched from the ground. When a convenient handful has been pulled it is laid on the ground, and the next parallel to it at a foot or so apart. The next handfuls are laid across these, and so on until a small pile is made, after which another is begun. After lying in this position for a few days, the seed-vessels or bolls are separated from the flax by lifting each handful separately and pulling the top through a ripple or iron comb fixed upon a piece of plank. As many of these handfuls as will make a small sheaf are then laid very evenly together, and bound near both ends with bands formed of a few stems of flax. These sheaves are set up in stooks, and when dry enough to keep without heating are stacked and thatched until an opportunity occurs of disposing of the flax straw. Sometimes the flax is bound into sheaves and stooked as it is pulled, and treated exactly like a grain crop. In this case the seed is separated from the straw by passing the head of each sheaf between iron rollers. The only objection to this plan is that the bolls of separate sheaves get so entangled in each other as to render it exceedingly difficult to handle them in carrying the crop, and in building and taking down the stacks, without disarranging the sheaves and wasting much straw and seed.

It would be tedious to enter here into a minute detail of the ordinary method of separating the flax fibre from the woody part of the stem. Suffice it to say that in the ordinary practice the sheaves or beets of flax straw are immersed in a pit or pool filled with clear soft water. The sheaves are kept under water by laying boards upon them loaded with stones to keep them down. Here the flax undergoes a process of fermentation by which the parts are separated. About nine or ten days are usually required for this purpose, but this is much influenced by the temperature. A good deal of skill and close watching is required to know exactly when it has been watered enough. The flax is now taken from the pit and evenly spread upon a smooth, clean, recently-mown meadow, where it lies for about ten days more, receiving several turnings the while. When the *retting*, as this is called, is perfected, the flax is carefully gathered up when perfectly dry, and again tied into sheaves, in which state it is stored under cover until the breaking and scutching can be overtaken.

All this necessarily requires much skilful watching and nice manipulation,—more, as we have already said, than is

compatible with the other avocations of an extensive farmer. There are, however, improved modes of accomplishing this preliminary manufacture of flax which, wherever established, pave the way for the growth of flax as an ordinary field crop. For these see article FLAX.

The extent of flax cultivation in Ireland is considerable, but the acreage has been gradually diminishing during late years. In 1864 it reached the maximum, 301,693 acres; next year it fell to 251,433. Since 1869 it has steadily declined, there being 229,252 acres in flax crop that year, and only 122,003 in 1872.

Hemp, although at one time very generally grown in Great Britain, is now so rarely met with that it is unnecessary to enter into details of its cultivation.

Section 2.—Hops.

The hop is an important crop in several of the southern counties of England. Although an indigenous plant, it was originally brought into England for cultivation from Flanders in 1525. It is cultivated to a considerable extent in Belgium, Bavaria, in the United States of America, and more recently in Australia. Hops, as is well known, are chiefly used for preserving and imparting a peculiar flavour to beer. Probably the only parts of the hop flower which enter into the composition of the beer are the seeds, and the yellow glutinous matter which surrounds the outer integuments of the seed, and lies at the bottom of the petals. This yellow matter (technically termed the *condition* of the hop) has an intensely bitter taste, and emits a peculiar and very agreeable aroma, which, however, is extremely volatile; and hence the necessity for close packing as soon as possible after the hops are dried. When kept over a year, much of this aroma flies off, and hence *new* hops are indispensable in brewing the first kinds of beer. Several varieties of the hop are cultivated in England. Of these, the Farnham and Canterbury *whitebines* and *goldings* are esteemed the finest. These are tall varieties, requiring poles of from 14 to 20 feet. The *grapes*, so called from growing in clusters, and of which there are several varieties of various quality, require poles from 10 to 14 feet long. *Jones's*, adapted for lighter and inferior land, requires these but 8 to 10 feet. The *colegates* are a hardy and late-ripening variety, which grow best on stiff soils; and the *Flemish redbine*, only cultivated from its less liability than the other to be attacked by the aphis or black blight.

The hop is a very exhausting crop for the land, requiring to be planted only on the most fertile soils, and to have them sustained by frequent and large dressings of manure rich in nitrogen. Hops are principally cultivated in the counties of Kent, Sussex, Surrey, Hants, Worcester, and Hereford, and to a more limited extent in Essex, Suffolk, and Nottingham. The best quality of hops are grown at Farnham in Kent, upon the outcrop of the upper greensand formation, from whence the phosphatic nodules or coprolites now so well known in the manure market are obtained. In 1871 the land under hop cultivation in Great Britain measured 60,030 acres; in 1872 it amounted to 61,927 acres, of which there were in Kent 37,927, in Sussex 9738, and in Hereford 6106 acres.

In forming a new plantation, the ground soon after Michaelmas is trenched to the depth of 18 inches, if it has previously been in meadow or old pasture, taking care not to bury the surface-soil above half that depth. Subsoil-ploughing will suffice with land that is in tillage. If the land is wet, drains are made from 4 to 5 feet deep, laid with pipes, and a foot of broken stones over them, to prevent the roots of the hops from obstructing the pipes. The distance between the drains is determined by the necessities of each case. Perfect draining is essential to the success of the crop; and the hops are planted in squares or triangles at equal distances, varying from 6 to 7 feet, according to the fertility of the soil and the greater or less luxuriant habit of growth of the variety selected. The plants are raised by cutting off the layers or shoots of the preceding year, which are bedded out during the month of March in ground previously prepared, and in the succeeding autumn become what are called nursery plants or bedded sets. Early in November these are planted, one, two, or three being used for a hill according to the strength of the plants. Care must be taken to introduce a sufficient number of *male* plants, six hills to the acre being deemed sufficient. The presence of these is found to induce earlier maturity, and to improve both the quality and weight of the crops. The ground must at all times be kept free from weeds and have a good depth of pulverised soil. From the first, a stick, 6 feet high or so, is placed to each hill, to which *all* the young bines, as they shoot out during summer, must be tied. A liberal dressing of superphosphate of lime and guano is in June hoed in around each hill, which is repeated in July, under which treatment 2 or 3 cwt. of hops is obtained the first year, in addition to a crop of mangolds, turnips, or potatoes, grown in the intervals between the hills. On newly broken up ground lime is applied the following spring. When a plantation has been established, the annual routine of culture begins in autumn, as soon as the crop has been gathered, when the haulm is stripped from the poles, and stored away as a substitute for straw. The poles are stacked or piled in quantities of 400 or 500, at regular distances on the ground. During winter they are sorted and repointed when required, and new ones substituted for those that are broken or decayed; this work and the carrying on of manure being accomplished in frosty weather. The ground is dug over by the fork at this season. In March the earth is removed from the plants by a beck or pronged hoe till the crown is exposed, that the plant may be pruned. Immediately after this the poles are set, the length and number of these for each hill depending upon the kind of hops and amount of growth anticipated. They are fixed into holes made for them by a hop-bar. As the season advances, the ground is hoed and again dug or stirred by a nidget or scarifier drawn by a horse. Early in May the bines or young shoots, as soon as long enough, are tied to the poles with rushes or bast. This tying is repeated several times as the bines get higher, and has even to be done by step-ladders. In June the hops are earthed up or *hilled*, at which time weak plants get a dressing of guano. Throughout the summer weeds are destroyed as they appear, and the soil kept loose by the nidget or the hand-hoe. If poles are blown over by high winds, they are immediately replaced.

The picking of the hops usually begins about the second week in September, and furnishes ample employment for several weeks to the entire population of the districts, and to a large influx of strangers; men, women, and children all engaging in it. The hop-pickers are arranged into companies, and are supplied with baskets or bins, holding 7 or 8 bushels each, which are gauged with black lines inside to save the trouble of measuring. Each company is under the superintendence of a hop-bailiff, who keeps an account of the earnings, &c. Under him are several men called pole-pullers, whose duty it is to supply the pickers with poles of hops, and to assist in carrying the picked hops to the carts. They use an iron lever called a hop-dog in pulling up the poles. The hops are picked, one by one, into the bins, care being taken that no bunches, nor leaves, nor mouldy hops, are included. The hops are dried in kilns or oast-houses, on floors of haircloth. Great improvements have been made of late years in the construction of these oasts. Much nice discrimination is required in managing the drying so as to produce the best quality of hops. As soon as they are removed from the kiln they are packed into pockets, which during the process are suspended from a hole in the floor, and the hops trodden into them by a man. This is now done more accurately by machines, in which a piston presses the hops into the pockets. Hop-growing is a hazardous speculative business, the return at times being very great, and at other times not covering expenses. This arises from the liability of the hop to the attacks of insects, but more especially to blight and mould. The blight is caused by innumerable hordes of the *Aphis humuli*, which sometimes destroy the plants altogether. The mould is a parasitical fungus. It is believed that a means has at last been discovered of checking the ravages of these assailants, by enveloping each plant separately in a light covering, and subjecting it to the fumes of tobacco in the case of blight, and to a cloud of powdered brimstone in the case of mildew. In blight years it usually happens that some grounds altogether escape, in which case the returns from them are enormous, owing to the enhanced price.

Section 3.—Sugar-Beet.

The Silesian white beet has long been cultivated in various states of continental Europe for the production of sugar, and in several of them is now a staple product of very great value and importance. After several abortive attempts to introduce this industry into our own country, it seems at last to have obtained a firm footing in England, through the enterprise and perseverance of Mr James

Duncan, sugar-refiner, of Mincing Lane, London, who five years ago erected the necessary buildings and machinery at Lavenham, in Suffolk. Through the kindness of Mr Duncan we are enabled to submit to our readers the following details regarding this most interesting enterprise.

The sugar factory at Lavenham was erected in 1868, although not completed until February 1869. Mr Duncan had first of all contracted with various farmers in that neighbourhood to grow beet for him at the price of 20s. per ton of clean roots, delivered at his factory, with the option to the growers of receiving back the resulting pulp at 12s. per ton, if removed as made. Mr Duncan also procured from the continent the necessary supplies of seed of the best sort, and furnished the growers with instructions as to the proper mode of cultivation. In growing mangolds farmers try to grow the largest possible weight per acre, and for this purpose they manure heavily, and give the individual plants ample space. This will not do in the case of sugar-beet, as it is found that small roots are richest in sugar, and that 2½ ℔ each is the best size to aim at. The endeavour, therefore, must be to have the roots small individually, and yet to secure a good weight per acre. As the part of the bulb that grows above ground contains very little sugar, a further object is to have as little of it exposed to light as possible. All this is accomplished by sowing the crop in rows about 16 inches apart, and leaving the plants close to each other. If all is well managed, the crop should yield from 15 to 20 tons of cleaned roots per acre. The delivery of the roots at the factory begins about the end of September, when they are carted direct from the field as they are pulled. The exigences of wheat-sowing and other field labour at that season induce the growers to store a considerable part of their beet crop at home, and to deliver it at the factory from time to time as they can overtake this heavy cartage. The roots lose weight rapidly when kept in clamps, to cover which a little extra price is given as the season advances. The convenience of the growers is much furthered by this arrangement; but it sometimes results in irregular supplies, and consequent loss to the manufacturer. Owing to the extreme drought of 1868 the beet was late in being sown, and the crop was small, amounting only to 1200 tons; but it was exceedingly rich in sugar. The following season was moist, and the yield per acre good, but the area under crop was small, and the total quantity delivered at the factory about 3000 tons. The year 1870 was again an extremely hot and dry one, with a gross produce of 4500 tons, which yielded 12 per cent. of syrup. The produce in 1871 was 6000 tons, yielding 10 per cent. of syrup, and that of 1872 exceeded 7000 tons of very good roots; but the wetness of the season and strikes among the labourers so protracted the factory work, that instead of being completed in December it was prolonged until March, and the percentage of sugar was smaller than it ought to have been. The particulars of this last crop are as follows. The total weight of clean roots from 571 acres was—

Delivered fresh from the fields, .	2370 tons.
Clamped by growers at their farms,	5485 ,,
	7855 ,,

Of the 571 acres,	89	by 2	growers averaged	17	tons per acre.
,,	115	by 2	,,	,,	16	,,
,,	61	by 2	,,	,,	15	,,
,,	21	by 26	,,	,,	14	,,
,,	147			,,	13	,,
,,	10			,,	12	,,
,,	33			,,	11	,,
,,	18			,,	10	,,
,,	15			,,	9	,,
,,	62			,,	8	,,

So that with a total average of 13¾ tons per acre, two-thirds of the crop averaged 15 tons, and the remaining third only 9⅓ tons. The proportion of feeding pulp has been large in 1871 and 1872,—both having been moist seasons,—and has been 22 per cent. of the weight of the roots. In 1870 it was only 19 per cent. The details of the disposal of the pulp from crop 1872 are also interesting. Of 1235 tons of pulp purchased by nine farmers—

597 tons were taken by one,
326 ,, by another,
116 ,, by another,
95 ,, by another, not a grower of beet.

In addition to these quantities sold, about 500 tons were stored at the factory, where at the same time about 100 tons of crop 1871 were still on hand, and in excellent condition. To this latter fact we can add our own testimony, having been favoured by Mr Duncan with a sample of it after it had been eighteen months in store, when we found it perfectly sweet and good, retaining unimpaired the taste and smell of fresh beet-root. The mode of storing the pulp is very simple. On a piece of dry ground a trench is dug out about 7 feet wide and 1 foot deep. Into this trench the pulp is firmly trodden by the feet of the labourers, and gradually drawn to a point, precisely as is done in storing roots. The whole is then covered with earth to the depth of 12 inches; and thus stored, the pulp keeps well for two or three years. In using it, a thin crust from the outsides is rejected. In Germany and Austria tanks of brick-work are used to economise space, but not in France or Belgium. Three tons of this pulp are estimated to be equal in feeding value to one ton of good hay. Hitherto farmers give the preference to fresh-made pulp; but Mr Duncan regards this as quite a mistake, as in his own practice he finds that pulp a year old is a better feeding material than when newly made. In 1872 he fattened 50 cattle on pulp *three* years old, and in the summer of 1873 he had 60 cattle consuming the surplus of the previous season. These cattle (27 yearlings and 33 two-year-olds) consumed daily 35 cwt. of pulp and 4 cwt. of cut chaff (of hay and barley straw) mixed together. The older beasts received daily in addition 7 ℔ each of bean-meal, on which ration they made good progress. To meet the cartage difficulty, Mr Duncan contracted that year (1873) with one grower to perform the haulage of 2000 tons of beet roots a distance of 5 miles by a traction engine.

Several joint-stock companies have been formed for prosecuting this industry, but Mr Duncan's is the only factory as yet in actual operation. It is known also that Mr Lawes and Dr Gilbert have for several years been engaged in extensive experiments on sugar-beet, and with most successful results.

The manufacture of sugar from beet-root has attained to very great dimensions on the continent of Europe. It is known that from the crop of 1872 there has been produced 1,025,000 tons of sugar, worth £24 per ton, and 250,000 tons of molasses, worth £3 per ton, and that new factories, some of them on a gigantic scale, are now in course of erection. A most important fact connected with this rapidly-extending industry is that the erection of a sugar factory is immediately accompanied by an improvement in the agriculture, and an increase in the value of the land, of the surrounding district. In many places farmers gladly contract to supply beet-root at 18s. per ton for ten years, on condition that they receive back pulp in fair proportion to the quantity of root supplied by them. Russia produces the finest quality of beet, instances being known in which the roots yielded 10 per cent. of loaf-sugar. There are good grounds for concluding that Russia will at no very distant date take a prominent place as a sugar-producing country.

There seems at present a reasonable prospect that the

cultivation of sugar-beet will be adopted in various parts of our own country. It has already been proved that the beet grown in the south-eastern counties of England is richer in sugar than that produced in the north of France. And it seems well worth while to ascertain, by careful experiment, whether in certain parts of Scotland, such as the Lothians, Fife, and the carses, sugar-beet could not with advantage be substituted for the precarious and exhausting potato crop. The repeal of the sugar-duty would give a great stimulus to this enterprise, and should be pressed for in the interest of our native agriculture.

Section 4.—Chicory (for its Roots).

The very extensive and constantly increasing consumption of the roots of chicory as a substitute for coffee, renders it now an agricultural crop of some importance. The soils best adapted for its growth are deep friable loams. The process of cultivation is very similar to that required for the carrot, excepting only that it is not sown earlier than the first week of May, lest the plants should run to seed. When this happens, such plants must be thrown aside when the crop is dug, else the quality of the whole will be injured. About 4 ℔ of seed is the quantity to sow per acre, either broadcast or in rows. The latter is undoubtedly the best mode, as it admits of the land being kept clean, and yields roots of greater weight. The crop is ready for digging up in November. A long stout fork is the best implement for this purpose. In using it, care must be taken to get out the roots entire, not only for the sake of the roots, but to lessen an inconvenience attendant on the culture of this plant, namely, that the fragments left in the soil grow amongst the after crops, and are as troublesome as weeds. The roots, when dry, are carefully washed, cut into thin slices, and kiln-dried, when they are fit for the coffee-grinder. From 1 to 1½ tons per acre of the dried root is an average produce.

Section 5.—Oil-yielding Plants.

Various plants are occasionally cultivated in Britain for the sake of the oil which is expressed from their ripened seeds. We have already noticed the value of flax-seed for this purpose, although the fibre is the product which is chiefly had in view in cultivating it. The plants most commonly sown expressly as oil-yielding crops are—rape (*Brassica Napus*), colza (*Brassica campestris oleifera*), gold of pleasure (*Camelina sativa*), and the poppy (*Papaver somniferum*). Rape is the plant most frequently and extensively grown for the production of oil. The colza is said to yield better crops of seed than the other species. This plant is much cultivated in Flanders for this purpose. In Great Britain it seems rather on the decline. It is chiefly on rich alluvial soils that this crop is grown. For a seed-crop rape is sown in June or July, precisely in the manner already described for turnips. The young plants are thinned out to a width of 6 or 8 inches apart, and afterwards kept clean by hoeing. The foliage may be eaten down by sheep early in autumn, without injuring it for the production of a crop of seed. In spring the horse and hand hoe must be used, and the previous application of 1 or 2 cwt. of guano will add to the productiveness of the crop. It suits well to lay down land to clover or grass after a crop of rape or turnip seed, and for this purpose the seeds are sown at the time of giving this spring culture. The crop must be reaped as soon as the seeds are observed to acquire a light brown colour. The reaping is managed precisely as we have described in the case of beans. As the crop, after being reaped and deposited in separate handfuls on the ground, very soon gets dry enough for thrashing, and as the seed is very easily shed after this is the case, this process must be performed as rapidly as possible. Sometimes it is conveyed to the thrashing-mill on harvest carts, on which a cloth is stretched to save the seeds knocked out in the loading and unloading, but more usually the flail is used on temporary thrashing-floors provided in the field by spreading down large cloths. The crop is gently lifted from the ground and placed, heads innermost, on a blanket which two persons grasp by the corners, and carry to the thrashing-floors. A large number of people are required to push this process through rapidly, for unless the crop is quickly handled, a great loss of seed ensues. The seed is immediately spread thinly upon a granary floor, and frequently turned until dry enough to keep in sacks, when it is cleaned and disposed of. On good soil and in favourable seasons the yield sometimes reaches to 40 bushels per acre. The haulm and husks are either used for litter or burned, and the ashes spread upon the land. It makes good fuel for clay-burning.

Section 6.—Seeds of Agricultural Crops.

In the case of seed-corn it is customary for farmers either to select from the best of their own growth, to exchange with or purchase from neighbours, or, if they wish a change from a different locality, to employ a commission-agent to buy for them. In all districts there are careful farmers who, by occupying land that produces grain of good appearance, and being at pains to have good and pure sorts, are stated sellers of seed-corn, and manage in this way to get a few shillings more per quarter for a part of their produce. It is therefore only in the case of new and rare varieties that professional seedsmen ordinarily deal in seed-corn. There are, however, other field crops, such as clovers, grasses, turnip, mangold, carrots, winter vetches, &c., the seeds of which, to a large extent, pass through the hands of seedsmen, and the growing of which is restricted to particular districts, and is in the hands of a limited number of farmers. These seed crops are sometimes very remunerative to the grower; but are hazardous ones for farmers to attempt at their own risk. The only safe course is to grow them at a stipulated price, to the order of some thoroughly respectable seedsman, and to hold to the production of the particular kind or kinds which he requires. This applies in a less degree to the clovers, and to the more commonly cultivated grasses, than to the other seeds just referred to. Such an arrangement is beneficial to all concerned.

We have already described (chap. xiii. sec. 13) the mode of saving the seeds of Italian or common ryegrass; and as other grasses are managed in the same way, it is unnecessary to say more regarding them.

It is only in the southern parts of England that *clover* is grown for the sake of its seeds. When it is meant to take a crop of seed, the clover is fed off with sheep, or mown early in the season, and then allowed to produce its flowers and ripen its seeds. This preliminary eating or cutting over causes the plants to throw up a greater number of seed-stems, and to yield a fuller and more equally ripening crop. The crop is mown when the seeds are seen to be matured. In the case of white clover the cutting takes place while the dew is upon the crop, as working amongst it when dry would cause a loss of seed. After mowing and turning the crop, the ground is raked with close-toothed iron rakes, to catch up loose heads. The thrashing is a twofold process—first the separation of the heads or cobs from the stem, called "cobbing," and then of the seeds from the husks, called "drawing." This was formerly accomplished by a laborious and tedious process of thrashing with flails, but it is now done by machinery. In favourable seasons the yield is about 5 or 6 bushels (of 70 ℔ each) per acre.

Turnip seed is the next most important crop of this kind.

From the strong tendency in the best varieties of turnips and swedes to degenerate, and the readiness with which they hybridise with each other, or with any member of the family *Brassica*, no small skill and pains are needed to raise seed that can be depended upon to yield roots of the best quality. Turnip seed is saved either from selected and transplanted roots, or from such as have been sown for the express purpose, and allowed to stand as they grow. The first plan, if the selection is made by a competent judge, is undoubtedly that by which seed of the purest quality is obtained. But it is an expensive way, not only from the labour required in carrying it out, but from the yield of seed being generally much less than from plants that have not been disturbed. Professional seed-growers usually resort to a compromise by which the benefit of both plans is secured, viz., by selecting with great care and transplanting a limited number of bulbs, and saving the seed obtained from them to raise the plants which are to stand for their main seed crop. The latter are carefully examined when they come into bloom, and all plants destroyed the colour of whose flower varies from the proper shade. Turnips that are to bear seed are purposely sown much later in the season than when intended to produce cattle food, as it is found that bulbs about 1 ℔ weight are less liable to be injured by frost or to rot before the seed is matured, than those of larger size. The management of a turnip-seed crop, both as regards culture and harvesting, is identical with that of rape for its seeds, which has already been described.

Mustard.—Both the white and brown mustard is cultivated to some extent in various parts of England. The former is to be found in every garden as a salad plant; but it has of late been coming into increasing favour as a forage crop for sheep, and as a green manure, for which purpose it is ploughed down when about to come into flower. The brown mustard is grown solely for its seeds, which yield the well-known condiment. When white mustard is cultivated for its herbage, it is sown usually in July or August, after some early crop has been removed. The land being brought into a fine tilth, the seed, at the rate of 12 ℔ per acre, is sown broadcast, and covered in the way recommended for clover seeds. In about six weeks it is ready either for feeding off by sheep or for ploughing down as a preparative for wheat or barley. White mustard is not fastidious in regard to soil. When grown for a seed crop it is treated in the way about to be described for the other variety. For this purpose either kind requires a fertile soil, as it is an exhausting crop. The seed is sown in April, is once hoed in May, and requires no further culture. As soon as the pods have assumed a brown colour the crop is reaped and laid down in handfuls, which lie until dry enough for thrashing or stacking. In removing it from the ground it must be handled with great care, and carried to the thrashing-floor or stack on cloths, to avoid the loss of seed. The price depends much on its being saved in dry weather, as the quality suffers much from wet. The yield varies from 20 to 30 bushels per acre, and the price from 10s. to 20s. per bushel. It is chiefly grown on rich alluvial soils in the south-eastern counties of England. This great evil attends its growth, that the seeds which are unavoidably shed in harvesting the crop remain in the soil, and stock it permanently with what proves a pestilent weed amongst future crops.

Market Gardening.—In Essex and Kent no inconsiderable extent of land is annually occupied in growing the seeds of the staple crops of our kitchen and flower gardens. Wholesale seedsmen contract with farmers to grow these seeds for them at a stipulated price.

The growth of fruits and of culinary vegetables is in various parts of Great Britain an important department of farming—for the scale on which it is conducted allies it quite as much to agriculture as to horticulture. In the counties contiguous to London thousands of acres are occupied in growing vegetables and in producing fruit. Very large numbers of persons find employment in these market gardens. The system of cultivation pursued in them is admirable. The soil is trenched two spits deep for nearly every crop; it is heavily manured and kept scrupulously clean by incessant hoeing. Whenever a crop is removed, some other suited to the season is instantly put in its place, and not an inch of ground is suffered to be unproductive. A young farmer, bent on knowing his business thoroughly, could not occupy a few months to better purpose than by placing himself under one of these clever market gardeners.

Kent has long been peculiarly celebrated for its orchards. The best of them are on the borders of the greensand formation, or ragstone as it is provincially called. Apples, pears, plums, cherries, and nuts are produced in immense quantities. The filbert plantations alone are said to occupy 5000 acres. An abundant and cheap supply of fruit and vegetables for the inhabitants of our towns is undoubtedly an important object, and is likely to occupy increased attention wherever a suitable soil and exposure, with facility of carriage by railway, are combined. In Cornwall and in the Channel Islands the cultivation of brocoli and early potatoes is an important and growing industry.

CHAPTER XV.

LIVE STOCK—HORSES.

The breeding and rearing of domesticated animals has ever been a favourite pursuit in Great Britain, and has been carried to greater perfection than any other department of rural affairs. In no other country of similar extent can so many distinct breeds of each class of these animals be found—most of them excellent of their kind, and admirably adapted to the particular use for which they are designed. Observing the usual order, we notice first *Horses.*

Section 1.—*Breeds.*

Here we shall confine our attention to those breeds which are cultivated expressly for the labours of the farm; for although the breeding of saddle-horses is chiefly carried on by farmers, and forms in some districts an important part of their business, it does not seem advisable to treat of it here. It is a department of husbandry requiring such a combination of fitness in the soil, climate, and enclosures of the farm, of access to first-class stallions, and of taste and judgment on the part of the farmer, that few indeed of the many who try it are really successful. The *morale* too of the society into which the breeding of this class of horses almost necessarily brings a man is so unwholesome, that none can mingle in it freely without experiencing to their cost that "evil communications corrupt good manners." We have noted it as a fact of peculiar significance, in this connection, that of the few men who really make money by this business, scarcely one desires to see it prosecuted by his sons.

The immense size and portly presence of the *English black horse* entitle him to priority of notice. This breed is widely diffused throughout England, though found chiefly in the midland counties. It is in the fens and rich pastures of these counties that the celebrated dray horses of London are bred and reared. These horses are too slow and heavy for ordinary farm-work, and would not be bred but for the high prices obtained for them from the great London brewers, who pride themselves on the great size, majestic bearing, and fine condition of their team horses. The breeders of these horses employ brood mares and young

colts exclusively for their farm-work. The colts are highly fed, and worked very gently until four years old, when they are sold to the London brewers, often at very great prices. The same breed is largely used in England for ordinary farm labour, although not found of such gigantic proportions as in those districts where they are bred for the special destination just referred to. Although very docile, their short step, sluggish gait, large consumption of food, and liability to foot lameness, render them less profitable for ordinary farm-work than the breeds about to be mentioned.

The Suffolk Punch is a well-marked breed which has long been cultivated in the county from which it takes its name. These horses are, for the most part, of a sorrel, bay, or chestnut colour, and are probably of Scandinavian origin. They are compact, as their name imports, hardy, very active, and exceedingly honest pullers. These horses at one time were very coarse in their form and rather slow; but they have now been so much improved in form and action that we find them the chief prize-takers at recent exhibitions of the Royal Agricultural Society.

The Cleveland Bays are properly carriage-horses; but still in their native districts they are largely employed for field work. Mr. Milburn says—"The Cleveland, as a pure breed, is losing something of its distinctiveness. It is running into a proverb, that 'a Cleveland horse is too stiff for a hunter, and too light for a coacher;' but there are still remnants of the breed, though less carefully kept distinctive than may be wished by advocates of purity. Still, the contour of the farm-horses of Cleveland has the lightness, and hardiness, and steadiness of the breed; and it is singular that while the lighter soils have horses more calculated for drays, the strong-land farmer has the compact and smaller, but comparatively more powerful animal."

In the north-eastern counties of England, and the adjacent Scottish borders, compact, clean-legged, active horses, of medium size, with a remote dash of blood in them, are generally preferred to those of a heavier and slower kind. One needs only to see how such horses get along at turnip-sowing, or with a heavy load in a one-horse cart, to be convinced of their fitness for the general work of a farm.

The Clydesdale Horses are not excelled by any cart breed in the kingdom for general usefulness. They belong to the larger class of cart-horses, sixteen hands being an average height. Brown and bay are now the prevailing colours. In the district whose name they bear the breeding of them for sale is extensively prosecuted, and is conducted with much care and success. Liberal premiums are offered by the local agricultural societies for good stallions. Horses of this breed are peculiarly distinguished for the free step with which they move along when exerting their strength in cart or plough. Their merits are now so generally appreciated that they are getting rapidly diffused over the country. Many small farmers in Clydesdale make a business of raising entire colts, which they either sell for stallions or send into distant counties to serve for hire in that capacity.

In the Highlands of Scotland, a breed of hardy and very serviceable ponies, or "garrons," as the natives call them, are found in great numbers. In their native glens they are employed in tillage, and although unfit for stated farm-work in the low country, are even there often used in light carts for work requiring despatch rather than great power. Similar ponies abound in Wales.

Section 2.—Breeding of Cart-Horses.

In breeding cart-horses regard must be had to the purpose for which they are designed. If the farmer contemplates the raising of colts for sale, he must aim at a larger frame than if he simply wishes to keep up his own stock of working cattle. These considerations will so far guide him as to the size of the mares and stallions which he selects to breed from; but vigorous constitutions, perfect freedom from organic disease, symmetrical form, and good temper are qualities always indispensable. Nothing is more common than to see mares used for breeding merely because, from lameness or age, they have ceased to be valuable for labour. Lameness from external injury is, of course, no disqualification: but it is mere folly to expect valuable progeny from unsound, mis-shapen, ill-tempered, or delicate dams, or even from really good ones, when their vigour has declined from age. A farmer may grudge to lose the labour of a first-rate mare for two or three months at his busiest season; but if he cannot make arrangements for doing this, he had better let breeding alone altogether; for it is only by producing horses of the best quality that it can be worth his while to breed them at all. It is always desirable that both sire and dam should have arrived at maturity before being put to breed.

The head of the cart-horse should not be large, at least not heavy in the bones of the face and jaws, nor loaded with flesh. Full development of brain is, indeed, of great importance, and hence a horse somewhat wide between the ears is to be preferred. Prick ears and narrow forehead have by some been reckoned excellences, but we have so invariably noticed such horses to be easily startled, given to shying, and wanting in courage and intelligence, that we regard such a form of head as a defect to be avoided. The eye should be bright, full, and somewhat prominent, the neck inclining to thickness, of medium length, and slightly arched, and the shoulders oblique. Upright shoulders have been commended as an advantage in a horse for draught, it being alleged that such a form enables him to throw his weight better into his collar. It should be remembered, however, that the horses which display the greatest power in drawing heavy loads are characterised by muscular vigour and nervous energy rather than mere weight of carcase; and these qualities are more usually found in connection with the oblique shoulder than the upright one—not to mention that this form is indispensable to that free and full step so necessary in a really useful farm-horse.

"The back should be straight and broad, the ribs well arched, and the false ribs of due length, so as to give the abdomen capacity and roundness. The tail should be well set out, not too drooping, and the quarters should be full and muscular. The horse should girth well, and have his height in his body rather than in his legs, so as to look less than measurement proves him to be. The forelegs should be strong, and flat below the knee, and by no means round and gummy either before or behind, neither should they have white hair about them, nor much hair of any colour. The hocks should be broad in front, and neither too straight nor too crooked, nor yet cat-hammed. All diseases of this joint, whether curbs, spavins, or thoroughpins, are sufficient grounds for rejecting a horse. The feet are a matter of very much importance. The tendency of many heavy horses is to have thin horn and flat feet. A stallion possessing such feet is exceedingly objectionable. Plenty of horn is a recommendation, and the feet had better be too large than too small. The brood mare should possess as many of the points now enumerated as possible. If the mare is small but symmetrical, we may very properly select a large stallion, provided he has good action. If, on the other hand, the mare is large and has a tendency to coarseness, we should select a middle-sized horse of symmetrical appearance."[1]

Sixteen hands is a good height for a farm-horse. Except for very heavy land, we have always had more satisfaction from horses slightly below this standard than above it.

We have repeatedly put a well-bred saddle mare to a cart-horse, and have invariably found the produce to prove excellent farm-horses. The opposite cross, betwixt a cart-mare and blood stallion, is nearly as certain to prove ungainly, vicious, and worthless. These horses are generally

[1] Morton's *Cyclopædia of Agriculture*—article "Horse."

much stronger than their appearance indicates, have great powers of endurance, and can be kept in prime working condition at much less cost than bulkier animals. It is on muscular power and nervous energy that the strength of animals depends, and this, therefore, should be sought after in the farm-horse rather than mere bulk.

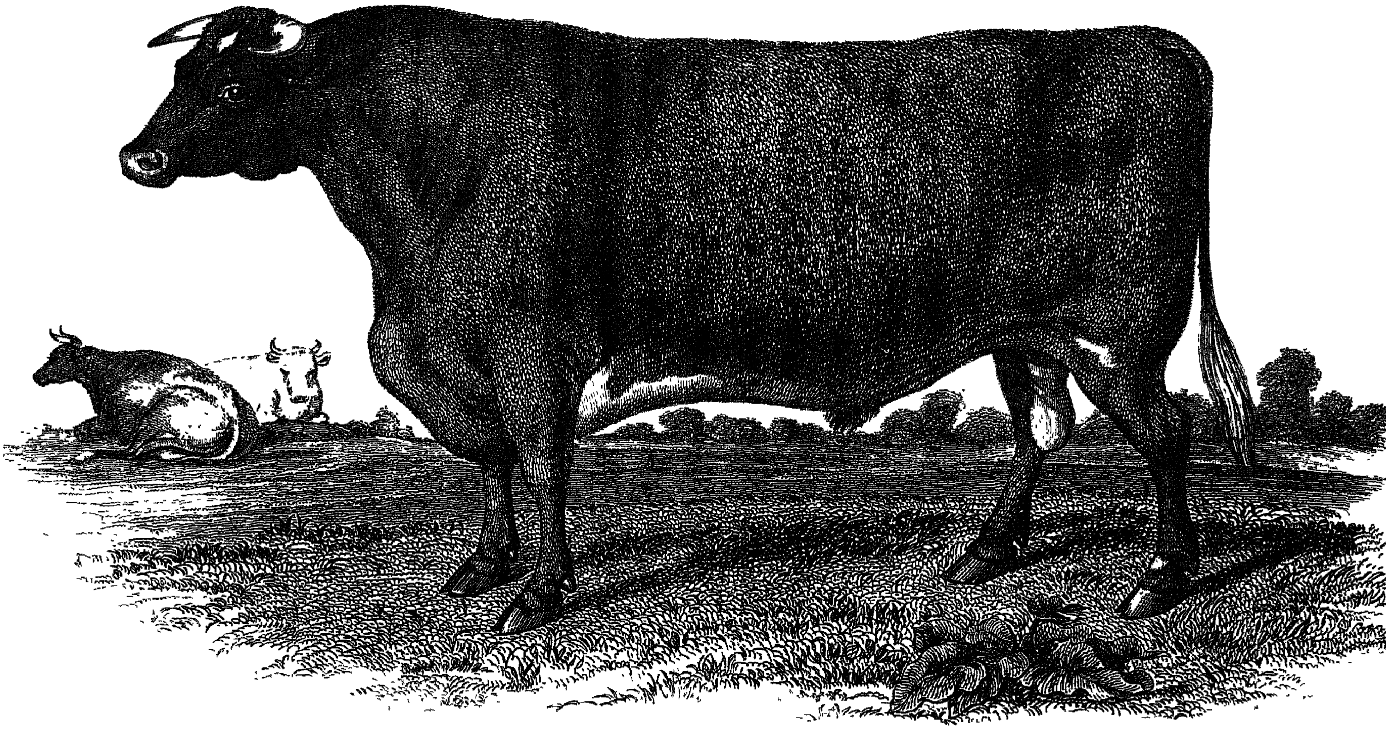
Cart-mares should not foal earlier than May. Provided they are not unduly pushed or put to draw heavy loads, they may be kept at work almost up to their time of foaling, and are thus available for the pressing labours of spring. It is of importance, too, that the pasture should be fresh and the weather mild ere their nursing duties begin. Mares seldom require assistance in bringing forth their young, and although it is well to keep an eye upon them when this event is expected, they should be kept as quiet as possible, as they are impatient of intrusion, and easily disturbed in such circumstances. A sheltered paddock with good grass, and where there are no other horses, is the most suitable quarters for a mare that has newly foaled. There must be no ditch or pond in it, as young foals have a peculiar fatality for getting drowned in such places. A mare, in ordinary condition, receives the stallion on the ninth or tenth day after foaling, and with a greater certainty of conceiving than when it is delayed until she is again in heat. If the mare's labour can at all be dispensed with, it is desirable to have her with her foal for two months at least. She may then be put to easy work with perfect safety, so that she is not kept away from the foal longer than two or three hours at a time. When the foal has got strong enough, it may even be allowed to follow its dam at her work, and to get suck as often as it desires it. Towards the end of September foals are usually weaned, and are then put under cover at night, and receive a little corn, along with succulent food. Good hay, bran, carrots, or swedes, and a few oats, must be given regularly during the first winter, with a warm shed to lie in, and an open court for exercise. At weaning it is highly expedient to put a cavasin on colts, and lead them about for a few times. A few lessons at this early age, when they are easily controlled, saves a world of trouble afterwards. Before being turned to grass in spring, they should, on the same principle, be tied up in stalls for a week or so. It is customary to castrate colts at a year old. Some, indeed, advise its being done a few weeks after birth, when, of course, the pain to the animal and risk of death are less. It must, however, be borne in mind that this early emasculation will probably ensure a skranky neck, whereas a natural tendency to this defect can in good measure be remedied by deferring the operation. We have seen a puny colt much improved in figure by being left entire until he was two years old. By giving good pasture in summer, and a liberal allowance of hay, roots, and oats in winter, colts may with safety, and even benefit, be put to moderate work in their third spring. Some time before this is done they should be put through a short course of training, to use them to the bit, and make them quiet and handy. Many good cart-horses are ruined for want of a little timely attention in this way. When they have got familiar with the harness, they should be yoked to a log of wood, and made to draw that up and down the furrows of a fallow field, until they become accustomed to the restraint and exertion, after which they may with safety be put to plough alongside a steady and good-tempered horse, and, what is of equal consequence, under the charge of a steady, good-tempered ploughman. As they should not have more than five hours' work a-day for the first summer, it is always an advantage to have a pair of them to yoke at the same time, in which case they take half-day about, and do a full horse's work betwixt them. With such moderate work and generous feeding their growth will be promoted. By midsummer, the press of field labour being over, it is advisable to turn the striplings adrift, and let them enjoy themselves in a good pasture until after harvest, when they can again be put to plough. Horses should not be required to draw heavy loaded carts until they are five years old. When put into the shafts earlier than this they frequently get strained and stiffened in their joints. On every farm requiring four or five pairs of horses it is highly expedient to have a pair of young ones coming in annually. This enables the farmer to be provided against contingencies, and to have his stable occupied at all times with horses in their full vigour, which go through their work with spirit, and never falter for a little extra pushing in emergencies.

Section 3.—Feeding and General Management of Farm-Horses.

As there is true economy in employing only the best quality of horses, and these in their prime, so also is there in feeding them uniformly well, and looking to their comfort in all respects. The following quotation from the *Transactions* (for October 1850) of the Highland and Agricultural Society of Scotland, describes the practice of some of our most experienced farmers in this particular :—

"The system of feeding I adopt is as follows :—From the middle of October till the end of May my horses get one feed of steamed food and two feeds of oats daily, with the best oat or wheat straw for fodder. I never give bean straw unless it has been secured in fine condition, having often seen the bad effects of it, partly owing, I think, to its long exposure to the weather. In our variable climate, and from the quantity of sand which adheres to it, I use it generally for litter. The steamed food used is well washed Swedish turnips and potatoes in equal proportions, mixed with sifted wheat-chaff. In those years when we had a total loss of potatoes Swedish turnip alone was used, but not with the same good effect as when mixed with potatoes. This year, having plenty of diseased potatoes in a firm state, I give a larger proportion of potatoes than turnip, and never upon any occasion give oat husks, commonly called meal-seeds, having often seen their injurious effects. At five o'clock in the morning each horse gets 6 ℔ weight of bruised oats, at noon the same quantity of oats, and at half-past seven P.M. 47 ℔ weight of steamed food. I find that it takes 62 ℔ weight of unsteamed potatoes and turnip to produce 47 ℔ steamed ; to each feed of steamed food, 4 oz. of common salt are added, and mixed up with one-fourth part of a bushel of wheat-chaff, weighing about $1\frac{1}{2}$ ℔, a greater quantity of wheat-chaff than this having generally too laxative an effect. Each horse eats from 14 ℔ to 18 ℔ of fodder during the twenty-four hours, besides what is required for litter. In spring I sometimes give a mixture of bruised beans and oats, instead of oats alone ; from June to the middle of October those horses that are required for the working of the green crop, driving manure, and harvest-work, are fed with cut grass and tares in the house ; and about 7 ℔ of oats each day, given at twice, increasing or decreasing the quantity according to the work they have to do ; and I turn out to pasture only those horses that are not required until the busy season. I disapprove of horses that are regularly worked being turned out to grass, and exposed to all the changes of our variable climate, as I believe it to be the origin of many diseases. By this mode of feeding the horses are always in fine sleek condition, and able for their work. I have acted upon this system for the last fifteen years, have always had from 16 to 20 horses, and during that period I have only lost 7 horses, 3 of them from accidental causes ; and I attribute this, in a great measure, to the mode of feeding, and in particular to the steamed food."

The treatment of horses differs somewhat in other places from that now detailed. In Berwickshire, for example, they are usually turned to pasture as soon as the mildness of the weather and the forwardness of the pasture admit of it. While employed in carrying the crop, their fodder consists largely of tares, and afterwards till Martinmas they are fed on hay. From this date oat and bean straw, with 8 or 10 ℔ of raw swedes to each per diem, is substituted till the 1st of March, when, with the recurrence of harder labour, hay is again given till the return of the grazing season. During three-fourths of the year they receive about 16 ℔ of oats per diem, in three separate feeds. From the close of turnip-sowing until harvest, oats are either withheld or given only when a harder day's work occurs. The practice



SHORT-HORNED BULL

PHŒNIX

Bred by and the property of Mr Crisp Hawkhill Northumberland Winner in 1852 of the First Prizes given by the Agricultural Societies of England Scotland & Ireland

J Stewart W Forrest

SHORT-HORNED COW

CHARITY

Bred by and the Property of Mr Booth Warlaby Yorkshire

of bruising the whole of the oats given to horses, and also of chopping their hay, is now very prevalent. By giving a few pounds of chopped hay with each feed of bruised oats, and oat-straw in the racks, during the whole of the winter half-year, horses are kept in better condition and at no more expense than by giving them straw alone for half the period, and hay alone the other half. We are persuaded, also, that unless horses are stripped of their shoes and turned adrift altogether for a summer's run, soiling in boxes or sheds, with an open yard, is preferable to grazing. Hay and oats ought undoubtedly to constitute the staple fare of farm-horses. Without a liberal allowance of suitable and nourishing food, it is impossible that they can perform the full amount of work of which they are capable, or be sustained for any length of time in robust health. When *alleged* very cheap plans of feeding horses are inquired into, it is usually found that the amount and quality of the work performed by them is in fitting proportion. In this, as in so many other things, cheapness and economy are not convertible terms. The true way to economise the horse-labour of a farm is to have only good and well-fed animals, and to get the greatest possible amount of work out of them.

CHAPTER XVI.

LIVE STOCK—CATTLE.

Section 1.—*Breeds*—1*st, Heavy Breeds.*

As our limits do not admit of even a brief notice of all those breeds of cattle for which Great Britain is so famous, we shall restrict our remarks to some of the most important of them. Without entering upon curious speculations as to the origin of these breeds, we proceed to notice them in the order suggested by their relative importance in practical agriculture. The large lowland cattle thus claim our first attention, and amongst them we cannot hesitate in assigning the first place to the

Short-horns.—It appears that from an early date the valley of the Tees possessed a breed of cattle which, in appearance and general qualities, were probably not unlike those *quasi* short-horns which abound in various parts of the country at the present day. By the time that the Messrs Colling came upon the field it is evident that there were many herds around them in which considerable improvement had already been effected, and that they commenced their memorable efforts in cattle-breeding with exceedingly hopeful materials to work upon. But in their masterly hands these materials seemed at once to acquire an unwonted plasticity; for in an incredibly short time their cattle exhibited, in a degree that has not yet been excelled, that combination of rapid and large growth with aptness to fatten, of which their symmetry, good temper, mellow handling, and gay colours are such pleasing indices and accompaniments, and for which they have now acquired a world-wide celebrity. It was by judicious selection in the first instance, and then by coupling animals of near affinity in blood, that they so developed and stereotyped these qualities in their cattle as to entitle them at once to take rank as the progenitors of a new and well-marked breed. These *Durham*, *Teeswater*, or *Short-horn* cattle, as they were variously called, were soon eagerly sought after, and spread over the whole country with amazing rapidity. For a time their merits were disputed by the eager advocates of other and older breeds, some of which (such as the long-horns, once the most numerous breed in the kingdom) they have utterly supplanted, while others, such as the Herefords, Devons, and Scotch polled cattle, have each their zealous admirers, who still maintain their superiority to the younger race. But this controversy is meanwhile getting practically decided in favour of the short-horns, which constantly encroach upon their rivals even in their headquarters, and seldom lose ground which they once gain. Paradoxical as the statement appears, it is yet true that the very excellence of the short-horns has in many cases led to their discredit. For many persons desiring to possess these valuable cattle, and yet grudging the cost of pure-bred bulls, or being ignorant of the principles of breeding, have used worthless cross-bred males, and so have filled the country with an inferior race of cattle, bearing indeed a general resemblance in colour, and partaking in some measure of the good qualities of short-horns, but utterly wanting in their peculiar excellences. By ignorant or prejudiced persons the genuine race is nevertheless held answerable for the defects of the mongrels which usurp their name, and for the damaging comparisons which are made betwixt them and choice specimens of other breeds. That the short-horn breed should spread as it does, in spite of this hinderance, is no small proof of its inherent excellence, and warrants the inference that whenever justice is done to it, it will take its place as the one appropriate breed of the fertile and sheltered parts of Great Britain. This desirable consummation has hitherto been retarded by the scarcity and high price of pure-bred bulls. We are quite aware that bull-breeding, as hitherto conducted, is a hazardous and unremunerative business, notwithstanding the great prices sometimes obtained for first-class animals. We are of opinion, however, that it might be conducted in such a way as to be safer and more profitable to the breeder, and more beneficial to the country at large, than it has hitherto been. There is at present a large and growing demand for good yearling short-horn bulls, at prices ranging from £25 to £50. With a better supply both as to quality and numbers, this demand would steadily increase, for we have long observed that there is no want of customers for really good animals at such prices as we have named. When higher prices than these are demanded, farmers who breed only for the production of beef feel that they are beyond their reach, and are fain to content themselves with lower-priced and inferior animals. We are glad, therefore, that it is a steadily increasing practice for breeders of short-horns to dispose of their young bulls by an annual auction sale on their own premises; or for a number of breeders to concur in offering their lots for sale on the same day at some central auction mart. The good effects of this increasing supply of well-bred bulls are becoming apparent in the improved quality of the cattle now brought to our markets.

A great stimulus has been given to the breeding of high-class short-horns by the extraordinary prices which of late have been obtained for animals of certain favourite and fashionable strains. To illustrate this we give the following particulars of the four principal sales of the year 1872:—

The late Mr Pawlet's .	herd of 60	animals averaged	£195	18	7
Mr G. Bowly's . .	„ 30	„	153	1	9
Earl of Dunmore's . .	„ 54	„	242	18	9
Messrs Harward & Downay's	„ 61	„	253	8	2

It is said that the operations of one enterprising Canadian breeder—Mr Cochran of Hillhurst—have had a powerful effect in determining these extraordinary market rates for short-horns of the choicest type. One cargo, including forty short-horn bulls and heifers, and choice specimens of Cotswold sheep and Berkshire pigs, taken out by this gentleman in 1870, is said to have cost him £15,000. American breeders of short-horn cattle have now established a herd-book of their own, and have been so successful in their efforts that already they have made numerous sales to English breeders at long prices. While we write, accounts have come of the sale by auction, on 10th September 1873, of the herd of Mr Campbell of New York Mills, near

Utica, when 108 animals realised $380,000. Of these 10 were bought by British breeders, 6 of which, of the Duchess family, averaged $24,517, and one of them, "Eighth Duchess of Geneva," was bought for Mr Pavin Davies of Gloucestershire at the unprecedented price of £8120. Choice specimens of these cattle are now also being sent in large numbers to our Australian colonies and to various parts of the continent of Europe. Indeed, it may be said of them, that, like our people, they are rapidly spreading over the world.

As already hinted, the *Hereford* is the breed which in England contests most closely with the short-horns for the palm of excellence. They are admirable grazier's cattle, and when of mature age and fully fattened, present exceedingly level, compact, and massive carcases of excellent beef. But the cows are poor milkers, and the oxen require to be at least two years old before being put up to fatten—defects which, in our view, are fatal to the claims which are put forward on their behalf. To the grazier who purchases them when their growth is somewhat matured they usually yield a good profit, and will generally excel short-horns of the same age. But the distinguishing characteristic of the latter is that, when properly treated, they get sufficiently fat and attain to remunerative weights at, or even under, two years old. If they are kept lean until they have reached that age their peculiar excellence is lost. From the largeness of their frame they then cost more money, consume more food, and yet do not fatten more rapidly than bullocks of slower growing and more compactly formed breeds. It is thus that the grazier frequently gives his verdict in favour of Herefords as compared with short-horns. Even under this mode of management short-horns will usually yield at least as good a return as their rivals *to the breeder and grazier conjointly.* But if fully fed from their birth so as to bring into play their peculiar property of growing and fattening simultaneously, we feel warranted in saying that they will yield a quicker and better return for the food consumed by them than cattle of any other breed. Unless, therefore, similar qualities are developed in the Herefords, we may expect to see them more and more giving place to the short-horns. These remarks apply equally to another breed closely allied to the Herefords, viz., the

North Devons, so much admired for their pleasing colour, elegant form, sprightly gait, and gentle temper, qualities which fit them beyond all other cattle for the labour of the field, in which they are still partially employed in various parts of England. If it could be proved that ox-power is really more economical than horse-power for any stated part of the work of the farm, then the Devons, which form such admirable draught oxen, would be deserving of general cultivation. It is found, however, that when agriculture reaches a certain stage of progress, ox-labour is inadequate to the more rapid and varied operations that are called for, and has to be superseded by that of horses.

Scotland possesses several indigenous breeds of heavy cattle, which for the most part are *black* and *hornless*, such as those of Aberdeen, Angus, and Galloway. These are all valuable breeds, being characterised by good milking and grazing qualities, and by a hardiness which peculiarly adapts them for a bleak climate. Cattle of these breeds, when they have attained to three years old, fatten very rapidly, attain to great size and weight of carcase, and yield beef which is not surpassed in quality by that of any cattle in the kingdom.

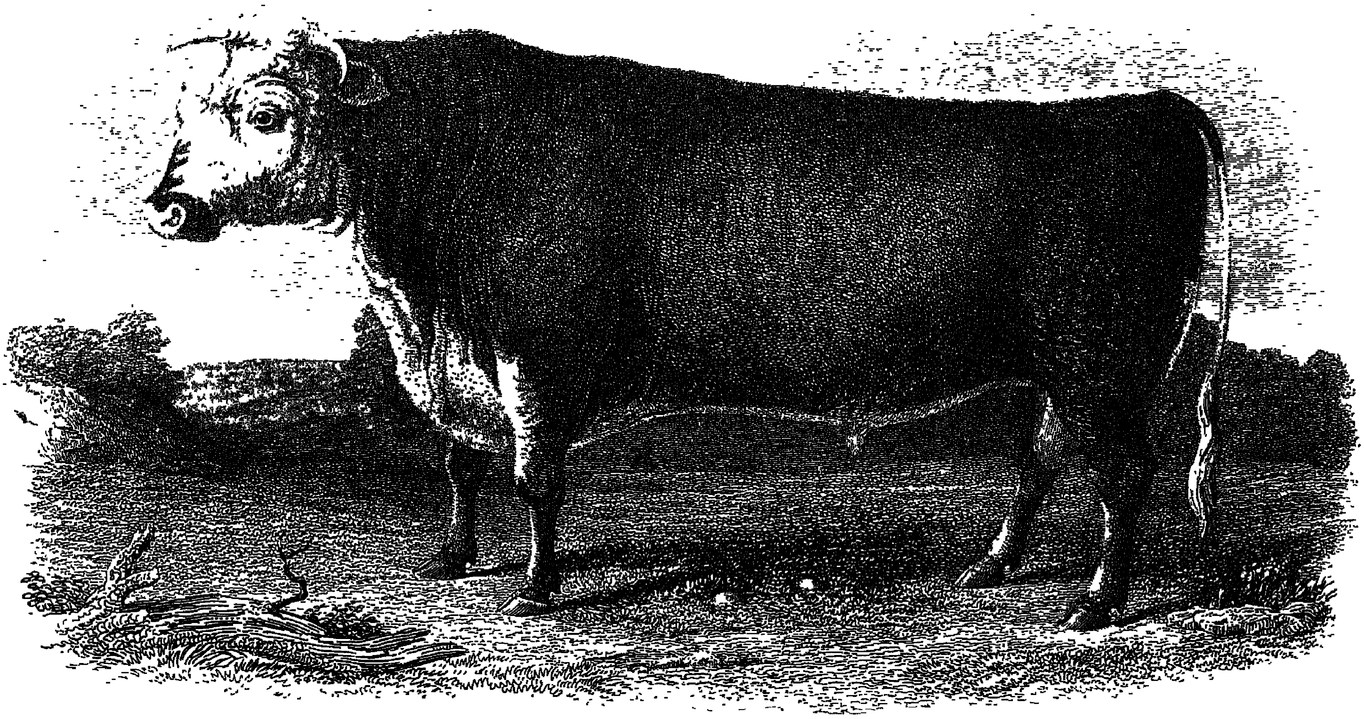
The cows of these breeds, when coupled with a short-horn bull, produce an admirable cross-breed, which combines largely the good qualities of both parents. The great saving of time and food which is effected by the earlier maturity of the cross-breed has induced a very extensive adoption of this practice in all the north-eastern counties of Scotland. Such a system is necessarily inimical to the improvement of the pure native breeds; but when cows of the cross-breed are continuously coupled with pure short-horn bulls, the progeny in a few generations become assimilated to the male parent, and are characterised by a peculiar vigour of constitution and excellent milking power in the cows. With such native breeds to work upon, and this aptitude to blend thoroughly with the short-horn breed, it is much more profitable to introduce the latter in this gradual way of continuous crossing than at once to substitute the one pure breed for the other. The cost of the former plan is much less, as there needs but the purchase from time to time of a good bull; and the risk is incomparably less, as the stock is acclimatised from the first, and there is no danger from a wrong selection. The greatest risk of miscarriage in this mode of changing the breed is from the temptation to which, from mistaken economy, the breeder is exposed of rearing a cross-bred bull himself, or purchasing a merely nominal short-horn bull from others.

From this hurried review of our heavy breeds of cattle it will be seen that we regard the short-horn as incomparably the best of them all, and that we anticipate its ultimate recognition as the breed which most fully meets the requirements of all those parts of the country where grain and green crops are successfully cultivated.

2d.—Dairy Breeds.

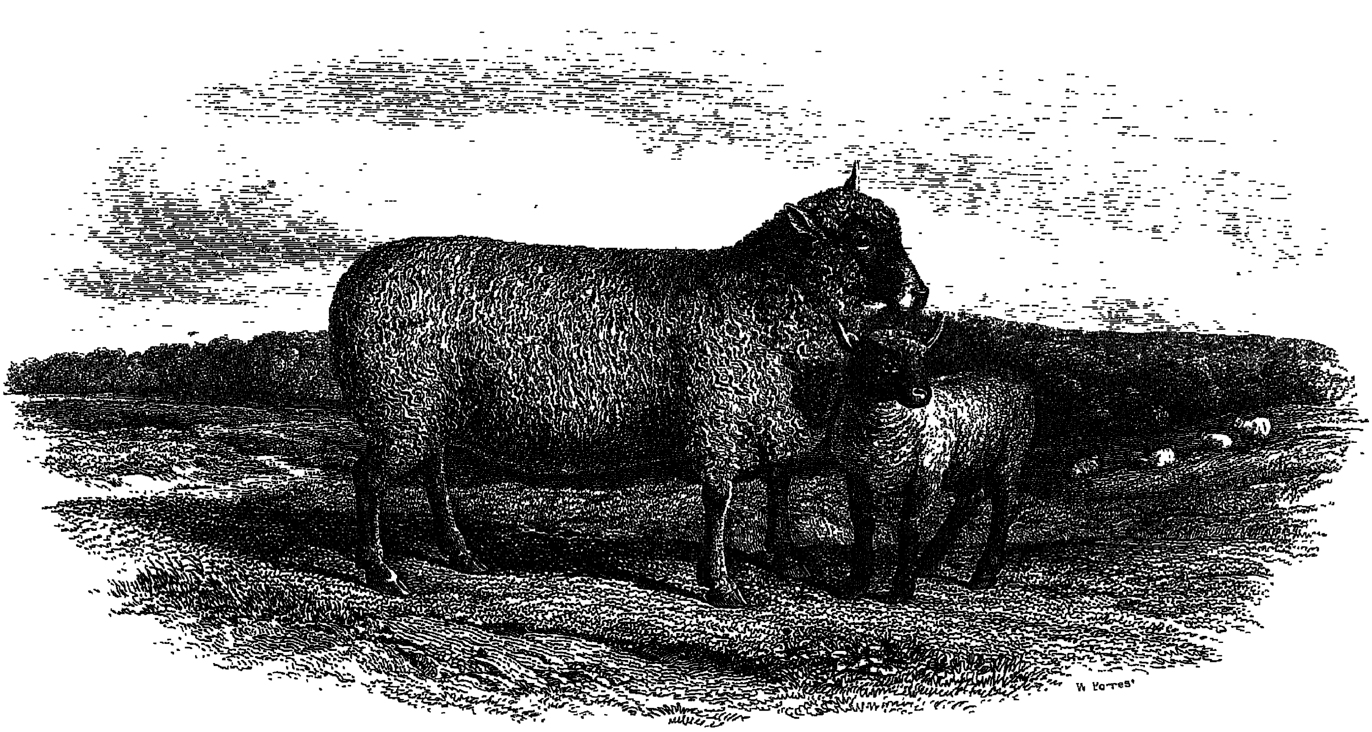
The *dairy breeds* of cattle next claim our attention, for although cattle of all breeds are used for this purpose, there are several which are cultivated chiefly, if not exclusively, because of their fitness for it. Dairy husbandry is prosecuted under two very different and well-defined classes of circumstances. In or near towns, and in populous mining and manufacturing districts, it is carried on for the purpose of supplying families with new milk. In the western half of Great Britain, and in many upland districts, where the soil and climate are more favourable to the production of grass and other green crops than of corn, butter and cheese constitute the staple products of the husbandman. The town dairyman looks to quantity rather than quality of milk, and seeks for cows which are large milkers, which are long in going dry, and which can be readily fattened when their daily yield of milk falls below the remunerative measure. Large cows, such as short-horns and their crosses, are accordingly his favourites. In the rural dairy, again, the merits of a cow are estimated by the weight and quality of the cheese or butter which she yields, rather than by the mere quantity of her milk. The breeds that are cultivated expressly for this purpose are accordingly characterised by a less fleshy and robust build than is requisite in grazier's cattle. Of these we select for special notice the Ayrshire, the Suffolk dun, and the Jersey breeds.

The Ayrshires, by common consent, now occupy the very first rank as profitable dairy cattle. From the pains which have been taken to develop their milk-yielding power it is now of the highest order. Persons who have been conversant only with grazing cattle cannot but be surprised at the strange contrast between an Ayrshire cow in full milk and the forms of cattle which they have been used to regard as most perfect. Her wide pelvis, deep flank, and enormous udder, with its small wide-set teats, seem out of all proportion to her fine bone and slender forequarters. As might be expected, the breed possesses little merit for grazing purposes. Very useful animals are, however, obtained by crossing these cows with a short-horn bull, and this practice is now rather extensively pursued in the west of Scotland by farmers who combine dairy husbandry with the fattening of cattle. The function of the Ayrshire cattle is, however, the dairy. For this they are unsurpassed, either as respects the amount of produce yielded by them in proportion to the food which they consume, or the faculty which they possess of converting the herbage of poor exposed soils, such as abound in their native district, into butter and cheese of the best quality.



BULL, HEREFORD BREED

Bred by the Right Hon^ble the Earl of Talbot



EWE & LAMB, SOUTH DOWN BREED

Bred by Thomas Ellman Esq^r Beddingham

Copied by permission from Professor Low's description of breeds of Domesticated Animals

W & A.K. Johnston

The county of Suffolk has for centuries been celebrated for its dairy produce, which is chiefly obtained from a polled breed of cattle, the prevailing colour of which is dun or pale red, from which they are known as the *Suffolk Duns.* They have a strong general resemblance to the Scotch polled cattle, but nevertheless seem to be indigenous to Suffolk. They are ungainly in their form and of little repute with the grazier, but possess an undoubted capacity of yielding a large quantity of milk in proportion to the food which they consume. They are now encroached upon by, and will probably give place to, the short-horns, by which they are decidedly excelled for the combined purposes of the dairy and the fattening stall.

The breeds already referred to are those to which professional dairymen give the preference, but the cattle of the Channel Islands, of which the *Jersey* may be regarded as the type, are so remarkable for the choice quality of the cream and butter obtained from their rather scanty yield of milk, that they are eagerly sought after for private dairies, in which quality of produce is more regarded than quantity. The rearing of heifers for the English market is of such importance to these islands that very stringent regulations have been adopted for insuring the purity of their peculiar breed. These cattle in general are utterly worthless for the purposes of the grazier. The choicer specimens of the Jerseys have a certain deer-like form which gives them a pleasing aspect. The race, as a whole, bears a striking resemblance to the Ayrshires, which are alleged to owe their peculiar excellences to an early admixture of Jersey blood.

3*d.*—*Mountain Breeds.*

The mountainous parts of Great Britain are not less favoured than the lowlands in possessing breeds of cattle peculiarly adapted to the exigencies of the climate.

The *Kyloes* or *West Highland cattle* are the most prominent of this group. They are widely diffused over the Highlands of Scotland, but are found in the greatest perfection in the larger Hebrides. Well-bred oxen of this breed, when of mature growth and in good condition, exhibit a symmetry of form and noble bearing which is unequalled by any cattle in the kingdom. Although somewhat slow in arriving at maturity, they are contented with the coarsest fare, and ultimately get fat where the daintier short-horns could barely exist. Their hardy constitution, thick mellow hide, and shaggy coat, peculiarly adapt them for a cold humid climate and coarse pasturage. Fewer of these cattle are now reared in the Highlands than formerly, owing to the lessened number of cottars and small tenants, the extension of sheep husbandry, and latterly from the excessive multiplication of deer forests. Large herds of cows are, however, kept on such portions of farms as are unsuited for sheep walks. The milk of these cows is very rich, but as they yield it in small quantity, and go soon dry, they are unsuited for the dairy, and are kept almost solely for the purpose of suckling each her own calf. The calves are generally housed during their first winter, but after that they shift for themselves out of doors all the year round. Vast droves of these cattle are annually transferred to the lowlands, where they are in request for their serviceableness in consuming profitably the produce of coarse pastures and the leavings of daintier stock. Those of a dun or tawny colour are often selected for grazing in the parks of the aristocracy, where they look quite as picturesque as the deer with which they are associated. Indeed, they strikingly resemble the so-called wild cattle that are carefully preserved in the parks of several of our nobility, and like them are probably the descendants of the cattle of the ancient Britons. This view is confirmed by the strong family likeness borne to them by the

Welsh cattle, which is quite what might be expected from the many features, physical and historical, which the two provinces have in common. Although the cattle of Wales, as a whole, are obviously of common origin, they are yet ranged into several groups, which owe their distinctive features either to peculiarities of soil and climate or to intermixture with other breeds. The *Pembrokes* may be taken as the type of the mountain groups. These are hardy cattle, which thrive on scanty pasturage and in a humid climate. They excel the West Highlanders in this respect, that they make good dairy cattle, the cows being peculiarly adapted for cottagers' purposes. When fattened they yield beef of excellent quality. Their prevailing and most esteemed colour is black, with deep orange on the naked parts. The *Anglesea* cattle are larger and coarser than the Pembrokes, and those of *Merioneth* and the higher districts are smaller, and inferior to them in every respect. The county of *Glamorgan* possesses a peculiar breed, bearing its name, which has long been in estimation for combined grazing and dairy purposes. It has latterly been so much encroached upon by Herefords and short-horns that there seems some likelihood of its becoming extinct, which will be cause for regret, unless pains are taken to occupy its place with cattle not inferior to it in dairy qualities. We conclude this rapid review of our native breeds by noticing the most singular of them all, viz.,

The *Shetland cattle*, which are the most diminutive in the world. The carcase of a Shetland cow, when fully fattened, scarcely exceeds in weight that of a long-woolled wether. These little creatures are, however, excellent milkers in proportion to their size; they are very hardy, are contented with the scantiest pasturage, come early to maturity, are easily fattened, and their beef surpasses that of all other breeds for tenderness and delicacy of flavour. The diminutive cows of this breed are not unfrequently coupled with short-horn bulls, and the progeny from such apparently preposterous unions not only possess admirable fattening qualities, but approximate in bulk to their sires. These curious and handsome little creatures, apparently of Scandinavian origin, are so peculiarly fitted to the circumstances of their bleak and stormy habitat, that the utmost pains ought to be taken to preserve the breed in purity, and to improve it by judicious treatment.

Section 2.—Farm Management of Cattle.

We shall now endeavour to describe the farm management of this valuable class of animals, under the heads of *breeding, rearing, fattening,* and *dairy management.* The proceedings of those engaged in the breeding and rearing of cattle for the production of beef are, however, largely determined by the character of the soil and climate of particular districts and farms. The occupiers of all comparatively fertile soils carry forward to maturity such animals as they breed, and dispose of them directly to the butcher. Those who are less fortunately circumstanced in this respect advance their young cattle to such a stage as the capabilities of their farms admit of, and then transfer them to others, by whom the fattening process is conducted. It cannot be too strongly impressed upon those who engage in this business that it never can be profitable to breed inferior cattle; or (however good their quality) to suffer their growth to be arrested by cold or hunger; or to sell them in a lean state. In selecting a breeding stock of cattle, the qualities to be aimed at are a sound constitution and a symmetrical form, aptitude to fatten, quiet temper, and large milk-yielding power in the cows. As all these qualities are hereditary, cattle are valuable for breeding purposes not merely in proportion as they are developed in the individuals, but according to the measure in which they are known to have been possessed by their progenitors. A really good pedigree adds therefore greatly to the value of breeding-stock. It is doubtless important to have both parents good; but in the case of ruminants, the predominating influence of the male in determining the qualities of the progeny is so well ascertained, that the selection of the bull is a matter of prime importance. We are able to state, from ample personal experience, that by using a bull that is at once good himself and of good descent, a level and valuable lot of calves can be obtained from very indifferent cows. It is indeed miserable economy to grudge the price of a good bull. Coarse, mis-shapen, unthrifty cattle cost just as much for rearing and fattening as those of the best quality, and yet may not be worth so much by £3 or £4 a-head when they come ultimately to market. The loss which is annually sustained from breeding inferior cattle is far greater than those concerned seem to be aware of. It is impossible to estimate this loss accurately, but from careful observation and inquiry we are confident that it amounts to not less than 50s. a-head on one-half of the fat cattle annually slaughtered in Great Britain. If this be so, it follows that without expending a farthing more than is done at present on food, housing, and attendance, the profit which would accrue from using only the best class of bulls would be equivalent to an advance of 1s. per stone in the price of beef as regards half of the fat bullocks brought to market. This profit could, moreover, be secured by a very moderate outlay; for if properly gone about, the best class of bulls might be employed without adding more than 3s. or 4s. a-head to the price of each calf reared. We may surely anticipate that such a palpable source of profit will not continue to be neglected by the breeders of cattle. There are many instances in which landlords would find it

much for their interest to aid their tenantry in at once procuring really good bulls. Cattle shows and prizes are useful in their way as a means of improving the cattle of a district, but the introduction of an adequate number of bulls from herds already highly improved is the way to accomplish the desired end cheaply, certainly, and speedily. We must here protest against a practice by which shorthorn bulls are very often prematurely unfitted for breeding. Their tendency to obesity is so remarkable that unless they are kept on short commons they become unwieldy and unserviceable by their third or fourth year. Instead, however, of counteracting this tendency, the best animals are usually "made up," as it is called, for exhibition at cattle shows or for ostentatious display to visitors at home, and the consequence is, that they are ruined for breeding purposes. We rejoice to see that the directors of our national agricultural societies are resolutely setting their faces against this pernicious practice. It is needful certainly that all young animals, although intended for breeding stock, should be well fed, for without this they cannot attain to their full size and development of form. But when this is secured, care should be taken, in the case of all *breeding* animals, never to exceed that degree of flesh which is indispensable to perfect health and vigour. The frequent occurrence of abortion or barrenness in high-pedigreed herds seems chiefly attributable to overfeeding. The farmer who engages in cattle-breeding with the view of turning out a profitable lot of fat beasts annually, will take pains first of all to provide a useful lot of cows, such as will produce good calves, and if well fed while *giving milk* will yield enough of it to keep two or three calves a-piece. That he may be able to obtain a sufficient supply of good calves he will keep a really good bull, and allow the cottagers residing on the farm or in its neighbourhood to send their cows to him free of charge, stipulating only that when they have a calf for sale he shall have the first offer of it.

Cows are an expensive stock to keep, and it is therefore of importance to turn their milk to the best account. It is poor economy, however, to attempt to rear a greater number of calves than can be done justice to. Seeing that they are to be reared for the production of beef, the only profitable course is to feed them well from birth to maturity. During the first weeks of calf-hood the only suitable diet is unadultered milk, warm from the cow, given three times a-day, and not less than two quarts of it at each meal. By three weeks old they may be taught to eat good hay, linseed cake, and sliced swedes. As the latter items of diet are relished and freely eaten, the allowance of milk is gradually diminished until about the twelfth week, when it may be finally withdrawn. The linseed cake is then given more freely, and water put within their reach. For the first six weeks calves should be kept each in a separate crib; but after this they are the better of having room to frisk about. Their quarters, however, should be well sheltered, as a comfortable degree of warmth greatly promotes their growth. During their first summer they do best to be soiled on vetches, clover, or Italian ryegrass, with from 1 ℔ to 2 ℔ of cake to each calf daily. When the green forage fails, white or yellow turnips are substituted for it. A full allowance of these, with abundance of oat straw, and not less than 2 ℔ of cake daily, is the appropriate fare for them during their first winter. Swedes will be substituted for turnips during the months of spring, and these again will give place in due time to green forage or the best pasturage. The daily ration of cake should never be withdrawn. It greatly promotes growth, fattening, and general good health, and in particular is a specific against the disease called blackleg, which often proves so fatal to young cattle. Young cattle that have been skilfully managed upon the system which we have now sketched, are at 18 months old already of great size, with open horns, mellow hide, and all those other features which indicate to the experienced grazier that they will grow and fatten rapidly. This style of management is not only the best for those who fatten as well as rear, but is also the most profitable for those who rear only.

We have already stated that in Scotland comparatively few cattle are fattened on pasturage. An increasing number of fat beasts are now prepared for market during the summer months by soiling on green forage; but it is by means of the turnip crop, and during the winter months, that this branch of husbandry is all but exclusively conducted in the northern half of Great Britain. But a few years ago the fattening of cattle on Tweedside and in the Lothians was conducted almost exclusively in open courts, with sheds on one or more sides, in which from two to twenty animals were confined together, and fed on turnips and straw alone. Important changes have now been introduced, both as regards housing and feeding, by means of which a great saving of food has been effected. Under the former practice the cattle received as many turnips as they could eat, which, for an average-sized two-year-old bullock, was not less than 220 ℔ daily. The consequence of this enormous consumption of watery food was, that for the first month or two after being thus fed the animals were kept in a state of habitual diarrhœa. Dry fodder was, indeed, always placed within their reach; but as long as they had the opportunity of taking their fill of turnips, the dry straw was all but neglected. By stinting them to about 100 ℔ of turnips daily, they can be compelled to eat a large quantity of straw, and on this diet they thrive faster than on turnips at will. A better plan, however, is to render the fodder so palatable as to induce them to eat it of choice. This can be done by grating down the turnips by one or other of the pulping-machines now getting into common use, and then mixing the grated turnip with an equal quantity, by measure, of cut straw. Some persons allow the food after being thus mixed to lie in a heap for two days, so that fermentation may ensue before it is given to the cattle. There is, however, a preponderance of evidence in favour of using it fresh. To this mess can conveniently be added an allowance of ground cake, whether of linseed, rape, or cotton seed, and of meal of any kind of grain which the farmer finds it most economical at the time to use. The ground cake and meal are, in this case, to be thoroughly mixed with the pulped turnip and cut straw. The same end can be accomplished by giving a moderate feed (say 50 ℔) of sliced roots twice a-day, and four hours after each of these meals, another, consisting of cut straw, cake, and meal. In this case the chaff and farinaceous ingredients should be mixed and cooked by steam in a close vessel; or the meal can be boiled in an open kettle, with water enough to make it of the consistency of gruel, and then poured over the chaff, mixed thoroughly with it, and allowed to lie in a heap for two or three hours before it is served out to the cattle. From 2 to 4 ℔ of meal, &c., a-head per diem is enough to begin with. But as the fattening process goes on it is gradually increased, and may rise to 7 or 8 ℔ during the last month before sending to market. It is advisable to mix with the cooked mess about 2 ounces of salt per diem for each bullock. An important recommendation to this mode of preparing cattle food is, that it enables the farmer to use rape-cake freely; for when this article is reduced to a coarse powder, and heated to the boiling point, it not only loses its acrid qualities, but acquires a smell and flavour which induce cattle to eat it greedily. Moreover, if the rape-seeds should have been adulterated with those of wild mustard before going to the crushing-mill (as not unfrequently happens),

and a cake is thus produced which in its raw state is poisonous to cattle, it has been ascertained that boiling deprives such spurious cake of its hurtful qualities and renders it safe and wholesome. As rape-cake possesses fattening elements equal to those of linseed-cake, and can usually be bought at half the price, it is well worth while to have recourse to a process by which it can so easily be rendered a palatable and nourishing food for cattle.

Fattening cattle are usually allowed to remain in the pastures to a later date in autumn than is profitable. The pressure of harvest work, or the immature state of his turnip crop, often induces the farmer to delay housing his bullocks until long after they have ceased to make progress on grass. They may still have a full bite on their pastures; but the lengthening nights and lowering temperature lessen the nutritive quality of the herbage, and arrest the further accumulation of fat and flesh. The hair of the cattle begins also to grow rapidly as the nights get chilly, and causes them to be housed with rougher coats than are then expedient. To avoid these evils the farmer should early in August begin to spread on the pasture a daily feed of green forage, consisting of vetches, peas, and beans grown in mixture in about equal proportions, which if well podded and full of soft pulse, supplies exactly the kind of food required to compensate for the deteriorating pasturage. Early in September cabbages and white globe turnips should be given on the pasture in lieu of the green forage. After ten days or so of this treatment they should be transferred to their winter quarters. For the first two months after they go into winter quarters they make as good progress on yellow turnips as on any kind of roots; for the three following months well stored swedes are the best food for them; and from the beginning of March until the end of the season, mangolds and potatoes, in the proportion of four parts of the former to one of the latter. The chaff of wheat, oats, or beans, if tolerably free from dust, is quite as suitable as cut straw for mixing with the pulped roots and cooked food. The addition of a small quantity of chopped hay, or of the husks of kiln-dried oats, to the other food, usually induces cattle to feed more eagerly. In short, the animals must be closely watched, and occasional variations made in the quantity and quality of the food given to particular individuals or of the general lot as their circumstances may require. Besides the food given in the manger it is desirable that each animal should receive a daily allowance of fresh oat straw in a rack to which he has access at pleasure.

A better appreciation of the effects of temperature on the animal economy has of late years exerted a beneficial influence upon the treatment of fattening cattle. Observant farmers have long been aware that their cattle, when kept dry and moderately warm, eat less and thrive faster than under opposite conditions. They accounted for this in a vague way by attributing it to their greater comfort in such circumstances. Scientific men have now, however, showed us that a considerable portion of the food consumed by warm-blooded animals is expended in maintaining the natural heat of their bodies, and that the portion of food thus disposed of is dissipated by a process so closely analogous to combustion that it may fitly be regarded as so much fuel. The fat which, in favourable circumstances, is accumulated in their bodies, may in like manner be regarded as a store of this fuel laid up for future emergencies. The knowledge of this fact enables us to understand how largely the profit to be derived from the fattening of cattle is dependent upon the manner in which they are housed, and necessarily forms an important element in determining the question whether *yards*, *stalls*, or *boxes* are best adapted for this purpose. A really good system of housing must combine the following conditions:—

1st, Facilities for supplying food and litter, and for removing dung with the utmost economy of time and labour;
2d, Complete freedom from disturbance;
3d, A moderate and unvarying degree of warmth;
4th, A constant supply of pure air;
5th, Opportunity for the cattle having a slight degree of exercise; and
6th, The production of manure of the best quality.

We have no hesitation in expressing our opinion that the whole of these conditions are attained most fully by means of well-arranged and well-ventilated boxes. Stalls are to be preferred where the saving of litter is an object, and yards for the rearing of young cattle, which require more exercise than is suitable for fattening stock. These yards are now, however, in the most improved modern homesteads, wholly roofed over, and thus combine the good qualities of both yard and box.

CHAPTER XVII.

LIVE STOCK—SHEEP.

When Fitzherbert so long ago said, "Sheep is the most profitablest cattle that a man can have," he expressed an opinion in which agriculturists of the present day fully concur. But if this was true of the flocks of his time, how much more of the many admirable breeds which now cover the rich pastures, the grassy downs, and the heath-clad mountains of our country. Their flesh is in high estimation with all classes of the community, and constitutes at least one-half of all the butcher meat consumed by them. Their fleeces supply the raw material for one of our most flourishing manufactures. They furnish to the farmer an important source of revenue, and the readiest means of maintaining the fertility of his fields.

Section 1.—*Breeds.*

The distinct breeds and sub-varieties of sheep found in Great Britain are very numerous. We have no intention of describing them in detail, but shall confine our observations to those breeds which by common consent are the most valuable for their respective appropriate habitats. They may be fitly classed under three heads—viz., the heavy breeds of the plains, those adapted for downs and similar localities, and the mountain breeds.

1*st.*—*Heavy Breeds.*

Of the first class, the improved *Leicesters* are still the most important to the country. They are more widely diffused in the kingdom than any of their congeners. Although, from the altered taste of the community, their mutton is less esteemed than formerly, they still constitute the staple breed of the midland counties of England. Leicester rams are also more in demand than ever for crossing with other breeds. It is now about a century since this breed was produced by the genius and perseverence of Bakewell, in whose hands they attained a degree of excellence that has probably not yet been exceeded by the many who have cultivated them since his day. The characteristics of this breed are extreme docility, extraordinary aptitude to fatten, and the early age at which they come to maturity. The most marked feature in their structure is the smallness of their heads, and of their bones generally, as contrasted with their weight of carcase. They are clean in the jaws, with a full eye, thin ears, and placid countenance. Their backs are straight, broad, and flat, the ribs arched, the belly carried very light, so that they present nearly as straight a line below as above; the chest is wide, the skin very mellow, and covered with a beautiful fleece of long, soft wool, which weighs on the average from 6 to 7 lb. On good soils and under careful treatment

these sheep are currently brought to weigh from 18 to 20 ℔ per quarter at 14 months old, at which age they are now usually slaughtered. At this age their flesh is tender and juicy; but when feeding is carried on till they are older and heavier, fat accumulates so unduly as to detract from the palatableness and market value of the mutton.

Lincolns.—These were at one time very large, ungainly animals, with an immense fleece of very long wool. By crossing them with the Leicesters the character of the breed has been entirely changed, and very greatly for the better. It is now, in fact, a sub-variety of the Leicester, with larger frame and heavier fleece than the pure breed. Their wool, however, retains its distinctive characteristics—viz., great length of staple, an unctuous feeling, and, in particular, a brightness or *lustre* which adds largely to its value. Sheep of this kind are reared in immense numbers on the wolds and heaths of Lincolnshire, and are sold when about a year old in the wool, and in very forward condition, to the graziers of the fens and marshes, who ultimately bring them to very great weights.

Cotswolds, sometimes called Glo'sters or New Oxfords, are also large and long-woolled sheep, with good figure and portly gait. Great improvement has been effected in this breed during the last 30 years, in consequence of which they are rising rapidly in public estimation. The qualities for which they are prized are their hardiness, docility, rapid growth, aptitude to fatten, and the great weight to which they attain. Their chief defect is that they yield mutton somewhat coarse in the grain and with an undue preponderance of fat. But in addition to their great merits as a pure breed they are especially valuable for the purpose of crossing with Downs and other short-woolled sheep. Of this we shall speak more particularly when we come to notice the *Cross-breeds.*

Teeswaters.—This breed, found formerly in the vale of the Tees, used to have the reputation of being one of the largest and heaviest of our native breeds. They had lighter fleeces than the old Lincolns, but greater aptitude to fatten. Like them, however, they have been so blended with Leicester blood as to have lost their former characteristics. As now met with, they constitute simply a sub-variety of the latter breed.

The *Kents* or *Romney Marsh Sheep*, are another distinct long-woolled breed which have much in common with the old Lincolns, although they never equalled them either in the weight or quality of their fleece. They too have been much modified by a large infusion of Leicester blood; but as their distinctive qualities fit them well for a bleak and humid habitat, there is now an aversion to risk these by further crossing. As they now exist they are a great improvement upon the old breed of the Kentish marshes; and this, in the first instance at least, was the result of crossing rather than selection.

2*d.*—*Down and Forest Breeds.*

The breeds peculiar to our chalky downs and other pastures of medium elevation next claim our notice.

Southdowns.—Not long after Robert Bakewell had begun, with admirable skill and perseverance, to bring to perfection his celebrated Leicesters, which, as we have seen, have either superseded or totally altered the character of all the heavy breeds of the country, another breeder, Mr John Ellman of Glynde, in Sussex, equal to Bakewell in judgment, perseverance, and zeal, and wholly devoid of his illiberal prejudice and narrow selfishness, addressed himself to the task of improving the native sheep of the downs, and succeeded in bringing them to as great perfection, with respect to early maturity and fattening power, as they are perhaps susceptible of. Like Bakewell, he early began the practice of letting out rams for hire. These were soon eagerly sought after, and the qualities of his improved flock being rapidly communicated to others, the whole race of down sheep has more or less become assimilated to their standard. These improved Southdowns have, in fact, been to all the old *forest* and other fine-woolled breeds what the Leicesters have been to their congeners. Many of them have entirely disappeared, and others only survive in those modifications of the improved Southdown type which are to be found in particular localities. These down sheep possess certain well-marked features which distinguish them from all other breeds. They have a close-set fleece of fine wool, weighing, when the animals are well fed, about 4 lb.; their faces and legs are of a dusky brown colour, their neck slightly arched, their limbs short, their carcase broad and compact, their offal light, and their buttocks very thick and square behind. They are less impatient of folding, and suffer less from a pasture being thickly stocked with them than any other breed. It is in connection with this breed that the practice of folding as a means of manuring the soil is so largely carried out in the chalk districts of England. It is well ascertained that the injury done to a flock by this practice exceeds the benefit conferred on the crops. Now that portable manures are so abundant, it is to be hoped that this pernicious practice of using sheep as mere muck machines will be everywhere abandoned.

These sheep are now usually classed as *Sussex Downs* and *Hampshire Downs*, the former being the most refined type of the class, both as regards wool and carcase, and the latter, as compared with them, having a heavier fleece, stronger bone, and somewhat coarser and larger frame.

The *Shropshire* sheep, while partaking of the general characteristics of the Southdown, is so much heavier both in fleece and carcase, and is altogether so much more robust an animal, that it now claims to be ranked as a separate breed. The qualities just referred to as distinguishing it from other downs seem, however, to be the result of selection rather than of crossing with other breeds, and thus the Shropshire sheep, while a pure down, is yet of so distinct a type from the high-bred "Southdown," that it is well entitled to be recognised as a distinct and very valuable breed, as has been done by the Royal Society, which now assigns it a separate class at its annual meetings. Shropshire rams are eagerly sought after, and many breeders of eminence in that county have now their annual sales of these animals.

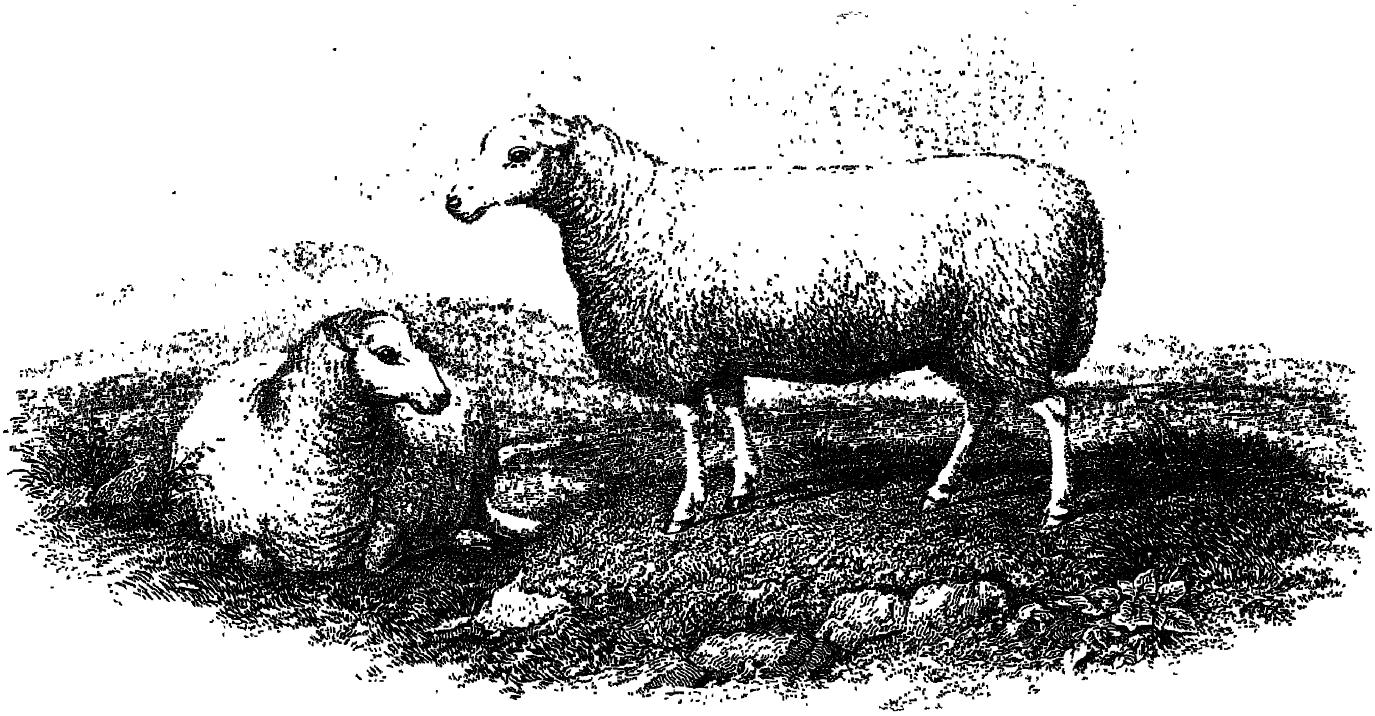
These breeds are peculiarly adapted for all those parts of England where low grassy hills occur, interspersed with, or in proximity to, arable land. In such situations they are prolific, hardy, and easily fattened at an early age. It is to their peculiar adaptation for crossing with the long-woolled breeds that they are indebted for their recent and rapid extension to other districts.

Dorsets.—This breed has from time immemorial been naturalised in the county of Dorset and adjacent parts. They are a white-faced, horned breed, with fine wool, weighing about 4 ℔ per fleece. They are a hardy and docile race of sheep, of good size, and fair quality of mutton. But the property which distinguishes them from every other breed in Great Britain is the fecundity of the ewes, and their readiness to receive the male at an early season. They have even been known to yean twice in the same year. Being, in addition to this, excellent nurses, they have long been in use for rearing house lamb for the London market. For this purpose the rams are put to them early in June, so that the lambs are brought forth in October, and are ready for market by Christmas. But for this peculiarity, they would ere now have shared the fate of so many other native breeds, which have given place either to the Leicesters or Southdowns, according to the nature of the pastures. So long, however, as the rearing of early house lamb is found profitable, there is a sufficient inducement to preserve the Dorset breed in their purity, as they are unique in their property of early yeaning.

3*d.*—*Mountain Breeds.*

Cheviots.—As we approach and cross the Scottish border we find a range of hills covered with coarser herbage than the chalky downs of the south, and with a climate considerably more rigorous. Here the Southdown sheep have been tried with but indifferent success. This, however, is not to be regretted, seeing that the native Cheviot breed rivals them in most of their good qualities, and possesses in addition a hardihood equal to the necessities of the climate. This breed, besides occupying the grassy hills of the border counties, is now found in great force in the north and west Highlands of Scotland. In the counties of Sutherland and Caithness, where they were introduced by the late Sir John Sinclair, they have thriven amazingly, and in the hands of some spirited breeders have attained to as great perfection as in their native district. During the last 30 years this breed has undergone very great improvement in size, figure, weight of fleece, and aptitude to fatten. In proof of this, it is enough to mention that Cheviot wether lambs are now in the border counties brought to market when weaned, and are transferred to the low country graziers, by whom they are sent fat to the butcher at sixteen months old, weighing then from 16 to 18 ℔ per quarter. This is particularly the case in Cumberland, where Cheviot lambs are preferred to all other breeds by the low-country farmers, by whom they are managed with great skill and success. It is not at all unusual with them to realise an increase of from 20s. to 25s. per head on the purchase price of these lambs, after a twelvemonth's keep. This fact is peculiarly interesting from the proof which it affords of a hitherto unsuspected capacity in Cheviots, and probably in other upland breeds, to attain to a profitable degree of fatness and weight of carcase at almost as early an age as the lowland breeds when the same attention and liberal feeding is bestowed upon them. There is no breed equally well adapted for elevated pastures, consisting of the coarser grasses with a mixture of heath; but whenever, from the nature of the soil or greater elevation, the heaths unmistakably predominate, a still hardier race is to be preferred, viz.—

The *Blackfaced* or *Heath Breed.*—They are accordingly found on the mountainous parts of Yorkshire, Lancashire, Cumberland, and Westmoreland; over the whole of the Lammermuir range, the upper part of Lanarkshire, and generally over the Highlands of Scotland. Both male and female of this breed have horns, which in the former are very large and spirally twisted. The face and legs are black or specked with black, with an occasional tendency to this colour on the fleece; but there is nothing of the brown or russet colour which distinguishes the down breeds. The choicest flocks of these sheep



CHEVIOT EWE

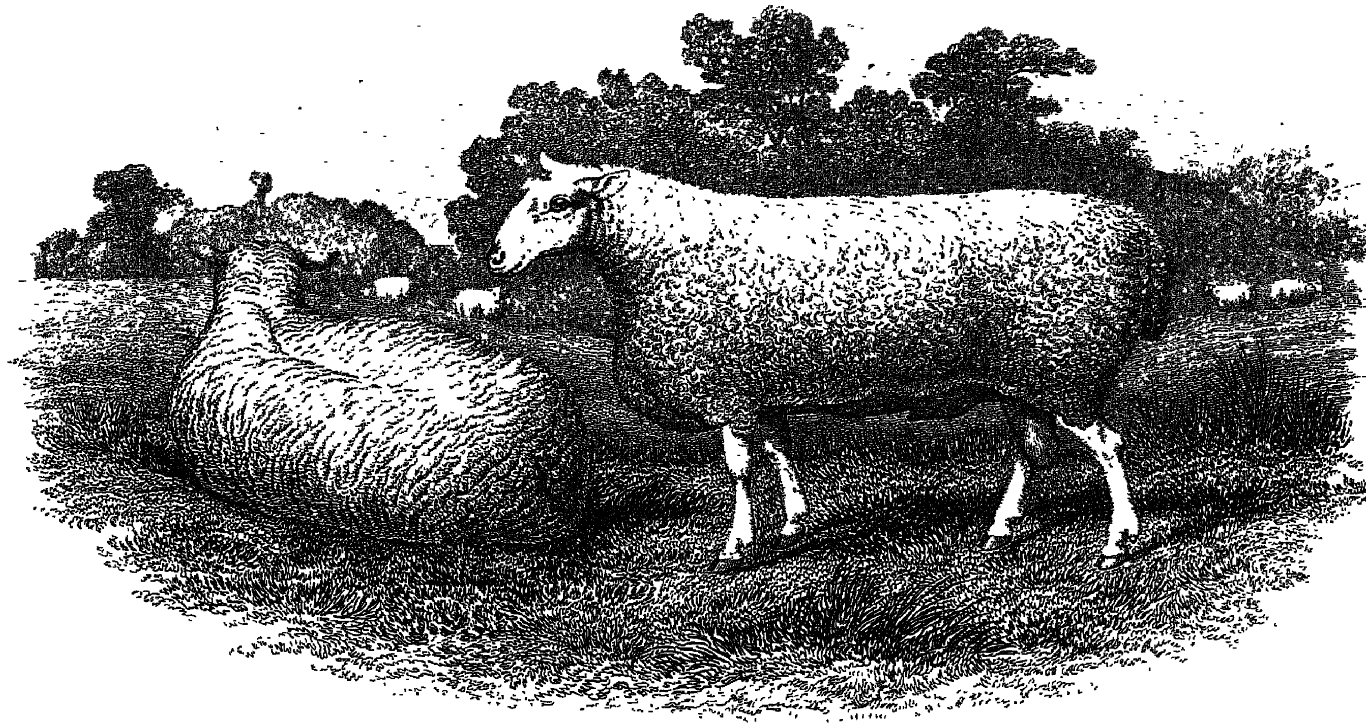
Bred by and the Property of Mr Thomas Elliott Hyndhope, Roxburghshire

THE BLACK-FACED [illegible] BREED

One Year Old.

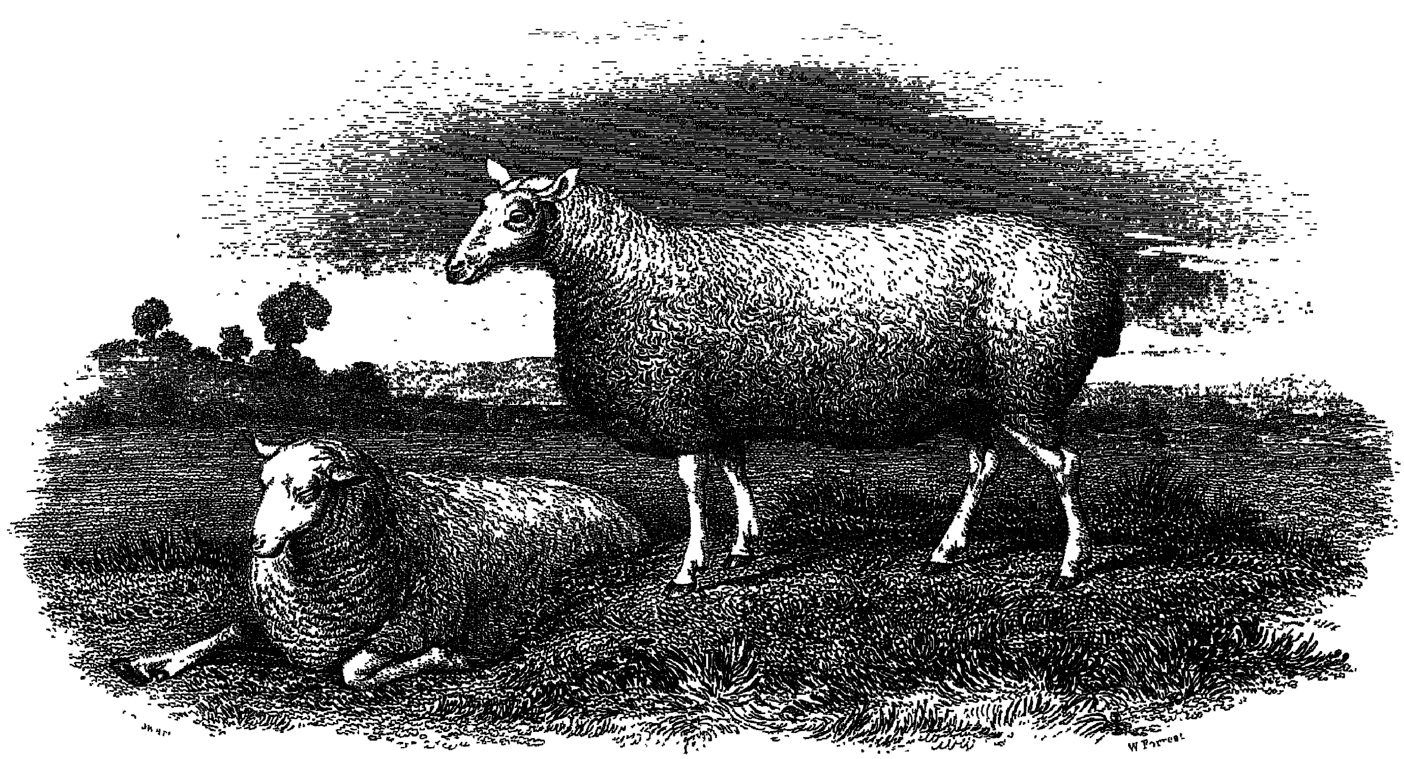
Bred by Mr Thomas Robertson Broomlea, County of Peebles

Copied by permission from Professor Low's description of breeds of Domesticated Animals



LEICESTER RAM

Bred by and the Property of Mr Dickinson Magdalene Hall. Roxburghshire



LEICESTER EWE

Bred by and the Property of Mr George Thomson, Haymount Roxburghshire

are found in Lanarkshire and in the Lammermuirs, where considerable pains are now bestowed on their improvement. Their chief defects are coarseness of fleece and slowness of fattening until their growth is matured. In most flocks the wool, besides being open and coarse in the staple, is mixed with *kemps* or hairs, which detract from its value. Rams with this defect are now carefully avoided by the best breeders, who prefer those with black faces, a mealy mouth, a slight tuft of fine wool on the forehead, horns flat, not very large, and growing well out from the head, with a thickset fleece of long, wavy, white wool. Greater attention is now also being paid to their improvement in regard to fattening tendency; in which respect we do not despair of seeing them brought nearer to a par with other improved breeds. Whenever this is accomplished we shall possess in the breeds now enumerated, and their crosses, the means of converting the produce of our fertile plains, grassy downs, rough upland pastures, and heath-clad mountains, into wool and mutton of the best quality, and with the utmost economy of which the circumstances admit.

In the higher grounds of Cumberland, and also in Westmoreland, Lancashire, and parts of Yorkshire, two varieties of the heath breed of sheep are found, viz., Herdwicks and Lonks—which, with a general resemblance to the blackfaced Highland breed, differ from it in having a close-set fleece of fine soft wool. They are sometimes described by saying that they have "the fleece of a Cheviot on the carcase of a Highlander;" but the Herdwicks are so small, and both breeds are so inferior to the blackfaced in aptitude to fatten, that they are losing ground in their native districts, where the blackfaces are spreading rapidly, being in great repute for breeding crosses to long-woolled rams.

4th.—Cross-Breeds.

We have thus enumerated the most important of our pure breeds of sheep, but our list would be defective were we to omit those cross-breeds which are acquiring increased importance every day. With the extended cultivation of turnips and other green crops there has arisen an increased demand for sheep to consume them. Flockmasters in upland districts, stimulated by this demand, happily bethought them of putting rams of the improved low-country breeds to their Cheviot ewes, when it was discovered that the lambs produced from this cross, if taken to the low country as soon as weaned, could be fattened nearly as quickly, and brought to nearly as good weights, as the pure low-country breeds. The comparatively low prime cost of these cross-bred lambs is a farther recommendation to the grazier, who finds also that their mutton, partaking at once of the fatness of the one parent and of the juiciness, high flavour, and larger proportion of lean flesh of the other, is more generally acceptable to consumers than any other kind, and can always be sold at the best price of the day. The wool, moreover, of these crosses, being at once long and fine in the staple, is peculiarly adapted for the manufacture of a class of fabrics now much in demand, and brings in consequence the best price of any British-grown wool. The individual fleeces, from being close set in the pile, weigh nearly as much as those of the pure Leicesters. On all these accounts, therefore, these sheep of mixed blood have risen rapidly in public estimation, and are produced in ever-increasing numbers. This is accomplished in several ways. The occupiers of uplying grazings in some cases keep part of their ewe flock pure, and breed crosses from another part. They sell the whole of their cross-bred lambs, and get as many females from the other portion as keeps up the number of their breeding flock. This system of crossing cannot be pursued on the most elevated farms, as ewes bearing these heavier crossed lambs require better fare than when coupled with rams of their own race. The surplus ewe lambs from such high-lying grazings are an available source of supply to those of a lower range, and are eagerly sought after for this purpose. Others, however, take a bolder course. Selecting a few of the choicest pure Cheviot ewes which they can find, and putting these to a first-rate Leicester ram, they thus obtain a supply of rams of the first cross, and putting these to ewes, also of the first cross, manage in this way to have their entire flock *half-bred*, and to go on continuously with their own stock without advancing beyond a first cross. They, however, never keep rams from such crossed parentage, but always select them from the issue of parents each genuine of their respective races. We know several large farms on which flocks of crosses betwixt the Cheviot ewe and Leicester ram have been maintained in this way for many years with entire success; and one at least in which a similar cross with Southdown ewes has equally prospered. Many, however, prefer buying in females of this first cross, and coupling them again with pure Leicester rams. In one or other of these ways cross-bred flocks are increasing on every side. So much has the system spread in Berwickshire, that whereas, in our memory, pure Leicesters were the prevailing breed of the county, they are now confined to a few ram-breeding flocks. The cross-breed in best estimation in England is that betwixt the Cotswold and Southdown, which is in such high repute that it is virtually established as a separate breed under the name of Oxford Downs. In Scotland the cross betwixt the Leicester ram and Cheviot ewe is that which seems best adapted to the climate and other conditions of the country, and is that accordingly which is most resorted to on farms a portion of which is in tillage. On higher grounds a cross betwixt the Cheviot ram and blackfaced ewe is in good estimation, and has been extending considerably in recent years. This cross-breed seems to equal the pure blackfaced in hardiness, and is of considerably greater value both in fleece and carcase. This cross-breed is known by the name of *Halflangs.* As in the case of the Leicester-Cheviot ewes, flocks are maintained by using rams of the cross-breed.

Section 2.—Management of Lowland Sheep.

As the management of sheep is influenced mainly by the nature of the lands upon which they are kept, we shall first describe the practice of Lowland flockmasters, and afterwards that pursued on Highland sheep-walks.

On arable farms, where turnips are grown and a breeding stock of sheep regularly kept, it is usual to wean the lambs about the middle of July. When this has been done, the aged and faulty ewes are drafted out, and put upon good aftermath or other succulent food, that they may be got ready for market as soon as possible. In many districts it is the practice to take but three crops of lambs from each ewe. A third part of the breeding flock—viz., the four-year-old ewes—is thus drafted off every autumn, and their places supplied by the introduction of a corresponding number of the best of the ewe-lambs of the preceding year's crop. These cast or draft ewes are then sold to the occupiers of richer soils in populous districts, who keep them for another season to feed fat lambs. Such parties buy in a fresh stock of ewes every autumn, and, as they phrase it, "feed lamb and dam." In other cases the ewes are kept as long as their teeth continue sound, and after that they are fattened and sold to the butcher directly from the farm on which they have been reared. When the ewes that are retained for breeding stock have been thus overhauled, they are put to the worst pasture on the farm, and run rather thickly upon it. Attention is necessary, for some days after weaning, to see that none of them suffer from gorging of the udder. When it appears very turgid in any of them, they are caught and partially milked by hand; but usually the change to poorer pasturage, aided by their restlessness and bleating for want of their lambs, at once arrests the flow of milk. The time of admitting the ram is regulated by the purpose for which the flock is kept, and by the date at which fresh green food can be reckoned upon in spring. When the produce is to be disposed of as fat lambs, it is of course an object to have them early; but for a holding stock, to be reared and fattened at fourteen to sixteen

months old, from 20th September to 20th October, according to the climate of the particular locality, is a usual time for admitting rams to ewes. A few weeks before this takes place the ewes are removed from bare pasture, and put on the freshest that the farm affords, or, better still, on rape; failing which one good feed of white turnips per diem is carted and spread on their pastures, or the ewes are folded for part of the day on growing turnips. The rams are turned in amongst them just when this better fare has begun to tell in their improving appearance, as it is found that in such circumstances they come in heat more rapidly, and with a greatly increased likelihood of conceiving twins. On level ground, and with moderate-sized enclosures, one ram suffices for sixty ewes; but it is bad economy to overtask the rams, and one to forty ewes is better practice. Sometimes a large lot of ewes are kept in one flock, and several rams, at the above proportion, turned among them promiscuously. It is better, however, when they can be placed in separate lots. The breasts of the rams are rubbed with ruddle, that the shepherd may know what they are about. Those who themselves breed rams, or others who hire in what they use at high prices, have recourse to a different plan for the purpose of getting more service from each male, and of knowing exactly when each ewe may be expected to lamb; and also of putting each ewe to the ram most suitable to her in point of size, figure, and quality of flesh and fleece. The rams in this case are kept in pens in a small enclosure. What is technically called a *teaser* is turned among the general flock of ewes, which, on being seen to be in heat, are brought up and put to the ram that is selected for them. They are then numbered, and a note kept of the date, or otherwise a common mark, varied for each successive week, is put on all as they come up. The more usual practice is to mark the breast of the ram with ruddle, as already described, for the first seventeen days that they are among the ewes—that being the time of the periodic recurrence of the heat—and then to use soot instead. When lambing-time draws near, the red-rumped ewes, or those that conceived from the first copulation, are brought into the fold, and the remainder after the lapse of the proper interval. If all goes on well, six weeks is long enough for the rams to remain with the flock. The ewes are then put to more moderate fare, taking care, however, not to pinch them, but to preserve the due medium betwixt fatness and poverty. Under the first-mentioned extreme there is great risk of losing both ewe and lamb at the time of parturition; and under the second, of the ewe shedding her wool, and being unable to nourish her lamb properly either before its birth or after. When there is a considerable breadth of grass-land, the *grit* or in-lamb ewes are run thinly upon it so long as the weather continues moderate. As the pasturage fails or winter weather sets in, they receive a daily feed of turnips or hay, or part of both. In districts where the four-course rotation is pursued, and wheat sown after seeds, there is a necessity for keeping the ewes wholly on turnips and chopped hay or straw. In this case they are made to follow the fattening sheep, and to eat up their scraps, an arrangement which is suitable for both lots. A recently-introduced practice is better still—namely, to feed the ewes at this season on a mixture of one part by measure of pulped turnips or mangel-wurzel to two of chopped straw, which is served out to them in troughs set down in their pastures. From the large quantity of straw which ewes are thus induced to eat, they can be allowed to take their fill of this mixture, and be kept in a satisfied and thriving state with a very moderate allowance of roots. As their time to lamb draws near, the mess should be made more nourishing by adding to it ground rape-cake, bean-meal, and bran, at the rate of from $\frac{1}{4}$th to $\frac{1}{3}$d of a pound of each of these articles to each ewe daily.

The period of gestation in the ewe is twenty-one weeks. No lambs that are born more than twelve days short of this period survive. Before any lambs are expected to arrive a comfortable fold is provided, into which either the entire flock of ewes, or those that by their markings are known to lamb first, are brought every night. This fold, which may either be a permanent erection or fitted up annually for the occasion, is provided all round with separate pens or cribs of size enough to accommodate a single ewe with her lamb or pair. The pasture or turnip fold to which the flock is turned by day is also furnished with several temporary but well-sheltered cribs, for the reception of such ewes as lamb during the day. It is of especial consequence that ewes producing twins be at once consigned to a separate apartment, as, if left in the crowd, they frequently lose sight of one lamb, and may refuse to own it when restored to them, even after a very short separation. Some ewes will make a favourite of one lamb, and wholly repudiate the other, even when due care has been taken to keep them together from the first. In this case the favourite must either be separated from her or be muzzled with a piece of network, to prevent it from getting more than its share of the milk in the shepherd's absence. Indeed the maternal affection seems much dependent on the flow of milk, as ewes with a well-filled udder seldom trouble the shepherd by such capricious partialities. As soon as the lambs have got fairly afoot, their dams are turned with them into the most forward piece of seeds, or to rape, rye, winter-oats, or water-meadow, the great point being to have abundance of succulent green food for the ewes as soon as they lamb. Without this they cannot yield milk abundantly, and without plenty of milk it is impossible to have good lambs. It is sometimes necessary to aid a lamb that has a poor nurse with cow's milk. This is at best a poor alternative; but if it must be resorted to, it is only the milk of a farrow cow, or at least of one that has been calved six months, that is at all fit for this purpose. To give the milk of a recently-calved cow to a young lamb is usually equivalent to knocking it on the head. Ewe milk is poor in butter, but very rich in curd, which is known to be also in a measure the character of that of cows that have been long calved and are not again pregnant. We have found the Aberdeen yellow bullock turnip the best for pregnant and nursing ewes. Mangel-wurzel is much approved of by the flockmasters of the southern counties for the same purpose. It is of importance at this season to remove at once from the fold and pens all dead lambs, and filth of every kind, the presence of putrefying matter being most hurtful to the flock. Should a case of puerperal fever occur, the shepherd must scrupulously avoid touching the ewe so affected; or if he has done so, some one should take his accoucheur duties for a few days, as this deadly malady is highly contagious, and is often unconsciously communicated to numbers of the flock by the shepherd's hands. Unnecessary interference with ewes during parturition is much to be deprecated. When the presentation is all right, it is best to leave them as much as possible to their natural efforts. When a false presentation does occur, the shepherd must endeavour to rectify it by gently introducing his hand after first lubricating it with fresh lard or olive-oil. The less dogging or disturbance of any kind that ewes receive during pregnancy the less risk is there of unnatural presentations. As soon as lambs are brought forth the shepherd must give them suck. When they have once got a bellyful, and are protected from wet or excessive cold for two or three days, there is no fear of their taking harm from ordinary weather, provided only that the ewes have plenty of suit-

able food. Lambs are castrated, docked, and ear-marked, with least risk when about ten days old. Ewes with lambs must have good and clean pasturage throughout the summer. For this purpose they must either be run thinly among cattle or have two or more enclosures, one of which may always be getting clean and fresh for their reception as the other gets bare and soiled. We have not found any advantage in allowing lambs yeaned in March to run with their dams beyond 20th July. A clover eddish or other perfectly clean pasture is the most suitable for newly-weaned lambs. Such as abound in *tath*, as it is called in Scotland—that is, rank herbage growing above the droppings of sheep or other animals—are peculiarly noxious to them. Folding upon rape or vetches suits them admirably, so that fresh supplies are given regularly as required. Sheep, when folded on green rye or vetches, require a good deal of water, and will not thrive unless this is supplied to them.

All sheep are liable to be infested with certain vermin, especially "fags" or "kaids" (*Melophagus ovinus*) and lice. To rid them of these parasites various means are resorted to. Some farmers use mercurial ointment, which is applied by parting the wool, and then with the finger rubbing the ointment on the skin, in three or four longitudinal seams on each side, and a few shorter ones on the neck, belly, legs, &c. Those who use this salve dress their lambs with it immediately after shearing their ewes, and again just before putting them on turnips. More frequently the sheep are immersed, all but their heads, in a bath in which arsenic and other ingredients are dissolved. On being lifted out of the bath, the animal is laid on spars, over a shallow vessel so placed that the superfluous liquor, as it is wrung out of the fleece, flows back into the bath. If this is done when the ewes are newly shorn, the liquor goes farther than when the process is deferred until the lambs are larger and their wool longer. It is a good practice to souse the newly-shorn ewes, and indeed the whole flock at the same time, in a similar bath, so as to rid them all of vermin.[1]

As turnips constitute the staple winter fare of sheep, it is necessary to have a portion of these sown in time to be fit for use in September. Young sheep always show a reluctance to take to this very succulent food, and should therefore be put upon it so early in autumn that they may get thoroughly reconciled to it while the weather is yet temperate. Rape or cabbage suits admirably as transitionary food from grass to turnips. When this transference from summer to winter fare is well managed, they usually make rapid progress during October and November. Some farmers recommend giving the *hoggets*, as they are now called, a daily run off from the turnip-fold to a neighbouring pasture for the first few weeks after their being put to this diet. We have found it decidedly better to keep them steadily in the turnip-fold from the very first. When they are once taught to look for this daily enlargement, they become impatient for it, and do not settle quietly to their food. If possible, not more than 200 should be kept in one lot. The youngest and weakest sheep should also have a separate berth and more generous treatment. Turnips being a more watery food than sheep naturally feed upon, there is great advantage in giving them from the first, along with turnips, a liberal allowance of clover hay cut into half-inch chaff. When given in this form, in suitable troughs and in regular feeds, they will eat up the whole without waste, and be greatly the better for it. To economise the hay, equal parts of good oat straw may be cut up with it, and will be readily eaten by the flock. A liberal supply of this dry food corrects the injurious effects which are so often produced by feeding sheep on turnips alone, and at the same time lessens the consumption of the green food. We believe also that there is true economy in early beginning to give them a small daily allowance, say ¼ lb each, of cake or corn. This is more especially desirable when sheep are folded on poor soil. The extraneous food both supplies the lack of nutrition in the turnips and fertilises the soil for bearing succeeding crops. An immense improvement has been effected in the winter feeding of sheep by the introduction of machines for slicing turnips. Some careful farmers slice the whole of the turnips used by their fattening sheep, of whatever age; but usually the practice is restricted to hoggets, and only resorted to for them when their milk-teeth begin to fail. In the latter case the economy of the practice does not admit of debate. When Mr Pusey states the difference in value between hoggets that have had their turnips sliced and others that have not, at 8s. per head in favour of the former from this cause alone, we do not think that he over-estimates the benefit. Those who slice turnips for older sheep, and for hoggets also as soon as ever they have taken to them, are, we suspect, acting upon a sound principle, and their example is therefore likely to be generally followed. There is no doubt of this at least, that hoggets frequently lose part of the flesh which they had already gained from the slicing of the turnips being unduly delayed. By 1st December their first teeth, although not actually gone, have become so inefficient that they require longer time and greater exertion to feed their fill than before; and this, concurring with shorter days and colder weather, operates much to their prejudice. When the slicing is begun, it is well to leave a portion of growing turnips in each day's fold, as there are always some timid sheep in a lot that never come freely to the troughs; and they serve, moreover, to occupy the lot during moonlight nights, and at other times when the troughs cannot be instantly replenished. As the sheep have access to both sides of the troughs, each will accommodate nearly as many as it is feet in length. There should therefore be provided at least as many foot-lengths of trough as there are sheep in the fold. The troughs should be perpendicular at their outer edges, as the sheep are less apt to scatter the sliced turnips on the ground with this form than when they slope outwards. It is expedient to have a separate set of similar troughs for the cake or grain and chopped fodder, which it is best to use mixed together.

As the season when frost and snow may be expected approaches it is necessary to provide in time for the flock having clean unfrozen turnips to eat in the hardest weather. To secure this, care must be taken to have always several weeks' supply put together in heaps and covered with earth to a sufficient thickness to exclude frost. The covering with earth is the only extra cost incurred from using this precaution, for if slicing the roots is practised at all, it necessarily implies that the roots must be pulled, trimmed, and thrown together, and this again should be done in such a way as to insure that the dung and urine of the sheep shall be equally distributed over the whole field. This is secured by throwing together the produce of 18 or 20 drills into small heaps, of about a ton each, in a straight row and at equal distances apart. For a time it will suffice to cover these heaps with a few of the turnip leaves and a spadeful of earth here and there to prevent the leaves from being blown off. This arrangement necessitates the regular moving of the troughs over the whole ground. As the heaps are stript of their covering special care must be taken to scatter the tops well about, otherwise there

[1] The mercurial and arsenical salves and washes commonly in use are believed often to have a hurtful effect on the health of the flocks to which they are applied, and have sometimes caused very serious losses. Having used Macdougall's dip (a preparation of carbolic acid) for many years, we can testify to its efficacy and safety.

will be corresponding rank spots in the grain crop that follows.

On light dry soils it is usually most profitable to consume the whole turnip crop where it grows by sheep, and to convert the straw of the farm into dung by store cattle kept in suitable yards, to which a daily allowance of rape or cotton cake is given, with wholesome water constantly at their command. But it may at times be more profitable to use young sheep instead of cattle for this purpose, and it is quite practicable to do so. In the winter of 1865–66, in consequence of the prevalence of rinderpest, we had recourse to this expedient with entire success. A lot of 200 hoggets was put into two contiguous yards, of a size which ordinarily had accommodated 15 cattle each; the hoggets were fed on hay cut into chaff, which was served to them in troughs so placed as to be protected from rain. Along with this chaff they received 2 ℔ each daily of mixed cakes and grain, and a constant supply of water. A covered passage by which the yards communicated was coated with quicklime, which was stirred up daily and added to twice a-week. Care was taken to drive the whole lot of sheep over this limed passage once every day, with liberty to them to pass and repass as much as they liked at all times. The yards were kept clean by being thinly covered over with fresh straw every day. By this means, and by an occasional paring of the hoofs when seen to be necessary, their feet were kept perfectly sound. In other respects they throve well, and the death-rate was unusually small.

To clear the ground in time for the succeeding grain crop a portion of the turnip crop is usually stored on some piece of grass or fallow, where the flock is folded until the pastures are ready to receive them. As the date of this varies exceedingly, it is well to lay in turnips for a late season, and rather to have some to spare than to be obliged to stock the pastures prematurely. If corn or cake has been given in the turnip field, it must be continued in the pasture. Hoggets that have been well managed will be ready for market as soon as they can be shorn, and may not require grass at all. They usually, however, grow very rapidly on the first flush of clovers and sown grasses, especially when aided by cake or corn. When the soil is of poor quality, it is expedient to continue the use of such extra food during summer. The best sheep are generally sent to market first, and the others as they attain to a proper degree of fatness. Store sheep or cattle are then purchased to occupy their places until the next crop of lambs is weaned.

Lowland flocks are for the most part shorn in May, although many fat sheep are sent to market out of their wool at a much earlier date. Indeed railway transit has made it practicable to forward newly-shorn sheep to market so quickly that there is now little risk of their suffering from exposure to bad weather, and accordingly few fat sheep are now sent to market *rough* after the 1st of April. But in the case of nursing ewes and store sheep of all kinds it is highly inexpedient to deprive them of their fleeces until summer weather has fairly set in. Accordingly, the latter half of May and the first half of June are, in average seasons, the best shearing time, beginning with the hoggets and ending with the ewes.

This practice of shearing a portion of the flock so early as April renders it necessary to make a change on that mode of sheep-washing so well described by the author of the *Seasons*. Artificial washing-pools are accordingly now provided by damming up some small stream of clean water. The bottom is paved and three sides faced with bricks set in cement, with a sluice to let off the foul water when necessary. The most accessible side of the pool is formed of strong planks, securely jointed, behind which the men engaged in washing the sheep stand dry, and accomplish their work much in the way that a washer-woman does hers at her tub. A sloping passage at the upper end of the pool allows the sheep to walk out, one by one, as they are washed. One such pool is often made to accommodate several neighbouring farms.

Section 3.—Management of Mountain Sheep.

We have already taken notice of the extent to which Cheviot sheep have of late years been introduced in the Highlands of Scotland. Many of the immense grazings there are rented by farmers resident in the south of Scotland, who only visit their Highland farms from time to time, and intrust the management of their flocks and shepherds, which rival in numbers those of the ancient patriarchs, to an overseer, whose duty it is to be constantly on the grounds, to attend in all respects to the interests of his employer, see his orders carried into effect, and give him stated information of how it fares with his charge.

The following pertinent remarks we quote from an extensive and experienced Highland sheep-farmer :—

"The management of flocks in the Highlands is much the same as on high and exposed farms in the higher districts of Roxburghshire, Dumfriesshire, and Selkirkshire, as regards the ewe hirsels; the ewe lambs either not being weaned, or that only for eight or ten days, so that they may continue to follow their mothers. The wether lambs are sent to the wether ground about the beginning of August, and herded on the part of it considered most adapted for their keep till about the middle of October, when they are sent to turnips mostly in Ross-shire, where they remain till the middle of March or beginning of April. This is one of the heaviest items of expense in Highland farming, amounting to fully 4s. per head; and thus, upon a farm equally stocked with ewes and wethers, adds just about one-third to the rental of the farm. On the return of the wether hogs they are put to particular parts of the wether ground, at large amongst the other ages of wether stock, where they remain until drawn out when three years old at the usual season to send to market; with this exception, that the year following (when they are dinmonts), the smallest of them, those that are not considered capable of wintering at home, say to the extent of two or three to the score, are again drawn out and sent with the hogs to turnips.

"Mr Sellar, in his Report of the County of Sutherland, gives a very minute and detailed account of the mode of management as practised on his farms. This, however, does not apply to extensive West Highland farms, which have no arable farms attached, no fields to bring in the diseased or falling-off part of the stock to, nor is it ever practicable to shift any part of the stock to different parts of the farm from that on which they have been reared."

Sheep Farming on the hills drained by the Tweed.

Until quite a recent date the grassy hills enclosing the upper valley of the Tweed and its numerous tributaries were stocked almost entirely with Cheviot sheep, and the highest and most heathery portions of the Lammermuir hills with the blackfaced breed. Since about the year 1850, under the stimulus of a growing demand and rapidly advancing price for cross-bred lambs, a great change of practice has been going steadily on. Formerly, on such hill-country farms, cultivation of the soil was restricted to a very small scale indeed, but latterly it has been extending up the valleys and hill-sides at a rapid rate. Large areas of rough natural pasture are yearly being converted into fields, which are well enclosed by substantial stone walls, and by draining, liming, and the liberal application of portable manures, are made to produce luxuriant crops of turnips, oats, and the cultivated clovers and grasses. As this process of reclamation goes on, *half-bred sheep* (Leicester-Cheviots) are substituted for pure Cheviots, the lambs of this cross breed being at weaning-time worth from 10s. to 15s. more per head than Cheviots, their fleeces heavier by 2 ℔ each as well as more valuable per ℔, and the draft ewes also more valuable in about the same proportion as the lambs. These half-bred sheep must be kept almost exclusively on the reclaimed lands, which, however, will keep about double the number of this more valuable breed of

sheep than they did of the less valuable when in their natural unreclaimed state. When the lowest-lying and kindliest soils of such farms have thus been improved and devoted to the keeping of half-bred sheep, the higher and poorer parts are often unfit for keeping Cheviot sheep, and are stocked with the hardier blackfaced breed. Cheviots are in consequence rather at a discount at present as compared with a period still recent.

The general management of these hill-country half-bred flocks does not differ materially from those of the plains. They require generous feeding, and being prolific and good nurses, they pay well for it. The oats grown on such farms are disposed of most profitably when consumed by the flock.

We begin our description of the management of strictly hill flocks with autumn, and assume that the yearly cast of lambs and aged ewes has been disposed of, and only as many of the ewe lambs retained as are required to keep up the breeding stock. A former practice was to keep these ewe lambs or hoggets by themselves on the best portions of the respective walks, or *rakes* as they are called on the Borders. Now, however, they are kept apart from their dams only as long (eight or ten days) as suffices to let the milk dry up; whereupon they are returned to the flock or *hirsel* to which they belong, and at once associate again each with its own dam. The hoggets, under the guidance of the ewes, are thus led about over the ground, according to varying seasons, and under the promptings of an instinct which far surpasses the skill and care of the best shepherd. The latter, indeed, restricts his interference chiefly to keeping his flock upon their own beat, and allows them to distribute themselves over it according to their own choice. When thus left to themselves each little squad usually selects its own ground, and may be found, the same individuals about the same neighbourhood day after day. This plan of grazing the hoggets and ewes together has been attended with the best results. There are far fewer deaths among the former than when kept separate, and being from the first used to the pasturage and acquainted with the ground, they get inured to its peculiarities, and grow up a healthy and shifty stock, more easily managed and better able to cope with trying seasons than if nursed elsewhere, and brought on to the ground at a more advanced age. Each hogget and its dam may be seen in couples all through the winter and spring, and with the return of summer it is a pretty sight to see these family groups grown into triplets by the addition to each of a little lamb.

As the autumn advances, the flockmaster makes his preparations for smearing or bathing. The smearing material is a salve composed of tar and butter, which is prepared in the following manner:—Six gallons of Archangel tar and 50 ℔ of grease-butter are thoroughly incorporated, and as much milk added as makes the salve work freely. This quantity suffices for 100 sheep. This salve destroys vermin, and by matting the fleece is supposed to add to the comfort and healthiness of the sheep. It adds considerably to the weight of the fleece, but imparts to it an irremediable stain, which detracts seriously from its value per ℔. A white salve introduced by Mr Ballantyne of Holylee is now in repute on the borders. It is prepared as follows:—30 ℔ butter, 14 ℔ rough turpentine, and 3 ℔ soft soap are melted and mingled in a large pot; 2 ℔ soda and ½ ℔ arsenic are then dissolved in a gallon of boiling water, and this, along with 12 gallons more of cold water, is intimately mixed with the other ingredients, and yields enough for dressing 100 sheep at the rate of a quart to each. Some persons, believing the arsenic an unsafe application, substitute for it half-a-gallon of tobacco juice. Instead of the rough turpentine, some also use half-a-gill of spirit of tar for each sheep; this ingredient being mixed in each quart-potful at the time of application.

In applying these salves, the sheep are brought to the homestead in daily detachments, according to the number of men employed, each man getting over about sixty in a day. A sheep being caught and laid upon a stool, the wool is parted in lines running from head to tail, and the tar salve spread upon the skin by taking a little upon the fingers and drawing them along. In using the white salve each shepherd has a boy assistant who pours the liquid salve from a tin pot with a spout, while he holds the wool apart. This white salve destroys vermin, and is believed to nourish the wool and to promote its growth. Of late years the practice of dipping has largely been substituted for salving or pouring. It is practised as already described in the case of low-country flocks, save only that with large flocks it is expedient to have it performed at some central and otherwise convenient part of the grounds. Instead of a movable tub and dripping board of wood, it is better to have a fixed one built of concrete, or bricks set in cement, with a paved dripping pen large enough to hold 50 sheep in each of its two divisions. The other requisites are a boiler to supply hot water for dissolving the dipping stuff, a pipe to convey cold water to the bath, and a waste pipe to empty it for cleansing. This salving or dipping must all be accomplished before the 20th November, about which time the rams are admitted to the flock. Before this is done another preliminary is required. As the ewe hoggets graze with the flock, it is necessary to guard them from receiving the male, for which purpose a piece of cloth is sewed firmly over their tails, and remains until the rams are withdrawn. This is called *breeking* them. On open hilly grounds about forty ewes are sufficient for each ram. To insure the vigour and good quality of the flock, it is necessary to have a frequent change of blood. To secure this by purchasing the whole rams required would be very costly, and therefore each flockmaster endeavours to rear a home supply. For this purpose he purchases every autumn, often at a high price, one or two choice rams from some flock of known excellence, and to these he puts a lot of his best ewes, carefully selected from his whole flock. These are kept in an enclosed field until the rutting season is over, and after receiving a distinctive mark are then returned to their respective hirsels. From the progeny of these selected ewes a sufficient number of the best male lambs is reserved to keep up the breeding stock of the farm. The rams are withdrawn from the flock about 1st January, and are then kept in an enclosed field, where they receive a daily feed of turnips.

Except in heavy falls of snow and intense frosts, the flocks subsist during the entire season on the natural produce of their pastures. It is necessary, however, to be provided for such emergencies both as regards food and shelter. For this purpose each shepherd has at suitable parts of his beat several *stells* or artificial shelters, such as are described at p. 402, and beside each of them a stack of hay from which to fodder the flock when required. So long as the sheep can get at heather or rushes by scraping away the snow with their feet they will not touch the hay, but when the whole surface gets buried and bound up, they are fain to take to it. The hay is laid out in handfuls over the snow, twice a day, if need be. The hay should, however, be administered with caution, and never to a greater extent than is absolutely necessary. Whenever there is a lull in the storm, the shepherd should use his utmost endeavour to move the flock out from their shelter to the nearest piece of rough heather or ground from which the wind has drifted off the snow, and where the sheep can by scraping with their feet get at their natural food. This should be done not merely to economise hay, but because

it is found that sheep invariably come through the hardships of winter in better condition when thus encouraged to shift as much as possible for themselves, than when fed to the full on hay, and allowed to keep to their shelter all the day.

Much vigilance, promptitude, and courage, are required on the part of shepherds in these wild and stormy districts in getting their flocks into places of safety on the breaking out of sudden snow-storms, and tending them skilfully there.

In spring advantage is taken of any dry weather that occurs to set fire to the roughest portions of the old heather and other coarse herbage, and this being thus cleared off, a fresh young growth comes up, which yields a sweeter pasture to the flocks for several succeeding years. Careful shepherds are at pains to manage the muir-burning so as to remove the dry effete herbage in long narrow strips, and thus to secure a regular intermixture of old and young heath.

The lambing season is one of much anxiety to the master; and to his shepherds and their faithful sagacious dogs it is one of incessant toil. They must be a-foot from "dawn till dewy eve," visiting every part of their wide range several times a-day, to see that all is right, and to give assistance when required. The ewes of these hardy mountain breeds seldom require man's assistance in the act of parturition, but still cross presentations and difficult cases occur even with them. Deaths occur also among the newly-dropt lambs, in which case the dam is taken to the nearest stell, and a twin-lamb (of which there are usually enough to serve this purpose) put in the dead one's place. The dead lamb's skin is stript off, and wrapt about the living one, which is then shut up beside the dam in a small crib or *parik*, by which means she is usually induced in a few hours (and always the sooner the more milk she has) to adopt the supposititious lamb. As the lambing season draws to a close, each shepherd collects the unlambed ewes of his flock into an inclosure near his cottage, and examines them one by one to ascertain which are pregnant. To the barren ones he affixes a particular mark, and at once turns them again to the hill, but the others are retained close at hand until they lamb, by which means he can attend to them closely with comparatively little labour. The lambs are castrated and docked at from 10 to 20 days old. For this and for all sorting and drafting purposes an ample fold and suit of pens, formed of stout post and rail, are provided on some dry knoll convenient for each main division of the flock. To this the flock is gently gathered, and penned off in successive lots of 10 or 12, taking care that each lamb has its own dam with it before it is penned, and to do this with as little dogging and running as possible. The male lambs of the pure blackfaced breed, when designed to be kept as wethers, are not castrated until they are eight or ten weeks old, partly because when this is done sooner their horns have a tendency to get so crumpled as to grow into their eyes, and partly because a bold horn is thought to improve the appearance of an aged wether.

On these elevated sheep-walks shearing does not take place until July. It cannot, in fact, be performed until the young wool has begun to grow or *rise*, and so admit of the shears working freely betwixt the skin and the old matted fleece. The sheep are previously washed by causing them to swim repeatedly across a pool with a gentle current flowing through it. They are made to plunge in from a bank raised, either naturally or artificially, several feet above the surface of the water. This sousing and swimming in pure water cleanses the fleece far more effectually than could be supposed by persons accustomed only to the mode pursued in arable districts. Shearing takes place three or four days after washing, and in the interim much vigilance is required on the part of the shepherd to prevent the sheep from rubbing themselves under banks of moss or earth, and so undoing the washing. In the case of blackfaced flocks washing is now not unfrequently altogether dispensed with, because the greater weight of unwashed wool more than counterbalances the difference in price betwixt washed and unwashed fleeces. Each man usually shears about 60 sheep a-day. It is neither practicable nor expedient to shear these mountain sheep so closely as the fat denizens of lowland pastures. For this operation each shearer is provided with a low-legged sparred stool, having a seat at one end, or with a bench built of green turf. These are arranged in a row close in front of a pen, in which the unshorn sheep are placed. The shearers being seated, each astride his stool or bench, with their backs to the pen, a man in it catches and hands over a sheep to each of them. The sheep is first laid on its back upon the stool, and the wool shorn from the under parts, after which its legs are bound together with a soft woollen cord, and the fleece removed, first from the one side and then from the other, by a succession of cuts running from head to tail. The fleeces are thrown upon a cloth and immediately carried to the wool-room, where, after being freed from clots, they are neatly wrapped up and stored away. Before the shorn sheep are released each receives a mark or *buist* by dipping the owner's cypher in melted pitch, and stamping it upon the skin of the animal. To discriminate different ages and hirsels, these marks vary in themselves or are affixed to different parts of the sheep. Once or twice a year all stray sheep found upon the farms of a well-defined district are brought to a fixed rendezvous, where their marks are examined by the assembled shepherds, and each is restored to its proper owner.

Weaning takes place in August or early in September. A sufficient number of the best ewe lambs of the pure breeds are selected for maintaining the flock, and are treated in the way already noticed. With this exception, the whole of the lambs are sold either to low-country graziers or as fat lambs to the butcher. The wether lambs usually go to the former, and the ewe lambs of the cross betwixt blackfaced ewes and Leicester rams to the latter. These ewes being excellent nurses, make their lambs very fat in favourable seasons, in which case they are worth more to kill as lambs than to rear. Immediately after the weaning, the ewes which have attained mature age are disposed of, generally to low-country graziers, who keep them for another year, and fatten lamb and dam. To facilitate the culling out of these full-aged ewes, each successive crop of ewe lambs receives a distinctive earmark, by which all of any one age in the flock can be at once recognised.

Section 4.—Wool.

Wool is such an important part of the produce of our flocks that it seems proper to offer a few remarks upon it before leaving this subject, although it will fall to be considered under its proper heading. We here insert with much pleasure the following communication received from the late John Barff, Esq., of Wakefield :—

"I willingly give you a reply to your various inquiries regarding wool, as far as I am able. As to the kinds grown in the various counties of the United Kingdom, this I cannot fully answer, as there are some counties' wools which have not come much under my inspection; but generally I may remark that wherever the turnip can be cultivated and has been introduced, the Leicester, Lincolnshire, Cotswold, and the half-breds from Down and Cheviot, are to be found; and in the same counties, in several instances, you have several kinds, if we except Lincolnshire and Leicestershire, which have entirely the long-wool sheep. The great bulk also of York, Warwick, Oxford, Cambridge, Gloucester, Northampton, and Nottingham shires, have this description of sheep, but they

have also Downs and half-breds. Kent has its own sheep, called Kents; the wool being much finer than the real long-wool sheep, running in quality and weight of fleece between the latter and the Down, something like your half-breds from Cheviot ewes by Leicester rams. They have somewhat of a similar sheep in Devon, Cornwall, Hereford, and Shropshire, but the quality in the two former counties scarcely so fine as the two latter, or the Kent wools. Norfolk has the original Down and the half-bred; Surrey, Suffolk, Essex, Sussex, and Hampshire are nearly all Down wools, though in these counties, upon some of their best lands, where they can cultivate the turnip, the half-bred are being introduced; and I need scarcely say to you, the Leicester sheep, as well as half-breds and Cheviots, are to be found in Durham, Northumberland, Berwickshire, Roxburghshire, Lothians, and other parts of Scotland where the turnip is cultivated; and in those parts where it is not, and on the hills, the Cheviot and blackfaced prevail. The blackfaced are used for low padding cloths, carpets, and horse-rugs. The Down wools were formerly all used for cloths and flannels; but now, from the improvement in worsted machinery, one-third is used for worsted yarns and goods; and as the portion suitable for combing purposes is more valuable for this purpose than for cloths or flannels, the grower aims at getting it as deep-stapled as possible; and this has led to a great increase in the weight of the fleece, but at the same time a deterioration in the quality. The Leicester, Lincolnshire, and half-bred, and Cotswolds, as well as the Kents and Devons, are entirely used for worsted yarns and goods; and a very small portion of the wools imported come in competition with them. The nearest approach is a little imported from Holland and Denmark; but they partake more of your cross from a blackfaced ewe by a Leicester ram. The Irish wools are either the long-woolled sheep similar to the Leicester, the mountain sheep similar to your Cheviot, or the small Welsh sheep. The Irish wools are generally open-haired, and have not the richness of the Leicester or our English, and are not so much esteemed or valuable as English wool of apparently the same quality by ½d. to 1d. per lb. Richness of handle is now very desirable, as there is a demand for what are called *glossy* yarns, which wools fed on pasture or good new seeds only can produce, and which cannot be obtained from the wools grown on chalk or hard lands, such as our midland counties—viz., Oxford, Bedford, and Northampton—generally produce.

"In every fleece of wool there are two or three qualities—not more than two or three in the blackfaced, four or five in the long-woolled sheep, five or six in the half-bred, and seven or eight in a Down fleece; and I may say every fleece undergoes this sorting or separation before being put into any process of manufacture. Of course the more there is of the best quality in any fleece the more desirable and valuable the fleece is; in blackfaced, to be free from dead hair or kemps; and we find in all the other wools that the more close the staple and *purly* the wool, the more it yields of the finer qualities, whilst the open-haired makes more of the lower quality. The breeder should therefore, in selecting his tups with a view to good wool, choose them with a close purly staple. A great deal of the excellence, however, of wool depends upon the nature of the soil on which the sheep are fed. Upon the chalk and sandy hard lands we always find the worst qualities of wool of its kind, whilst the best comes from the rich good lands, where there is plenty of old grass or seeds. Thus the wools of Roxburghshire, as a general rule, are better than Berwickshire or Lothian; Leicester, Lincolnshire, Nottingham, and Warwickshire, superior to Oxford, Cambridge, Bedford, or Northampton; and in Downs, Sussex and Surrey, better than Essex and Norfolk, from their downs being more grassy and the land better. The principal quality required in wool is a rich soft handle, as such is always found to improve in every process it is put through in the various stages of its manufacture, whilst the wools grown on chalk or hard lands, and which have a hard bristly handle, get coarser as they progress in the manufacture.

"With regard to the salves or baths used for destroying vermin, we do not know what kinds are used in the different localities, but of those used with you we dislike the spirit of tar and tobacco. Wilson of Coldstream's dip appears to answer, and one called Ballantyne's, used in Selkirkshire; but in all these a great deal depends upon their being properly attended to, and being put on at the proper season. If put on in the autumn, we don't perceive that they have been used, and whenever we have to make a complaint on this head, we find it arises from the baths having been used in spring."

CHAPTER XVIII.

LIVE STOCK—GOATS, &C.

Section 1.—Goats.

Goats never occupied an important place among the domesticated animals of the British Islands, and, with the exception of Ireland, their numbers have been constantly diminishing. By the statistical returns it appears that in 1871 there were 232,892 goats in Ireland, which in 1872 had increased to 242,310. The value of goat's milk, as a source of household economy, is much greater than is usually supposed. This is so well shown by Cuthbert W. Johnston, Esq., in an article in the *Farmers' Magazine*, that we shall quote from it at some length.

"The comfort derived by the inmates of a cottage from a regular supply of new milk need hardly be dwelt upon. Every cottager's wife over her tea, every poor parent of a family of children fed almost entirely on a vegetable diet, will agree with me that it is above all things desirable to be able to have new milk as a variation to their daily food of bread and garden vegetables. The inhabitant of towns and of suburban districts, we all know, is at the mercy of the milk dealer; the milk he procures is rarely of the best quality, and under the most favourable circumstances he receives it with suspicion, and his family consume it with sundry misgivings as to its wholesomeness.

"Having personally experienced these difficulties, and having about three years since commenced the attempt to supply my family with goat's milk, and as our experience is cheering, I desire in this paper to advocate the claims of the milch goat to the attention of the cottager, and the other dwellers in the suburban and rural districts.

"Few persons are perhaps aware of the gentleness and playfulness of the female goat—how very cleanly are its habits, how readily it accommodates itself to any situation in which it is placed. Confined in an outhouse, turned on to a common or into a yard, tethered on a grass plat, it seems equally content. I have found it readily accommodate itself to the tethering system, fastened by a leathern collar, rope, and iron swivel, secured by a staple to a heavy log of wood. The log is the best (and this with a smooth even surface at the bottom), because it can be readily moved about from one part of the grass plat to another. The goat, too, uses the log as a resting-place in damp weather. The goat should be furnished with a dry sleeping-place, and this, in case of its inhabiting open yards, can be readily furnished; anything that will serve for a dry dog-kennel will be comfortable enough for a goat.

"The milk of the goat is only distinguishable from that of the cow by its superior richness, approaching, in fact, the thin cream of cow's milk in quality. The cream of goat's milk, it is true, separates from the milk with great tardiness, and never so completely as in the case of cow's milk. This, however, is of little consequence, since the superior richness of goat's milk renders the use of its cream almost needless. The comparative analysis of milk of the cow and goat will show my readers how much richer the latter is than that of the former; 100 parts of each, according to M. Regnault, gave on an average—

	Cow.	Goat.
Water	84·7	82·6
Butter	4·0	4·5
Sugar of milk and soluble salts	5·0	4·5
Caseine (cheese), albumen, and insoluble salts,	3·6	9·0

So that, while the milk of the cow yields 12·6 per cent. of solid matters, that of the goat produces 17 per cent., goat's milk yielding rather more butter, rather less sugar of milk, but considerably more caseine (cheese) than that of the cow.

"It must not be supposed that the *taste* of the milk of the goat differs in any degree from that of the cow; it is, if anything, sweeter, but it is quite devoid of any taste which might very reasonably be supposed to be derivable from the high-flavoured shrubs and herbs upon which the animal delights to browse.

"The amount of the milk yielded by the goat varies from two quarts to one quart per day; it is greatest soon after kidding time, and this gradually decreases to about a pint per day, a quantity which will continue for twelve months. This is not a large supply, it is true; but still it is one which is available for many very useful purposes; and be it remembered that when mixed with more than its own bulk of lukewarm water, it is then in every respect superior to the milk supplied by the London dairymen.

"In regard to the best variety of goat to be kept, I would recommend the smooth-haired kind, which are quite devoid of beards or long hair. In this opinion I am confirmed by an experienced correspondent, Mr W. H. Place of Hound House, near Guildford, who remarked, in a recent obliging communication—'I found that the short-haired goats with very little beards were the best milkers; but from these I seldom had more than four pints a-day at the best (I should say three pints were the average), and this quantity decreases as the time for kidding approaches (the goat carries her young 21 to 22 weeks). They should not be fed too well near the time of kidding, or you will lose the kids. In winter I gave them hay, together with mangel-wurzel, globe and Swedish turnips, carrots, and sometimes a few oats, and these kept up their milk as well as anything, but of course it was most abundant when

they could get fresh grass. The milk I always found excellent, but I never had a sufficient quantity to induce me to attempt making butter except once, as an experiment: my cook then made a little, which was easily done in a little box-churn; the butter proved very good. I found the flesh of the kids very tender and delicate.'

"I can add little to Mr Place's information as to their food; mine have generally fed out of the same rack as a Shetland pony, with whom they are on excellent terms. The pony throughout the summer is soiled with cut grass, and I notice that the goats pick out the sorrel, sow thistle, and all those weeds which the pony rejects.

"In the garden (if they are, by any chance, allowed to browse), I notice that they select the rose-trees, common laurels, arbutus, laurestinas, and the laburnum. Of culinary vegetables they prefer cabbages and lettuces; they also bite pieces out of the tubers of the potato. They carefully pick up the leaves, whether green or autumnal, of timber trees; of these they prefer those of the oak and elm, and delight in acorns and oak-apples. We are accustomed to collect and store the acorns for them against winter; spreading the acorns thinly on a dry floor, to avoid the mouldiness which follows the sweating of acorns laid in a heap. As I have before remarked, none of these astringent substances affect the taste of their milk; and I may here observe that, with ordinary gentleness, there is no more difficulty, if so much, in milking a goat than a cow.

"The he-goat engenders at a year old. The she-goat can produce when seven months old. She generally yeans two kids. The manure of the goat is perhaps the most powerful of all our domestic animals.

"Such are the chief facts which I have deemed likely to be useful in inducing the extended keeping of the milch goat. It is an animal that, I feel well assured, may be kept with equal advantage by the cottager and the dwellers in larger houses. It is useless to compare it with the cow, or to suppose that the goat can supplant it in situations where the cow can be readily kept; but in the absence of pastures, and in places where there is too little food for cows, I feel well convinced that, with ordinary care and attention, and a moderate firmness in overcoming the prejudices of those unaccustomed to the goat (and unless these are found in the owner, live stock never are profitable), the value and the comfort of a milch goat are much greater than is commonly known.

"The waste produce of a garden is exceedingly useful in the keep of a goat. By them almost every refuse weed, all the cuttings and clearings which are wheeled into the rubbish-yard, are carefully picked over and consumed. To them the trimmings of laurels and other evergreens, pea-haulm, and cabbage stalks, &c., are all grateful variations of their food. In winter a little sainfoin, hay, or a few oats, keeps them in excellent condition. In summer, the mowings of a small grass-plot, watered with either common or sewage water, will, with the aid of the refuse garden produce, keep a goat from the end of April until October."

Section 2.—Hogs.

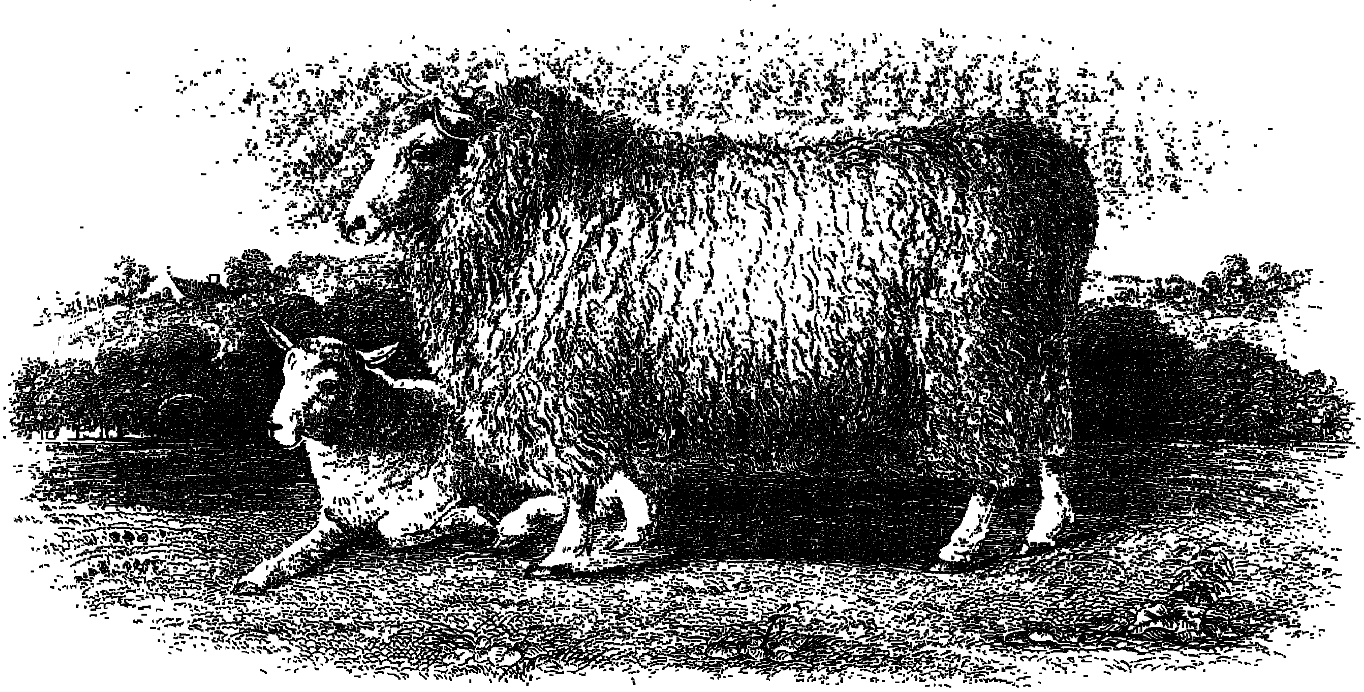
Although occupying a less prominent place in the estimation of the farmer than the ox and sheep, the hog is nevertheless an animal of great value. He is easily reared, comes rapidly to maturity, is not very nice as to food, consuming offal of all kinds, and yields a larger amount of flesh in proportion to his live weight and to the food which he has consumed, than any other of our domesticated animals whose flesh is used for food. To the peasantry he is invaluable, enabling the labouring man to turn the scraps even from his scanty kitchen, and from his garden or allotment, to the best account. On such fare, aided by a little barley or pollard, he can fatten a good pig, and supply his family with wholesome animal food at the cheapest possible rate.

The breeds of swine in Great Britain are numerous, and so exceedingly blended that it is often impossible to discriminate or classify them properly. The original breeds of the country seem to be two, viz., "*The old English Hog*," tall, gaunt, very long in the body, with pendent ears and a thick covering of bristles. The representatives of this old breed are found chiefly in the western counties of England, especially in Lancashire, Yorkshire, and Cheshire, where hogs of immense size are still reared, but greatly improved as compared with their ancestry. Their bones are smaller, their hair finer and thinner set, their skin thinner and with a pink tint, the ears still pendulous but much thinner, the carcase much thicker, and their propensity to fatten greatly increased. This large breed is exceedingly prolific, and the sows are excellent nurses, it being quite common for them to farrow and rear from 12 to 18 pigs at each litter. They are somewhat tardy in arriving at maturity, and do not fatten readily until that is the case. After sixteen months old they, however, lay on flesh very rapidly, grow to very great weights, and produce hams of excellent quality, with a large proportion of lean flesh in them. The *Berkshire* and *Hampshire hog* seems originally to have been from the same stock, but by some early cross acquired the thicker carcase, prick-ears, shorter limbs, and earlier maturity of growth, by which they are characterised. The other native breed is found in the *Highlands and Islands of Scotland*. They are very small, of a dusky brown colour, with coarse bristles along the spine, and prick-ears. They are exceedingly hardy, and subsist on the poorest fare, being often left to range about without shelter, and support themselves as they best can on the roots of plants, shell-fish, seaweed, and dead fish cast up by the tide.

The improved breeds now so abundant have been obtained by crossing these old races with foreign hogs, and chiefly with the *Chinese* and *Neapolitan*. Our modern *white breeds*, with prick-ears, short limbs, fine bone, delicate white flesh, and remarkable propensity to fatten at an early age, are indebted for these qualities to the Chinese stocks. The improved *black breeds*, of which the Essex may be selected as the type, and which possess the qualities just enumerated in even a greater degree, are a cross from the Neapolitan. They are characterised by their very small muzzle, fine bone, black colour, and soft skin nearly destitute of hair. They can be brought to profitable maturity at from eight to twelve months old, the white breeds at from twelve to sixteen months. Both kinds are peculiarly suitable for producing small pork to be used fresh, or for pickling. The flesh of these smaller breeds produces, however, excellent bacon when used in that manner, and at less cost than that of the larger breeds, for this reason, that it is only from the flesh of a hog that has reached maturity that bacon of the first quality can be produced; and as these have reached that point at an age when the others are but ready for beginning the fattening process, it follows that the carcase of the former, in a state fit for curing, is produced at less cost than that of the latter. Sows of the Neapolitan breed and its crosses are better mothers and nurses than the Chinese. Both kinds require peculiar care to prevent the pregnant sow from becoming hurtfully fat. Unless kept on poor and scanty fare they inevitably become useless for the purpose of breeding. The Berkshire hog combines the good qualities of the larger and smaller breeds already referred to, so happily, that he deservedly enjoys the reputation of being as profitable a sort for the farmer as can be found. With proper treatment he arrives at maturity at about sixteen months old, yields a good weight of carcase for the food which he has consumed, and his flesh is well adapted for being used either as fresh meat, pickled pork, or bacon, according to the age at which he is slaughtered. A very profitable hog is also obtained by coupling sows of the larger breeds with males of some of the smaller races.

It too frequently happens that less care is bestowed on the breeding of pigs than of the other domesticated animals.

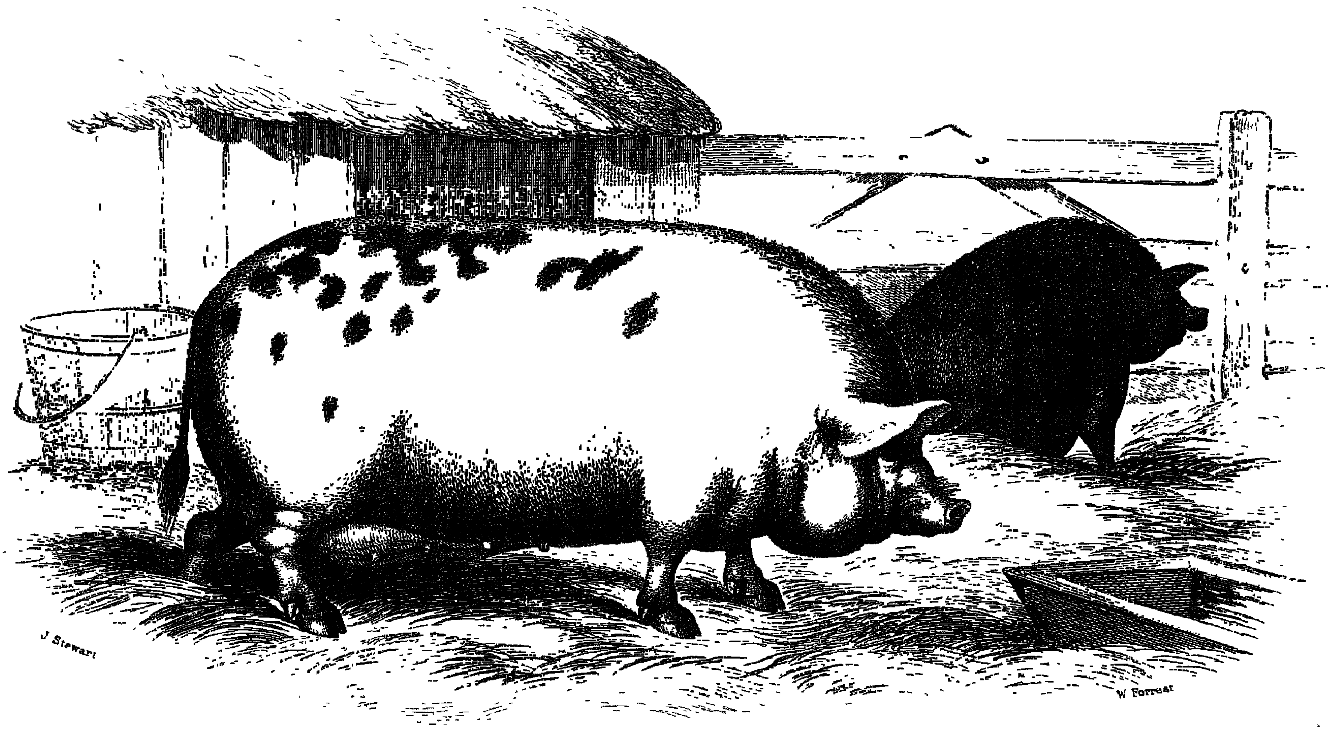
From the early age at which they begin to breed there is need for constant change of the male, to prevent the intermingling of blood too near akin. These animals, too, are exceedingly sensitive to cold, and often suffer much from the want of comfortable quarters. Whether for fattening hogs, or sows with young pigs, there is no better plan than to lodge them in a roomy house with a somewhat lofty *thatched* roof, the floor being carefully paved with stone or brick, and the area partitioned off into separate pens, each furnished with a cast-iron feeding-trough at the side next the dividing alley, and with adequate drainage, so that the litter in them may be always dry. The period of gestation with the sow is sixteen weeks, and as her pigs may be weaned with safety at six weeks old, she usually farrows twice in the year. In this climate it is desirable that her accouchement should never occur in the winter months. It is a common arrangement to have a pig-shed so placed that the store pigs lodged in it can have access to the cattle-courts, where they grub amongst the litter, and pick up scattered grains that have escaped the thrashing-mill, and fragments of turnips and other food dropped by the cattle. On such pickings, and the wash and offal from the farm kitchen, aided by a few raw potatoes, Swedes, or mangold, and in summer by green vetches, a moderate number of store pigs can be got into forward condition, and afterwards fattened very quickly, by putting them



THE [illegible] MARSH BREED

Ewe in her second fleece

Bred by Mr Bishop of Losenham House Kent



SOW OF THE LARGE ENGLISH BREED

Bred by, and the Property of Mr Eddison Yorkshire

W & A K Johnston.

into pens and improving their fare. There is no cheaper way of fattening hogs than by feeding them on boiled or steamed potatoes, mashed and mixed with a portion of barley or pease-meal. When barley-meal alone is used, it should be mixed with cold water, and allowed to soak for twelve hours before being given to the hogs. A few morsels of coal should be frequently thrown into their troughs. These are eaten with evident relish, and conduce to the health of the animals.

An interesting account of the most approved methods of cutting up, curing, and disposing of carcases of pork, is given in the *Journal of the Royal Agricultural Society*, vol. xi., p. 585.

Section 3.—Poultry.

is a class of stock deserving more attention than farmers generally give it. There are, indeed, few farm-yards untenanted by fowls of some sort, and few homesteads without a poultry-house. It is rare, however, to meet with an instance where the breeding and management of poultry is conducted with the care and intelligence so frequently bestowed on other kinds of live stock. Now, if poultry is kept at all, whether for pleasure or profit, it is surely worth while to use rational means for securing the object in view. To have good fowls, it is necessary to provide a dry, warm, well-ventilated house, in which they may roost and deposit their eggs. This house must be kept clean, and its tenants regularly supplied with abundance of suitable food. Constant and careful attention is also absolutely indispensable. On farms of the lesser sort, this duty is usually undertaken by the farmer's wife or daughters. It will, however, in most cases be better to entrust the entire charge of the poultry to some elderly female servant, who shall give her undivided attention to it.

The kinds of poultry most suitable for a farm-yard are the common fowls, geese, and ducks. Turkeys and guinea-fowl are difficult to rear, troublesome to manage, and less profitable than the other sorts. Of the common fowl there are now many excellent and distinct breeds. The *Cochin China* or *Shanghae* is the largest breed we have. They are hardy and very docile; their flesh is of good quality when young; their eggs, of a buff colour, are comparatively small but excellent in flavour, and are produced in great abundance. The hens resume laying very soon after hatching a brood; sometimes so soon as three weeks. They are the more valuable from the circumstance that their principal laying season is from October to March, when other fowls are usually unproductive. The *Dorkings*, of which there are several varieties, as the speckled, the silver, and the white, are not excelled by any breed for general usefulness. The hens are peculiarly noted for their fidelity in brooding, and their care of their young. The *Spanish fowls* are very handsome in their plumage and form, have very white and excellent flesh, and lay larger eggs than any other breed. The *Polish* and *Dutch every-day layers* are peculiarly suitable where eggs rather than chickens are desired, as the hens of both these breeds continue to lay for a long time before showing any desire to brood.

It is to be recommended that, except in situations where a good price can be got for chickens, the return should be sought for chiefly in eggs.

A suitable stock of fowls being selected, pains must be taken to preserve their health and other good qualities by breeding only from the best of both sexes, and these not too near akin. A very simple plan for securing this is to select a cock, and not more than six or eight hens, of the best that can be got, to entrust these to the care of some neighbouring cottager, whose dwelling is sufficiently apart to prevent intercourse with other fowls, and then to use only the eggs from these selected fowls for the general hatching. There are many advantages in such a course. The whole stock of fowls can thus be had of uniform character and superior quality. If it suit the fancy or object of the owner, his fowls may be of several distinct breeds without any risk of their intermingling; the select breeding stocks can be kept up by merely changing the cock every second year, and not more than one cock to thirty hens need be kept for the general stock, as it is no consequence whether their eggs are impregnated or not. Besides having the run of the barn-door, cattle-courts, and stack-yard, fowls are greatly benefited by having free access to a pasture or roomy grass-plot. If the latter is interspersed with evergreen shrubs so much the better, as fowls delight to bask under the sunny side of a bush, besides seeking shelter under it from sudden rain. Their court should also be at all times provided with clean water, and a heap of dry sand or coal-ashes, in which they wallow, and free themselves from vermin. To keep them in profitable condition, they require, besides scraps from the kitchen and refuse of garden stuffs, &c., a daily feed of barley or oats at the rate of a fistful to every three or four fowls. In cold weather they are the better of having some warm boiled potatoes thrown down to them, as also chopped liver or scraps of animal food of any kind. There is an advantage in having the poultry-house adjoining to that in which cattle-food is cooked in winter, as, by carrying the flue of the furnace up the partition-wall, the fowls get the benefit of the warmth thus imparted to their roosting-place. Saw-dust, dried peat, or burnt clay, are suitable materials for littering poultry-houses, and are preferable to straw. By strewing the floor with such substances two or three times a week, each time carefully removing the previous application, and storing it with the mingled droppings of the fowls *under cover*, a valuable manure can be secured. When 100 common fowls, a score of geese, and a dozen or two of ducks are kept, the quantity and value of the manure produced by them, if kept by itself and secured from the weather, will surprise those who have not made trial of such a plan.

Of late years the breeding of poultry has in various parts of the kingdom become quite a passion. Not only have many separate treatises been published entirely devoted to this subject, but every agricultural periodical now bears evidence to the popularity of this pursuit.

Section 4.—Treatment of Live Stock under Disease.

Time was when every such treatise as the present was expected to contain a description of the diseases to which the domesticated animals are most subject, and instructions for their treatment under them. But now that farriery is discarded and veterinary medicine is taught in colleges, the handling of such a subject is obviously beyond the province of a practical farmer. A few general observations is all, therefore, that we offer regarding it. The province of the stockmaster obviously is to study how to prevent disease, rather than how to cure it. For this end let him exercise the utmost care, first, in selecting sound and vigorous animals of their respective kinds, and then in avoiding those errors in feeding and general treatment which are the most frequent causes of disease. When cases of serious disease occur, let the best professional aid that is available be instantly resorted to; but in all those cases which farmers usually consider themselves competent to treat we advise that they should trust rather to good nursing, and to the healing power of nature, than to that indiscriminate bleeding and purging which is so commonly resorted to, and which in the majority of cases does harm instead of good.

CHAPTER XIX.

IMPROVEMENT OF WASTE LANDS.

Notwithstanding the great progress which agriculture has made, and the immense amount of capital, energy, and skill which for generations has been brought to bear upon the improvement of our soil, there are still large portions of the surface of our country lying in their natural state, and usually classed under the head of *Waste Lands*, in contradistinction to those which are under tillage, or have at some time been subjected to the plough. Of this (so called) waste land but a limited portion is absolutely unproductive. Much of it is capable of being converted into arable land, and doubtless will in course of time be so dealt with, but in the meantime this class of waste lands, and very much more that will never be tilled, is of great and steadily increasing value as sheep-walks. Even for this purpose most of it is susceptible of great improvement, and would well repay it. These lands are comprised under the following descriptions:—1*st*, Those hilly and mountainous parts of Great Britain which, from their steep and rugged surface and ungenial climate, are unfit for tillage; 2*d*, Those which lie uncultivated owing to natural poverty of soil, its wetness, or the degree to which it is encumbered with stones; 3*d*, Bogs and mosses; 4*th*, Lands so near the sea-level as to be more or less liable to be submerged; and 5*th*, Blowing sands.

Section 1.—Improvement of High-lying Sheep Pastures.

The lands referred to under the first of these heads are of very great extent, embracing the whole of the mountainous parts of Scotland and Wales, and much of the high grounds in the north of England and south of Scotland. These high grounds afford pasturage for innumerable flocks of sheep of our valuable mountain breeds. The business of sheep-farming has received a great stimulus of late years from the ever-growing demand for sheep to consume the green crops of arable districts. These upland sheep-walks are accordingly rising in value, and their improvement is becoming every day of increasing importance. The improvement of these hill grazings embraces these leading features, viz., drainage, shelter, and enclosure. Until of late years our hill flocks were peculiarly liable to the rot and other diseases arising from the presence of stagnant and flood water upon their pastures. Many grazings that had at one time an evil reputation on this account now yield sound and healthy sheep, solely from the care with which they have been drained. To guard against the pernicious effects of flooding, the courses of brooks and runnels, which in heavy rains overflow their grassy margins, are straightened, deepened, and widened, to such an extent as is required to carry off all flood water without allowing it to overflow. Some grounds are naturally so dry that this is all that is required to render them safe. But in general the slopes and hollows of hilly grounds abound with springs and deposits of peat, and with flats on which water stagnates after rain. On well-managed grounds such places are covered with a network of open drains or shallow ditches, about 30 inches wide at top and half as many deep, by which superfluous water is rapidly carried off. The cutting of these drains costs from 8s. to 10s. per 100 rods (of six yards each). In pastoral districts there are labourers who are skilled in this kind of work, and to whom the laying out of the lines is frequently entrusted, as well as the execution of the work. On very steep places they are careful to avoid a run directly down the declivity, as a strong current of water in such circumstances gutters the bottom of the drain, and chokes those below with the debris thus produced; but with this exception the drains are always run straight down the greatest slope of the ground. When such drains have been properly made, it is necessary to have them statedly overhauled and kept in good order.

Next in importance to drainage is good and sufficient shelter. This, in the absence of natural coppices of birch or hazel, is provided by means of clumps and belts of fir plantation. These should always be of such extent that the trees may shelter each other as well as the sheep. Trees planted in a mass always shoot up faster than in narrow strips, and restrain the snow-drift which passes through the latter. A shepherd who knows the ground well should always be consulted about the sites of such plantations. The conditions requisite are, that the soil be such as trees will grow in; that it be so far removed from any brook, ravine, or bog, as to be accessible to the flock from all sides; that there be rough herbage, such as heather, gorse, or rushes, near at hand, which the sheep may be able to get at in deep snow; that it be contiguous to the sheep-walk, and placed so as to afford defence against the most prevalent winds. A less costly shelter is formed by building what are called *stells*, which consist of a simple dry-stone wall enclosing a circular space twenty yards or so in diameter, with an opening on one side; or forming a cross, in one angle of which the sheep find shelter from whatever point the wind blows. A haystack is a necessary adjunct to such defences.

It is a further point of importance to have such grazings surrounded with a ring fence, consisting either of dry-stone walls, turf walls with wire a-top, or a simple wire fence. This prevents trespass; and the sheep having freedom to range, without watching, up to the boundary, more of them can be kept on the ground than when they are ever and anon turned back by the shepherd. These needful and inexpensive improvements are now generally attended to over the wide pastoral districts of the Scottish border counties. In the remote Highlands they are still much neglected. There are, however, few agricultural improvements which yield so quick and certain a return.

Section 2.—Reclaiming of Moor Lands.

The improvement of the second class of these unreclaimed lands is now much facilitated by the readiness with which portable manures can be obtained for them. Draining and enclosing here necessarily demand the first attention. In some cases the land is so encumbered with stones that careful trenching of the whole surface is the only way of getting rid of them. In the north of Scotland many thousands of acres formerly useless have been converted into valuable arable land by this means.

In nearly all parts of the country there are extensive tracts of this muiry soil, producing only a scanty and coarse herbage, which are susceptible of remunerative improvement. We are happy in being able to submit to the reader the following detailed account of a successful instance of this, kindly furnished to us by George A. Grey, Esq. of Millfield Hill, Northumberland:—

"It is said that 'necessity is the mother of invention.' I was told by some of my friends that I had given too high a price for this estate, and that it would be a dearer farm to me now than when I rented it from Lord Grey. To overcome this opinion or fact, I thought of several plans of making it more remunerative, and decided on that which I am now about to describe.

"On the high part of the farm, at an elevation of from 400 to 500 feet above the sea, I had upwards of 100 acres of moorland of a poor description, which had never been under the plough. This consisted of short heath, bilberry bushes, and dry white bent grass, and a soft dry deep moss, delightful as a Turkey carpet under foot, and excellent excursive ground for old hunters, with a small portion of spratty grass and rushes in the damp hollows. The soil is of a free turnip and barley loam on the rotten whinstone. By planting on the west side, and in some places suitable for shelter, I reduced the quantity to about 100 acres. This I divided into three fields of about 33 acres each.

"My great dread was the length of time which such a rough dry surface would require to decompose sufficiently to allow of cultivation, having seen heathery moors in many parts of Scotland lying for two, three, and four years before crops could be obtained, owing to the great cover of coarse vegetation preventing the furrow from lying over, and keeping the land so open and dry through summer that if a *braird* of corn or green crop was obtained, it would wither away in dry weather.

"I had heard of paring and burning, but knew nothing of the process. I, however, obtained the necessary information very much from Mr Langlands of Bewick, who had practised it to a considerable extent. With what I saw there I was so much pleased that I determined to proceed at once.

"I also saw Mr Langlands's work done by a paring-plough, such as is used in the south of England, with a wide plate to cut a furrow of 10 or 12 inches in width. On the point of this is an upright piece of steel, which cuts and divides the heath,—the mould-board turns the furrow over flat on its back, and from end to end of the landing the furrows lay side by side like planks from a saw-mill, and were about half an inch in thickness.

"I must, however, remark, as a caution to others against falling into the same error as I did, that this land had been in tillage at some former time, and was in ridges with a regular surface, so that when the plough was *set*, it cut the whole furrow at a uniform depth, and was drawn by two horses with ease, and at an expense of about eight shillings per acre.

"I got this plough, and gave it a fair trial, but from my land never having been laid smooth, it cut one part as thin as was wished, and the next yard perhaps six or twelve inches thick, which caused a great extra expense in drying, lifting, and burning, and wasted more soil than was necessary or desirable. Also my land having a great deal of small whinstone below the turf, the steel plate frequently got injured and broken. It was therefore with great reluctance laid aside, and the ordinary method of paring by hand adopted, which is slower and much more expensive, but very perfect. It saves soil and cheapens the burning operation, the paring being so thin when the heath, &c., was divided, that light could be seen through the sod, which was only held together with the roots and fibres.

"I began with No. 1 field in July 1849. I let the paring and burning to a company at 25s. per acre, but they made low wages, and after getting more than their work came to, gave up the job. I then got some experienced hands to pare, and paid them the usual wages, at that time 9s. per week, and gave them their food, say 13s. per week, the work being very hard. The total cost of this averaged me 24s. 9d. per acre. A portion of the top part of No. 1 was left undone owing to the lateness of the season. This was dry benty turf. It was ploughed in the common way, and grew no oats in 1850. It was again ploughed and much harrowed and rolled, and sown with the remainder of the field in 1851 with rape, and has grown only a few plants at wide distances. It is still in such a dry undecomposed state that although it is on the high part of the field where sheep draw to lie, I do not expect that it will grow a crop of corn next year; while a portion which was pared down the middle of it grew good corn and rape.

"A portion of No. 2 field was also ploughed in the ordinary way. This was moist land, growing shorter and sweeter grass than any other. It grew a very thin irregular crop of oats in 1850, not within three-quarters per acre of the pared land, but is now (1851) bearing a good crop of oats, that field being a second time in oat crop. To return:

"I had a fair crop of rape in the autumn of 1849 on a considerable portion of No. 1, where it was sown in tolerable season during all August; after that it appeared to be too late. All was, however, ploughed up at once to secure the ashes, and was well harrowed and sown with oats in the spring of 1850. The pared land turned out to be much too thickly sown at four bushels per acre. Corn tillers so much on such land that in some parts it prevented it from coming to maturity. I have since sown much thinner, say three bushels per acre, and even in some degree I find the same fault, there being from five to eight stems from one root. My crop of 1850 turned out to be 30 bushels per acre, but it was on the point of being cut when the high wind in August devastated this district, and that lying high and fully exposed to the wind suffered most severely. I should say it was not below six quarters per acre, and the quality of the grain good.

"In June and July 1850 I pared No. 3 by the same hands who finished my work the previous year. I let the burning of it to an Irishman at 2s. 6d. per acre, binding him to burn it closely piled up in good-sized heaps like hay-cocks, to prevent the escape of the ashes in the shape of smoke into the atmosphere.

"This, with the paring, cost me on 36 acres 19s. 6d. per acre. I got 20 acres of it ploughed and sown with white turnips, broadcast in July and August. I had a close nice crop, though the roots were small, which kept a large flock of sheep for several weeks. This had the good effect of treading down the land and making it plough up better for oats.

"Nos. 1 and 2 were limed at the rate of 7 loads per acre. In June 1851 No. 1 was sown broadcast with rape, by mixing 4 lb. of rape seed with one bushel of oat shellings for an acre, and sowing them out of a grass-seed machine. The crop is very close and fine, and has kept twenty scores of sheep from an early day in August to this date (September 27th).

"No. 2 in 1851 was again sown with oats, which proved a very fine crop, as also did No. 3. The produce was about nine quarters per acre. The oats are very thick and tall, and have very long, large heads, and the grain is plump and good; the stalks being strong, the crop is not lodged so as to injure the yield. I estimate it at certainly 7½ quarters per acre, but shall calculate it at 6 quarters.

"I sow on that land the sandy oat, being early, not liable to lodge nor to shake in moderately high winds, although it was not proof against that of 1850.

"Previously to breaking up I drained with pipes all the land which required drying, of which I shall give a statement, along with the expenses and profits of the whole.

"The result shows that if I had, some years ago, when prices of grain were good, done as *a tenant* what I have done now, I should have been amply repaid by the first or second crops, and have had my farm for the remainder of a twenty-one years' lease worth fully £100 a year more than when I began.

"The result of my experience is, that I neither agree with the generality of Scotsmen nor with many Southerns. The former are of opinion that burning wastes the vegetable matter, which should be kept to decompose and enrich the soil, not considering that at once the land receives a rich dressing of ashes quite equal to two quarters of bones, or 4 or 5 cwt. of the best guano; and that, during the several years which such a slow process would require to take place, the land might be much more enriched by growing and having eaten upon it fine crops of rape and turnip, and by producing heavy corn crops, which would in a much shorter space be returned to it in the shape of manure; and also that by the process of burning the land is freed from the larvæ of insects, such as grubs, slugs, wireworms, &c. &c., which are engendered among the rough grass, and fostered for a length of time under the rough, dry, undecomposed turf; to say nothing of the length of time which the speculator is kept out of a large amount of capital and interest, instead of having the former returned with the latter after the first or at most the second year.

"The latter, again (the Englishmen), are too much in the habit of repeating the operation of burning, even after the land has lain in grass only for a few years, when it might as well be ploughed and cultivated without such expense, thereby unnecessarily reducing the soil, there not being the same difficulties to be overcome nor the same advantage to be gained from it.

"I should certainly burn all land with a rough harsh surface, and should as certainly plough and sow all land with a sweet grassy face upon it.

"In my opinion there are few farms in this country which do not contain certain portions of land capable of remunerative improvement, and I have shown that such improvement is quite within the scope of a tenant with a lease, without which no man can farm well, at least in the Northumbrian system. Would it not be better, then, for landlords, tenants, and the country generally, were tenants to employ labourers on works so speedily remunerative to themselves, rather than run to their landlord whenever they feel the screw, and ask for abatement of rent, or to be allowed to plough out some piece of valuable old grass, or otherwise cross crop their land, with a view of obtaining some temporary advantage, but in the end to the inevitable injury of all concerned? (Signed) "G. A. GREY.

"Millfield Hill, *Dec.* 1, 1851."

From a statement of outlay and returns appended to the above paper it appears that the profits on the three fields were respectively £50, 12s. 5d., £84, 19s. 3d., and £39, 2s. 9d., from which, however, there falls to be deducted the expense of fencing (£35), leaving a gross profit of £139, 14s. 5d.

Section 3.—*Reclaiming of Bogs.*

The reclamation of extensive bogs, or deposits of peat, is a more arduous undertaking, requiring a considerable expenditure of capital and longer time before a return is obtained from it. The extent of land of this description in Great Britain and Ireland is very great. Very exaggerated statements of the profits to be derived from its improvement have often been published, and not a few persons have incurred serious loss by rashly undertaking this kind of work. On the other hand, when bogs are favourably situated with reference to a command of marl or other calcareous matter, to assist in their decomposition and consolidation, and of manure to enrich them, their

reclamation has proved a very profitable speculation. The well-known instance of Chat Moss in Lancashire affords so interesting an example of this that we shall here quote a description of it.

"Chat Moss, well known as that black barren swamp between Liverpool and Manchester, contains 6000 acres, one-half of which is in the township of Barton, and the remainder in the townships of Bedford, Astley, and Worsley.

"The principal part of this moss, which lies in Barton township, belongs to the Trafford family, and is entailed, but the ancestor of the present Sir Thomas de Trafford appears to have obtained, at the latter end of the last century, an Act of Parliament to grant a ninety-nine years' lease of 2500 acres to a Mr Wakefield, who about the year 1805 disposed of his interest in it to the late William Roscoe, of literary celebrity, who spent a large sum in a fruitless endeavour to improve it, failing in which, the lease was sold in 1821 to other parties. J. A. Brown, Esq., of Woolden Hall, bought 1300 acres; the late Edward Baines, M.P. for Leeds, purchased the remaining 1200 acres. The most extensive and successful efforts at improving this moss have been made on a part of the 1200 acres bought by Mr Baines, who, besides occupying the part operated upon by Mr Roscoe, improved a considerable breadth himself, and let several portions to other parties, who have made considerable progress in improving small portions. The most extensive operations, however, upon the whole, have been carried out by a company to whom Mr Baines, in 1828, granted a lease of 550 acres for 68 years, the remainder of the original term, at a nominal rent for the first year, increasing gradually till at the end of five years the rent attained its maximum of £165 per annum for the 550 acres. This company, which was formed at the time the Liverpool and Manchester Railway was in progress of being made on the property, consisted, amongst others, of some practical farmers, and originated with William Reed, who for the three first years was the manager, and resided on this farm, which they called Barton Moss farm. During that period I had the pleasure of paying my friend Reed a visit, and of witnessing the skill and success attending his enterprise and various experiments.

"The first operation, that of draining, had been effected by opening side drains at intervals of fifty yards, into which were laid covered ones six yards apart, at right angles with and emptying into the open side drains.

"The moss being in a semi-fluid state, it was necessary to proceed slowly with draining, taking out only one graft or depth at a time, allowing it to remain a week or a month, according to the state of the weather, before taking out the second graft; this admitted of the sides becoming consolidated, and of the second graft being taken out without the moss closing in. It was again allowed to remain as before till sufficiently dry to admit of the third being removed.

"The open drains were made 3 feet wide and 3 feet 6 inches deep, and the covered drains 16 inches wide and 3 feet deep; the last graft of the latter being only about 6 inches wide at the top, tapering to 4 inches at the bottom, and being taken out of the middle of the cut, left a shoulder on each side. The sod or graft first taken out had by this time become tough and dry, and was placed, with the heath side downwards, in the shoulder, thus leaving the narrow spit at the bottom open for a depth of about 14 inches; the other square sod being put on the top, completed the drain."

"The cost of this mode of draining, including the side drains, was about 38s. per acre. The drains first put in required to be renewed in a few years, in consequence of the moss becoming so much consolidated and reduced in height that the plough, as well as the horses' feet, broke through the roof, although the horses were shod with 'pattens,' or boards of about 10 inches square, with the angles taken off. The second draining, however, was more permanent, and would probably not have required renewing for many years but for the moles, which have been very troublesome in working down to the drains, and filling them up in various places; so that the operation of draining has required to be partially renewed in every field, and in many of them entirely so; and thus these little animals have been the cause of a very considerable increase in the cost of labour. It has subsequently been found advisable to put the under drains in at 4 yards, instead of 6 yards asunder, and the advantage in one crop has been quite sufficient to pay the extra cost. A two-horse engine was erected, which drives the thrashing-machine, straw-cutter, and crushing-mill; and the escape-steam from it steams the horses' food.

"The buildings were erected principally of timber, covered with asphalted felt.

"After draining, making roads, and burning off the heath plant, the land was scarified lengthwise of the fields by an implement with knives shaped like coulters, reversed, sharp on the convex side, fixed in two bars, and drawn by three horses yoked abreast.

"The tough surface was by this means cut at every four inches; the land was then ploughed across the scarifying; a roller, surrounded with knives, was next passed across the plough; after this the land was well harrowed till sufficiently reduced.

"From 60 to 100 cubic yards of marl were put on an acre, and in the following summer the land was manured, also by means of the movable railway, at the rate of fifty tons of black Manchester manure per acre, and planted with potatoes, which were followed by wheat, sown with red clover and ryegrass, for mowing for one or two years; then oats and potatoes, &c., as before. These were all flourishing crops; the wheat in particular looked bright and beautiful. The potatoes were sold for £25 and £30 per acre, which more than paid the whole cost of improvement. Mr John Bell, resident bailiff, has made many valuable experiments relative to the improvement of raw moss, one of which has resulted in a discovery likely to be of considerable importance, which is, that a mixture of lime and salt applied a while before seeding, with the addition of a good dressing of guano, in the proportion of four tons of lime and five cwt. of salt per acre, qualifies it to produce a crop of potatoes or oats equal to that after the application of 60 yards of marl per acre. It is essential that the mixture should be spread while it is hot. Mr Evens (one of the proprietors) is convinced that the peat on the surface ought never to be burned; he has always found that, when the heath sod is turned down to decay, much better crops have been obtained than when it has been burnt off, or than when the top has been taken away either for fuel or other purposes. What are termed moss-fallows,—that is, parts which have had the moss taken off for fuel,—will never bear so good a crop as the upper surface, however deep the moss may be underneath." —(*Notes on the Agriculture of Lancashire, with Suggestions for its Improvement*, by Jonathan Binns.)

About a century ago, Lord Kames, on becoming proprietor of the estate of Blair-Drummond, in the county of Perth, began the improvement of a large tract of worthless moss by a totally different process from that now detailed. In this case the moss had accumulated upon a good alluvial clay soil. Instead, therefore, of attempts being made to improve the moss itself, it was floated off piecemeal into the neighbouring Firth of Forth. The supply of water required for this purpose was obtained from the river Teith, from which it was raised to the requisite height by a powerful water-wheel. Being conveyed through the moss in channels, successive layers of peat were dug and thrown into these channels, which were shifted as occasion required, until the whole inert mass was removed. A thin stratum next the clay was burnt, and the ashes used as manure. An immense extent of moss has thus been got rid of on that estate and on others in the neighbourhood, and "an extensive tract of country, where formerly only a few snipes and muir-fowl could find subsistence, has been converted, as if by magic, into a rich and fertile carse of alluvial soil, worth from £3 to £5 per acre."

Section 4.—Reclaiming of Fen Lands.

We next notice the fen lands of England. "In popular language, the word *fen* designates all low wet lands, whether peat-bog, river alluvium, or salt marsh; but in the great Bedford level, which, extending itself in Cambridgeshire and five adjoining counties, is the largest tract of fen land in the kingdom, the farmer always distinguishes, and it is thought conveniently and correctly, between fen land and marsh land. By the former they mean land partly alluvial and formed by river floods, and partly accumulated by the growth of peat. Such lands are almost invariably of a black colour, and contain a great percentage of carbon. By marsh lands they mean low tracts gained from the sea, either by the gradual silting up of estuaries or by artificial embankments." Low-lying peat occurs in small patches in nearly every maritime county of Britain, being usually separated from the sea or from estuaries by salt marsh or alluvium. There is a large extent of such land in Somersetshire yet but partially drained, and a still larger breadth in Lancashire, where its improvement makes steady progress. In Kent, on the seaboard of Norfolk, on both shores of the Humber, and stretching along the sides of its tributaries, there are immense tracts of this description of land. But these are all exceeded in importance by the "great level of the fens, which occupies the south-eastern quarter of Lincolnshire, the northern half of Cambridgeshire, and

spreads also into the counties of Norfolk, Suffolk, Huntingdon, and Northampton. Its length is about 70 miles, its breadth from 3 or 4 to 30 or 40 miles, the whole area being upwards of 1060 square miles, or 680,000 acres. On the map the fens appear like an enlargement of the Wash, and in reality have the aspect of a sea of land, lying between that bay and the high lands in each of the above-named counties, which seem to form an irregular coast-line around it." This fen country has for centuries been the scene of drainage operations on a stupendous scale. The whole surface of the great basin of the fens is lower than the sea, the level varying from four to sixteen feet below high-water mark in the German Ocean. The difficulty of draining this flat tract is increased from the circumstance that the ground is highest near the shore, and falls inland towards the foot of the slope. These inland and lowest grounds consist of spongy peat, which has a natural tendency to retain water. The rivers and streams which flow from the higher inlands discharge upon these level grounds, and originally found their way into the broad and shallow estuary of the Wash, obstructed in all directions by bars and shifting sand-banks. These upland waters being now caught at their point of entrance upon the fens, are confined within strong artificial banks, and so guided straight seaward. They are thus restrained from flooding the low grounds, and by their concentration and momentum assist in scouring out the silt from the narrow channel to which they are confined. The tidal waters are at the same time fenced out by sea-banks, which are provided at proper intervals with sluice doors, by which the waters escape at ebb-tide. To show the extent of these operations, it may be mentioned that the whole sea-coast of Lincolnshire and part of Norfolk, a line of at least 130 miles, consists of marsh lands lower than the tides, and is protected by barrier banks, besides which there are hundreds of miles of river embankments. When this does not provide such a drainage as to admit of cultivation, the water is lifted mechanically by wind or steam mills into the main aqueducts.

The first use of steam-engines for the purpose of draining was in Deeping fen, where, in 1824-5, two, of 80 and 60 horse-power respectively, were erected. By means of these two engines upwards of 20,000 acres have now a good drainage, whereas formerly forty-four wind-mills, with an aggregate power of 400 horses, failed to keep them sufficiently dry. The scoop-wheel of the larger engine is 28 feet in diameter, and the float-boards are 5 feet wide. It was intended to have a "dip" of 5 feet, but the land has subsided so much in consequence of the draining that it seldom has a dip of more than 2 feet 9 inches. The water is lifted on an average 7 feet high. When both engines are at work they raise 300 tons weight of water per minute.

The soil of the fens consists for the most part of dark-coloured peat, from 1 to 8 or 10 feet in depth. The surface in general is not pure peat, but is mixed with silt or other soil. Under this there is in general a stratum of brown spongy peat, which sometimes rests upon gravel, but for the most part upon clay, which usually contains a portion of calcareous matter. The removal of the water has of course been the primary improvement; but subsidiary to this the rapid amelioration and great fertility of the fen lands are largely due to this fortunate conjunction of clay and peat. The early practice of the fen farmers was to pare and burn the surface, grow repeated crops of rape, oats, wheat, &c., and burn again. The subsidence of the soil subsequent to the draining and repeated paring and burning, brought the surface nearer to the subjacent clay, which the cultivators by and by began to dig up and spread over the surface. This practice is now universal, and its continued use, together with careful cultivation and liberal manuring, has changed a not very productive peat into one of the most fertile soils in the kingdom. Nowhere in our country has the industry and skill of man effected greater changes than in the fens. What was once a dismal morass, presenting to the view in summer a wilderness of reeds, sedges, and pools of water, among which the cattle waded, and in winter almost an unbroken expanse of water, is now a fertile corn land. The fen men, who formerly lived upon the adjacent high lands, and occupied themselves with fishing, fowling, and attending to their cattle, have now erected homesteads upon the fen lands, divided them by thorn hedges, and brought them into the highest state of cultivation.

We referred at the outset to the distinction betwixt *fen* land and *marsh* land. The following pertinent observations on the reclamation of marsh land are extracted from Mr David Stevenson's paper in the *Highland and Agricultural Society's Transactions*, vol. iii., 1871.

First, In order to insure success, the space to be reclaimed must be within the influence of water containing much alluvial matter, and not on the shores of an open sandy estuary.

Secondly, The spaces to be reclaimed should be allowed to receive the deposit left by the tide for as long a period as possible, and no attempt should be made entirely to exclude the water from them, until they have by gradual accretion attained the level of at least ordinary spring tides.

The first case to which I shall refer is Loch Foyle, a situation where the amount of salt water greatly preponderates over the fresh. Extensive reclamations have been made there, and I have received from Mr G. Henry Wiggins, of Londonderry, some notes regarding them, from which I extract the following interesting information:—

"After the salt water had been excluded, shallow surface drains were made with spades or forks, and in about two years ryegrass grew pretty freely: exceptional spots remained barren for some time. The grass was followed by oats, which improved as the salt left the soil. Deeper draining allowed the cultivation of flax and clover; afterwards, on deeper draining, all ordinary crops began to grow well—wheat, beans, turnips, mangold, and carrots—but all requiring fully as much manure as any old upper land. These sloblands, says Mr Wiggins, yield a great return for manure, but must have manure on the lower and damper portions. Feorin grass grows well without manure.

"Whenever the ditches have so far drained the soil as to allow of its becoming cracked and open to the air, the crops begin to increase in produce, but the full value of the soil is never known until thoroughly under-drained with tile or stone; it then mostly yields excellent crops of almost any produce, clover and ryegrass for hay being perhaps the most profitable. Grazing the land does not answer, except from the beginning of May to the end of September; after this the soil is too cold and damp for the beasts to lie down, and they begin to fail."

The expense of these intakes on the Foyle may be taken at about £20 an acre to get them from the sea; the expense of bringing the land when got into cultivation will come to at least £10 more; making a total of £30 per acre. The best lands are worth 50s. to 40s. the Cunningham or Scotch acre, and the lowest and wettest parts perhaps not more than 10s.—say 30s. round as a fair average. To this has to be added the expense of keeping up the banks and pumping water; so that I believe Mr Wiggins is right when he says that no great profit can be expected, and that these matters are generally undertaken by hopeful and energetic enthusiasts, who seldom realise their expectations, and afterwards fall into the hands of other parties, who are perhaps rather more successful.

The reclamations made by the Ulverston and Lancaster Railway in Morecambe Bay were rapidly formed by the embankment for carrying the railway, which was made in pretty deep water. Like the Foyle, there is also predominance of sea-water. Mr G. Drewry, of Holker in Lancashire, has favoured me with the following information:—"A portion of the land enclosed by the railway in 1856 was grassed over, and the remainder was sand without any vegetation on it. After it was levelled it was divided into fields by open ditches and wire fences; the ditches had to be made very wide at the top, in order to get them to stand. The land was then drained with 3-inch pipes, each drain opening into the ditch at each side of the field. The tiles were all covered round with peat moss, to act as a filter to prevent the sand from running into them. The sand is so fine that without this precaution the drains would have filled up very quickly. The drainage is the great difficulty, as they are very apt to fill up after every precaution has been taken.

"On the portion which was grassed over, two crops of oats were first taken, and then it was green-cropped. It grew for a few years

good crops of wheat, beans, and clover, as well as Swedish turnips and mangolds; but though a great quantity of manure was used, the crops fell off, and at present it is nearly all in grass. The portion which was bare sand was treated in the same way, except as to the first two crops of oats. It was green-cropped after it had been enclosed about two years. After the railway was made there was no means of silting the land. The tide was entirely kept out; had it been admitted, this land would have been much more valuable and much higher—we would then have had a better drainage and a richer sand. That portion which was grassed over at the time it was enclosed is still much the best.

"When land is reclaimed from the sea, the first thing to be looked to is a good outfall for the water, and, when it is possible, no doubt it is very desirable that the land should be silted up gradually. In our case this could not be done, as the reclamation of the land was a very secondary affair."

In the district called Marshland, in Norfolk, extending between the Ouse and the Nen; in that called South Holland, in Lincolnshire, stretching between the Nen and the Welland; northward of Spalding, and also north-east of Boston, there is a considerable tract of marine clay soil. In Marshland this is chiefly arable land, producing large crops of wheat and beans; but in Lincolnshire it forms exceedingly fine grazing land. This tract lies within the old Roman embankment by which the district was first defended from the ocean. Outside this barrier are the proper marsh lands, which have been reclaimed in portions at successive periods, and are still intersected in all directions by ranges of banks. The extraordinary feature of this tract is, that the surface outside the Roman bank is 3 or 4 feet higher than that in the inside, and the level of each new enclosure is more elevated than the previous one. The land rises step by step as the coast is approached, so that the most recently reclaimed land is often 12 or even 18 feet higher than the lowest fen land in the interior, the drainage from which must nevertheless be conveyed through these more elevated marshes to the sea.

Lands such as some of those which we have just been describing are often greatly improved, or rather may be said to be *made*, by means of a peculiar mode of irrigation called "warping." It is practicable only in the case of land lying below the level of high tide in muddy rivers. It is little more than a century since it was first practised in England, the first instance of it being near Howden, on the banks of the Humber. But although the practice is comparatively new in Britain, it has long been in use on the continent of Europe, particularly in Italy, and is thus described by Mr Cadell:—"In the Val de Chiana, fields that are too low are raised and fertilised by the process called *colmata*, which is done in the following manner:—The field is surrounded by an embankment to confine the water. The dike of the rivulet is broken down so as to admit the muddy water of the high floods. The Chiana itself is too powerful a body of water to be used for this purpose; it is only the streams that flow into the Chiana that are thus used. This water is allowed to settle and deposit its mud upon the field. The water is then let off into the river at the lower end of the field by a discharging course called *scolo*, and in French *canal d'ecoulement*. The water-course which conducts the water from a river, either to a field for irrigation or to a mill, is called *yora*. In this manner a field will be raised $5\frac{1}{2}$ and sometimes $7\frac{1}{2}$ feet in ten years. If the dike is broken down to the bottom, the field may be raised to the same height in seven years; but then in this case gravel is also carried in along with the mud. In a field of 25 acres, which had been six years under the process of *colmata*, in which the dike was broken down to within 3 feet of the bottom, the process was seen to be so far advanced that only another year was requisite for its completion. The floods in this instance had been much charged with soil. The water which comes off cultivated land completes the process sooner than that which comes off hill and woodland. Almost the whole of the Val di Chiana has been raised by the process of *colmata*."[1]

Section 5.—Blowing Sands.

On many parts of our sea-coasts, and especially in the Hebrides, there occur extensive tracts of blowing sands, which are naturally not only sterile themselves, but a source of danger to better lands adjoining them, which in some instances have been quite ruined by the sand deposited upon them by the winds. This mischief is effectually prevented by a process beautifully simple and useful, namely, planting the sand-banks with sea bent-grass (*Arundo arenaria*), the matting fibres and stems of which not only bind the sand, but clothe it with a herbage which is relished by cattle, and which, being able to resist the severest winter weather, furnishes a valuable winter forage in those bleak situations. The bent-grass can be propagated by seed, but in exposed situations it is found better to transplant it. This operation is performed betwixt October and March, as it succeeds best when the sand is moist and evaporation slow.

CHAPTER XX.

GENERAL OBSERVATIONS.

According to the method proposed at the outset, we now offer a few observations on several topics connected with our subject.

Section 1.—Of the Tenure of Land.

The extent of land in Great Britain occupied by its owners for agricultural purposes bears a very small proportion to the whole area. The yeoman class is still numerous in several parts of England, but must have diminished greatly from that continuous amalgamation of small estates into large ones which has formed a marked feature in our social history during the present century. This change, although to be regretted on public grounds, has had a favourable influence on the cultivation of the soil, for it almost invariably happens that a larger produce is obtained from land when it is occupied by a tenant than when it is cultivated by its proprietor. As a matter of fact, the land of the country is now, with trifling exceptions, let out to professional farmers in quantities varying from the rood-allotment of the village labourer to the square miles of the Highland grazier. Farms of all sizes are usually to be found in any district, and most important it is that this should be the case; but the extent of farms is chiefly determined by the amount of hired labour employed upon them, and the measure of personal superintendence on the part of the tenant which the kind of husbandry pursued upon them calls for. We accordingly find that in very fertile tracts, in the vicinity of towns, and in dairy districts, they seldom exceed 200 acres; where the ordinary alternate husbandry is practised the average ranges from 300 to 400; in more elevated tracts, where a portion of natural sheep-walk is occupied along with arable land, it rises to 800 or 1000; while that of the sheep grazings of our hills and mountains is limited only by the capital of the tenant. About a century ago there occurred in various parts of Great Britain a similar amalgamation of small holdings into farms of the sizes which we have now referred to as is at present in progress in Ireland. This enlargement of farms, with the employment of increased capital in their cultivation, insures a more rapid reclamation of waste lands, and general progress of agriculture up to a certain point, than would otherwise take place. But as every step in advance beyond this point implies an

[1] *Journey in Carniola, Italy, and France*, by W. A. Cadell, Esq., F.R.S.

increase of outlay in proportion to the extent, and the need for closer superintendence, it seems likely that, in future, the size of arable farms will not further increase, but may rather be expected to approximate towards that which at present obtains in suburban districts.

Farms are held either by yearly tenancy or under leases for a specified number of years. The latter plan is that upon which nearly the whole lands of Scotland are let; and it obtains also to a considerable extent in the northern counties of England, in West Norfolk, and in Lancashire. But with these and other exceptions, amounting altogether to about a tenth part, the farms of England are held by yearly tenancy, which can be terminated by either of the contracting parties giving the other six months' notice to that effect. This precarious tenure has been attended by far fewer changes than a stranger might suppose, owing to the highly honourable conduct for which English proprietors as a class have long been noted. On all the large estates it is quite common to find families occupying farms of which their ancestors have been tenants for generations, or even for centuries. The mutual esteem and confidence which usually subsist between such landlords and tenants are undoubtedly much to the credit of both, but not the less has the system, as a whole, operated unfavourably for all concerned; for however numerous and striking the exceptions, it is yet the fact that under this system of tenancy-at-will less capital has been invested in the improvement of farms, less labour has been employed, and less enterprise displayed in their ordinary cultivation, less produce has been obtained from them by the occupiers, and less rent has been received for them by the owners, than in the case of similar lands let on leases for a term of years. These different results ensue, not because tenants with leases are abler men or better farmers than their neighbours who are without them, but solely bcause the one system recognises certain important principles which the other ignores. It is contrary to human nature to expect that any body of men will as freely invest their capital, whether in the shape of money, skill, or labour, in a business yielding such slow returns as agriculture, with no better guarantee that they or their families shall reap the fruits of it than the continued good-will of existing proprietors or those who any day may succeed them, as they will do with the security which a lease for a term of years affords. It does therefore seem strange that a majority of the farmers of Great Britain should be tenants-at-will, and still more strange that they should be so of choice. It is nevertheless true that a considerable portion of the tenantry of England are even less disposed to accept of leases than their landlords are to grant them. The latter cling to the system because of the greater control which they thereby retain over their estates, and the greater political influence with which it invests them: the former do so because low rents are one of its accompaniments. Since the removal of restrictions on the importation of foreign agricultural produce, there are indications that neither landlords nor tenants are so well satisfied with this system of tenancy-at-will as they once were. Not only is the granting of leases becoming more common than it has hitherto been, but there is a growing desire on the part of tenants to obtain the benefit of that guarantee for the realising of their capital which *tenant-right* affords to enterprising farmers who may have unexpectedly to quit their farms. In certain districts of England this claim, called *tenant-right*, has been recognised so long that, apart either from written stipulation or statutory enactment, it has, by mere usage, attained to something like a legal standing. In Lincolnshire an out-going tenant can, by virtue of this usage, claim from his landlord or successor repayment, in certain definite proportions, of the cost of such ameliorations of a specified kind as he may have made during the last years of his occupancy, and the benefits of which his removal hinders him from realising in the natural way.

Tenant-right is certainly a valuable adjunct to tenancy-at-will, but still it does not meet the real exigencies of the case. There are feelings inherent in man's nature which cause him to recoil from exertions the fruits of which are as likely to be enjoyed by a stranger as by himself or his family. This repugnance, and its paralysing influence, is not to be removed by a mere "right" to pecuniary compensation. It is certainty of tenure—so far at least as human arrangements can be certain—which will really induce a farmer to throw his whole heart into his business. It is accordingly to this principle that leases owe their value, and by it also that the only weak point in them is to be accounted for. The first years of a lease are usually characterised by an energetic performance of various improvements, whereas towards its close there is usually such a withdrawing even of ordinary outlay as is unfavourable to the interests of both landlord and tenant. There is at present a very generally entertained opinion that this inconvenience would be obviated by engrafting the system of tenant-right upon that of leases. So strongly has the current of opinion been running in this direction that a bill has been submitted to the legislature for the purpose of conferring on out-going tenants a legal claim to compensation for certain specified investments which may have been made by them, but of which their removal hinders them from reaping the benefit. This bill further provided that in the event of a tenant having erected buildings for his own accommodation without the sanction of his landlord, he should have a right to remove the materials if the landlord or incoming tenant declined to purchase them. Through accidental circumstances this bill was withdrawn without being discussed, but it is certain to be re-introduced, and sooner or later to be passed. It is now admitted on all hands that land cannot be cultivated to its full measure of productiveness without a large investment of capital, and that this outlay, when once incurred, cannot be recouped for several years at the least. It is in vain, therefore, to expect that these so much needed investments will be made until those who should make them are secured against having their property confiscated by a six months' notice to quit.

It seems to be generally admitted that twenty-one years is the proper duration for an agricultural lease. Such a term suffices to give confidence to the tenant in embarking his capital, and secures to the landlord his legitimate control over his property, and due participation in its varying value. It is generally felt by tenants that the lease or document in which their agreement with their landlord is engrossed might with advantage be much shortened, as well as simplified in its terms. When treating of the succession of crops we have already expressed our views regarding those restrictive clauses which usually occupy a prominent place in such writings. Such restrictions are of course introduced with the view of guarding the property of the landlord from deterioration; but when he is so unfortunate as to meet with incompetent or dishonest tenants, they entirely fail to secure this object, and yet are a hindrance and discouragement to enterprising and conscientious tenants. It is probable that the existence of the laws of distraint in England and hypothec in Scotland, which give to landlords a lien over the effects of their tenantry in security for the payment of the current year's rent, has had its influence in adding to the number and stringency of these clauses, and has encouraged the practice of letting lands by tender to the highest offerer. For the law in question, by rendering landlords to a considerable extent independent of the personal character and pecuniary

circumstances of the occupiers of their land, has obviously a direct tendency to render them less cautious than they would otherwise be, and to induce them, when tempted by the promise of high rents, to trust more to this legal security than to the moral character, business habits, professional skill, and pecuniary competency of candidates for their farms.

Section 2.—Capital required for working a Farm.

The amount of capital that is required in order that the business of farming may be conducted advantageously, is largely determined by the nature of the soil, &c., of each farm, the system of management appropriate to it, the price of stock and of labour, and the terms at which its rents are payable. In the case of land of fair quality, on which the alternate husbandry is pursued, and when the rents are payable as the produce is realised, £10 per acre may be regarded as an amount of capital which will enable a tenant to prosecute his business with advantage and comfort. In letting a farm, a landlord not only does a just and prudent thing for himself, but acts as a true friend to his proposed tenant, when he insists upon being shown that the latter is possessed of available funds to an amount adequate to its probable requirements.

The importance of the topics to which we have thus referred is happily expressed by Mr Pusey, when, after enumerating various agricultural desiderata, he says, "In some degree none of us carry out all that is in our power; but want of capital and want of confidence in the tenure of farms are, I suppose, the two principal causes of this omission."

Section 3.—Education of Farmers.

But the mere possession of capital does not qualify a man for being a farmer, nor is there any virtue inherent in a lease to insure his success. To these must be added probity, knowledge of his business, and diligence in prosecuting it. These qualifications are the fruits of good *education* (in the fullest sense of that term), and are no more to be looked for without it than good crops without good husbandry. Common school instruction will, of course, form the groundwork of a farmer's education; but to this should be added, if possible, a classical curriculum. It has been the fashion to ask, "Of what use are Greek and Latin to a farmer?" Now, apart from the benefit which it is to him, in common with other men, to know the structure of language, and to read with intelligence the literature of his profession, which more and more abounds in scientific terminology, we believe that no better discipline for the youthful mind has yet been devised than the classical course which is in use in our best public schools. Of this discipline we desire that every future farmer should have the advantage. But the great difficulty at present lies in finding appropriate occupation for such youths between their fifteenth and twentieth years. In many cases the sons of farmers are during that period put to farm labour. If they are kept statedly at it, and are made proficient in every kind of work performed on a farm, it is a good professional training as far as it goes. The more common one—at least as regards the sons of the larger class of farmers—which consists of loitering about without any stated occupation, attending fairs and markets, and probably the race-course and hunting-field, is about the most absurd and pernicious that can well be imagined. Such youths are truly to be pitied, for they are neither inured to bodily labour nor afforded the benefits of a liberal education. It need not surprise any one that such hapless lads often prove incompetent for the struggles of life, and have to yield their places to more vigorous men who have enjoyed the benefit of "bearing the yoke in their youth." Unless young men are kept at labour, either of mind or of body, until continuous exertion during stated hours, confinement to one place, and prompt obedience to their superiors have ceased to be irksome, there is little hope of their either prospering in business or distinguishing themselves in their profession. Owing to the altered habits of society, there is now less likelihood than ever of such young persons as we are referring to being subjected to that arduous training to bodily labour which was once the universal practice; and hence the necessity for an appropriate course of study to take its place. Many Scottish farmers endeavour to supply this want by placing their sons for several years in the chambers of an attorney, estate-agent, or land surveyor, partly in order that they may acquire a knowledge of accounts, but especially for the sake of the wholesome discipline which is implied in continuous application and subjection to superiors. It is also common for such youths to be sent to Edinburgh for a winter or two to attend the class of agriculture in the University, and perhaps also that of chemistry, and the Veterinary College classes. This is well enough in its way; but there is wanting in it an adequate guarantee that there is real study—the actual performance of daily mental work. The agricultural college at Cirencester appears to come more fully up to our notion of what is needed for the professional training of farmers than any other institution which we yet possess. We shall rejoice to see such opportunities of instruction as it affords multiplied in Great Britain. After enjoying the benefits of such a course of training as we have now indicated, young men would be in circumstances to derive real advantage from a residence with some experienced practical farmer, or from a tour through the best-cultivated districts of the country. We are well aware that what we have now recommended will appear sufficiently absurd to the still numerous class of persons who believe that any one has wit enough to be a farmer. But those who are competent to judge in the case can well afford to smile at such ignorance. They know that agriculture is at once an art, a science, and a business; that the researches of naturalists, chemists, geologists, and mechanicians are daily contributing to the elucidation of its principles and the guidance of its practice; and that while its pursuits afford scope for the acutest minds, they are relished by the most cultivated. As a business it shares to the full in the effects of that vehement competition which is experienced in every other branch of industry, and has besides many risks peculiar to itself. The easy routine of the olden time is gone for ever; and without a good measure of tact, energy, and industry, no man can now obtain a livelihood by farming. It is desirable that all this should be known, as nothing has been more common than for parents who have sons too dull to be scholars or too indolent for trade, to put them to farming; or for persons who have earned a competency in some other calling to covet the (supposed) easy life of a farmer, and find it to their sorrow a harassing and ill-requited one.

Section 4.—Farm Labourers.

The agriculture of a country must ever be largely affected by the condition and character of the peasantry by whom its labours are performed. An acute observer has shown that in England a poor style of farming and low wages—that good farming and high wages, usually go together; and that a low rate of wages is significantly associated with a high poor-rate. The worst paid and worst lodged labourers are also the most ignorant, the most prejudiced, the most reckless and insubordinate. The eminence of the agriculture of Scotland is due in large measure, to the moral worth and intelligence of her peasantry. For this she is indebted to the early establish-

ment of her parochial schools, and to the sterling quality of the elementary education which the children of her tenantry and peasantry have for generations received in these schools together. These schools had unfortunately become inadequate to the increased population; but still in the rural districts of the Scottish lowlands it is a rare thing to meet with a farm labourer who cannot both read and write. Apart from higher benefits, the facilities which the services of such a class of labourers have afforded for the introduction and development of improved agricultural practices, the use of intricate machinery, and the keeping of accurate accounts, cannot well be over-rated. It is an interesting testimony to the value of a sound system of national education that our Scottish peasantry should be in such request in other parts of the kingdom as bailiffs, gardeners, and overseers. Recent legislation warrants the expectation that this inestimable blessing will speedily be enjoyed by our entire population.

The pernicious influence of the present law of settlement and removal upon the English labourer is now attracting the attention which it so urgently demands. The proprietors and tenants of particular parishes in various parts of England at present combine to lessen their own share of the burden of the poor-rate by pulling down cottages and compelling their labourers to reside out of their bounds. The folly and cruelty of such short-sighted policy cannot be too strongly reprobated. These poor people are thus driven into towns, where their families are crowded into wretched apartments, for which they must pay exorbitant rents, and where they are constantly exposed to moral and physical contamination of every sort. From these comfortless abodes the wearied and dispirited men must trudge in all weathers to the distant scene of their daily labours. One cannot conceive of a prosperous agriculture co-existing with such a system, nor feel any surprise that thieving, incendiarism, and burdensome rates should be its frequent accompaniments. It is pleasant to contrast with this close-parish policy the conduct of some of our English nobility, who are building comfortable cottages and providing good schools for the whole of the labourers upon their princely estates.

About the middle of the 18th century, when the old township system began to be broken up, and the land to be enclosed and arranged into compact farms of considerable size, it happily became the practice in the south-eastern counties of Scotland, and a portion of the north of England, to provide each farm with its own homestead, set down as near its centre as possible, and with as many cottages as would accommodate all the people statedly required for the work of that farm. These cottages, always placed in convenient proximity to the homestead, are let to the tenant along with the farm as a necessary part of its equipment. The farmer hires his servants by the year at stipulated wages, each family getting the use of a cottage and small garden rent free. The farmer has thus always at hand a staff of labourers on whose services he can depend; and they, again, being engaged for a year, are never thrown out of work at slack seasons, nor are they liable to loss of wages from bad weather or casual sickness. This arrangement has the further advantage of the men being removed from the temptations of the village alehouse. So successfully has this system worked that the counties in which it prevails have long had, and still have, an agricultural population unequalled in Great Britain for intelligence, good conduct, and general well-being.

Over a very large portion of Scotland, and more especially in the counties lying betwixt the Forth and the Moray Frith, while the arrangement of farms and mode of management are substantially the same as those of the border counties, there is this marked difference, that the ploughmen as a rule live by themselves in bothies. They are for the most part unmarried men, although not a few of them have wives and children living under the most unfavourable conditions in distant towns and villages; and so it comes to pass, under this bothy system, that about two-thirds of all the men statedly employed in farm labour are shut out from all the comforts and blessings of family life, and have become in consequence rude, reckless, and immoral. Until a quite recent date this system, because of its supposed economy, was stoutly defended both by landlords and farmers; but its evil effects have become so manifest as to convince them at last that the system is wrong, and there is now in consequence a general demand for more cottages on farms.

The condition of the agricultural labourers in the southern counties of England has long been of a most unsatisfactory character. The discontent that had long existed among them has at last, in the summer of 1873, culminated in wide-spread combinations and strikes for higher wages and better terms. To a large extent the labourers have been able to make good their demands, although at the cost of much unhinging of old relations betwixt them and their employers, and a great deal of mutual grudging and jealousy. The thorough healing of chronic social maladies is always difficult, and usually demands the patient use of a variety of remedial measures. We venture to express the opinion that much benefit would ensue from the adoption in southern England of the essential parts of the border system, viz., cottages on each farm for all its regular labourers, yearly engagements, and a cow's keep as part of the wages of each family.[1]

Section 5.—What the Legislature should do for Agriculture.

The further progress of our national agriculture is undoubtedly to be looked for from the independent exertions of those immediately engaged in it; but important assistance might be, and ought to be, afforded to them by the legislature, chiefly in the way of removing obstructions. What we desiderate in this respect is the repeal, or at least the important modification, of the law of distraint and hypothec; the commutation of the burdens attaching to copyhold lands; the reformation of the law of settlement; the removal of the risk and costs which at present interfere with the transference of land; the endowment of an adequate number of agricultural colleges, with suitable museums, apparatus, and illustrative farms; and the compulsory adoption of a uniform standard of weights and measures. We desire also to see the *arterial* or *trunk drainage* of the country undertaken by government. Until this is done, vast tracts of the most fertile land in the kingdom cannot be cultivated with safety and economy, or attain to the productiveness of which they are capable. It is the opinion of Mr Bailey Denton, the eminent draining engineer, that not more than three millions of acres of the land of Great Britain have yet been drained. Our national interests surely require that its agriculture should be freed from such obstructions as these, and that it should receive the benefit of a fair share of public provision, such as is made for training youths for the learned professions and for the public service; and of such grants as are given in aid of scientific research for the encouragement of the fine arts, and for the furtherance of manufactures and commerce.

We cannot close this section without referring to another grievance which has long had a most depressing effect on the agriculture of particular districts of our country, and is now, we regret to say, spreading rapidly to all parts of it,

[1] For confirmation and full illustration of the statements and opinions in the above section on agricultural labourers, the reader is referred to the reports of, and the evidence collected by, the "Commission on the Employment of Children, Young Persons, and Women in Agriculture," in 1870.

in the excessive preservation of game. This evil has been greatly aggravated since that mode of sporting called the battue has unhappily become the fashion. For this amusement a very large head of game is reckoned to be indispensable, and proprietors who engage in it are naturally enough led to vie with each other as to who shall show the greatest quantity of game, and report the heaviest bag, at their respective shooting parties. All this necessarily implies a grievous waste of farm produce, and frightful loss to farmers whose crops are exposed to the incursions of the privileged vermin. Worst of all, these hordes of game present such irresistible temptation to poaching that the rural population is demoralised by it to an alarming extent. So long as field sports were in a great measure restricted to resident landowners and their personal friends, they were, with rare exceptions, careful not to allow their tenants to be injured by game. Now, however, there are multitudes of men who, having acquired wealth in business, are eager to engage in field sports, and ready to give almost any amount of money for the privilege of doing so. These game tenants are often utterly regardless of the interests of farmers, and cause them both loss and annoyance. All this is occasioning such an amount of heart-burning and alienation of feeling between different classes of society as cannot fail to have disastrous consequences. A few years ago the removal of hares and rabbits from the list of animals protected by the game-laws would, so far at least as landlords and their tenants are concerned, have put an end to all this misery. The refusal of so moderate a concession has in all likelihood sealed the fate of these oppressive laws which have so long embittered society and disgraced our country.

Section 6.—Concluding Remarks.

On carefully comparing the present condition of British agriculture with what it was forty years ago, the change for the better is found to be very great indeed. But on all hands there are many indications warranting the anticipation that the progress of discovery and improvement in future will be more steady, more rapid, and more general than it has hitherto been. There is not only a more general and more earnest spirit of inquiry, but practical men, instead of despising the aids of science, seek more and more to conduct their investigations under its guidance. Experiments are made on an ever-widening scale and upon well-concerted plans. Their results are so recorded and published that they at once become available to all, and each fresh investigator, instead of wasting his energies in re-discovering what (unknown to him) has been discovered before, now makes his start from a well-ascertained and ever-advancing frontier. Formerly the knowledge of the husbandman consisted very much of isolated facts, and his procedure was often little better than a groping in the dark. As the *rationale* of his various processes is more clearly discovered, he will be enabled to conduct them with greater economy and precision than he can do at present. A clearer knowledge of what really constitutes the food of plants, and of the various influences which affect their growth, will necessarily lead to important improvements in all that relates to the collection, preparation, and use of manures.

What may truly be called a revolution in agriculture is now in the act of rapid development, in the application of steam-power to the tillage of the soil, which is spreading on every side. Enough has already been accomplished to show that, under the combined influence of drainage and steam tillage, the clay soils of England will speedily have their latent fertility brought into play in a manner that will mightily augment our supplies of home-grown bread-corn and butcher-meat. It may indeed now be reasonably anticipated that these hitherto impracticable soils will again take their place as our best corn-growing lands, and that those large portions of the country where for a long time our national agriculture presented its poorest aspect, may ere long exhibit its proudest achievements.

In closing this rapid review of British Agriculture, it is gratifying and cheering to reflect that never was this great branch of national industry in a healthier condition, and never were there such solid grounds for anticipating for it a steady and rapid progress. The time has hardly yet gone by when it was much the way with our manufacturing and trading men, and our civic population generally, to regard our farmers as a dull, plodding sort of people, greatly inferior to themselves in intelligence and energy. Many of them seem now, however, to be awakening to the fact that their rural brethren possess a full share of those qualities which so honourably distinguish the British race. Nay, some of them may have experienced no little surprise when they became aware that in a full competition of our whole industrial products with those of other nations, as at Paris in 1855, and at similar and more recent international expositions, the one department in which Britain confessedly outstripped all her rivals was not in any of her great staple manufactures, but in the live stock of her farms, and in her agricultural implements and machinery

List of Plates accompanying this Article.

Plate

No. III. Plan of Covered Homestead for a small Farm, by Mr J. Cowie.
IV. Ground Plan of Steading and Offices on the Home Farm of the Earl of Southesk.
V. Shorthorn Bull and Cow.
VI. Hereford Bull, and South Down Ewe and Lamb.
VII. Cheviot Ewe and Blackfaced Heath Sheep.
VIII. Leicester Ram and Ewe.
IX. Romsey Marsh Ewe, and Sow of the Large English Breed

The following description has been supplied along with the plan given in Plate IV.:—"It represents the ground plan of a steading of offices recently built on the home farm of the Earl of Southesk, planned by Charles Lyall, Esq., his lordship's factor. It contains a powerful thrashing-mill, corn-bruiser, oil-crusher, chaff-cutter, and turnip-slicer, all driven by a portable steam-engine; and is amply supplied with water for the troughs, and is lighted by gas. It may be regarded as a model, containing as it does all the conveniences and appliances necessary for the complete development of the stock and implement departments. It is calculated for an occupancy of 500 acres, and was built, including the steam-engine, at a cost of about £5000."

This plan may very well illustrate the present state of opinion as to whether or not cattle should be kept wholly under cover. It gives an affirmative answer to this question in the case of fattening cattle; but for breeding stock of all ages it provides accommodation in open yards. This we consider the best arrangement; for it is impossible in the case of breeding stock to retain that fine coat of hair which so enhances the good looks and value of high-class cattle without such an amount of exposure to the weather as is afforded by open yards with covered sheds. There is one feature in this plan which we cannot but regret, viz., its bothy. It is indeed one of the best of its kind, having a separate sleeping-place for each of its inmates, and suitable arrangements for their cleanliness and comfort; but the meanest cottage in the country, inasmuch as it admits of family life, is to be preferred to the most perfect bothy. (J. W.)

CHAPTER XXI.

LARGE AND SMALL FARMING.

No treatise on agriculture will in these days be considered complete which does not take note of some of the various modes in which the treatment of the soil may be affected by variations in the cultivating occupier's form of tenure. A farm may be the property of its occupier, or be held by him at will or on lease. According to its extent it will be the subject of *grande* or of *petite culture*, expressions which in the following pages will be Anglicised as large and small culture or farming. If a farm be of small size, and if its occupant be also its owner, peasant proprietorship comes into play. If it be let, its rent may consist of a payment of predetermined amount in money or in kind, or may, instead of a fixed portion, be a predetermined proportion of the annual produce. It may be let to one individual, singly responsible for the rent and for all imposts, fiscal or other, and exclusively entitled to the whole of the remaining net produce; or it may be held in common by any number of coparceners, all co-operating in the cultivation, and jointly and severally responsible for the rent and other dues, and all participating in the net profits.

Each of these systems has its advocates, and of one of them, at least, the admirers are so much enamoured as to be unable to perceive merit in any of the rest. A judgment upon them that would be generally acceptable is therefore impossible, and need not be attempted here. Nothing more will be aimed at than such an impartial estimate of the advantages and disadvantages of each as may help an unbiassed reader to judge for himself.

Tenancies at will and leases.

I. In regard to tenancy at will and to leases, little need be added to the observations made in previous chapters of this article. For the consideration, however, of those who insist on the undoubted fact that in Great Britain, where tenancy at will is still the rule, and leases as yet only the exception, the same families, although liable to be ousted at six months' notice, are nevertheless often found occupying the same land from generation to generation, the following may be suggested as a not improbable explanation of the landlord's non-exercise of the power of eviction. It may perhaps be not so much that the farmers really confound past continuity with future permanency of tenure, as that their want of security for the future prevents their investing liberally in improvements, and thereby bringing the land into a condition calculated to attract higher bidders for its possession. Such increase as does take place in its lettable value is chiefly due to enhancement of the prices of produce; and to a rise of rent proportionate to such enhancement the old tenants readily submit rather than be removed. The principal loser here is the landlord, whose short-sighted policy deters his tenants from a species of enterprise the benefit of which would eventually become principally his own. If the tenants took the trouble to make the comparison, they might, it is true, deliberately prefer the mere chance of a long series of years at a low rent to the certainty of the same low rent for a limited term, coupled with the nearly equal certainty of a rise of rent at the end of the term. Their gains in the former case, they might argue, however meagre, might at least be easily earned; whereas materially to increase them in the latter case, although perhaps possible, would be possible only at the expense of much anxiety of mind as well as of much extra sweat of the brow.

Large farming.

II. Of *grande culture*, or large farming, it may perhaps be thought almost superfluous here to enumerate the recommendations, which indeed on one condition are obvious and incontrovertible. Provided a large farmer be possessed of capital duly proportioned to the extent of his holding, and of intelligence to employ his capital judiciously, his husbandry can scarcely fail to prove abundantly satisfactory. In a territory entirely parcelled out among farmers of this description there would, from a purely agricultural point of view, seem little left to desire. The system certainly approaches towards the realisation of the great object of all agriculture—that of the production of the greatest possible quantity and the best possible quality of raw material for the use of man. The distinguishing characteristic of large culture is the scope it affords for the application to husbandry of the great principle of division of labour. A well-managed large farm is indeed a factory for the production of vegetable and animal substance. The extensive scale on which operations are there carried on necessitates the employment of several persons, to each of whom some special occupation may be assigned, and constant practice naturally increases the labourer's skill. Time, too, is saved which would otherwise be lost in turning frequently from one occupation to another; and there is also a further saving in implements, large and small, and in draught cattle, fewer of which will suffice for the tillage of a given area held entire than would be needed if the same acreage were divided amongst numerous tenants. Some, again, of the more important of agricultural operations, and notably those of drainage and irrigation, are in many situations incapable of being efficiently performed except on a large scale; and though they may be, and often are, most efficiently performed on the very largest scale by a combination of small landholders, still every such combination must necessarily be preceded by negotiations involving indefinitely prolonged delay, with which a single individual, occupying the entire tract, could at his option dispense. And a similar remark applies to the costlier implements and machines, in the adoption of which associations of small farmers may slowly follow the example of individual large farmers, but which they would not, without such example, have themselves adopted—which, indeed, unless previously patronised by large farmers, would never have been offered for their adoption. Probably no inventive genius, however disinterestedly ardent, would have been at the pains to devise a steam thrashing-machine or a steam plough, had there not been wealthy agriculturists, some of whom might readily be persuaded to risk, at their own cost and charges, an immediate trial of any promising invention. Farmers of limited means, even when living in the same neighbourhood, would have to be educated into faith in the novel apparatus before the inventor would get a single specimen taken off his hands.

Besides, wherever large farming prevails, large properties are its invariable concomitants; and wherever it is the fashion for proprietors to reside on their estates, many of them are sure to amuse themselves with farming. Very likely, if they were to count the cost, they might find the amusement an expensive one. Not impossibly they often spend on the land as much as they get back from it, or even more, the expenditure in that case at best producing only its bare equivalent. But the same expenditure, unless so applied, would as likely as not have remained utterly unproductive, being devoted to some other amusement, or to mere parade or luxury, from which no tangible return whatever would be possible; so that its application to agricultural extravagance is virtually a gain, in the sense, at all events, of preventing total loss. Nor in that sense only; for rich men who take to farming as a pastime are precisely those most likely to be forward in putting new inventions and new processes to the test of experiment; while the experience thereby acquired, instead of being jealously concealed, is liberally published far and wide, so becoming the property of the whole body of farmers by profession, and serving them, according to circum-

stances, as a guide to follow or a beacon to avoid. Every one interested in such matters knows how much has been done in this way by successive Dukes of Bedford and Portland and Marquesses Townshend; by the late Earls of Leicester and Scarborough and Earl Spencer; and by the present Earl of Ducie and Earl Grey; nor are there many ways in which a landed aristocracy can better rebut the reproach of inutility than by thus doing honour to agriculture, and having the honour reflected back on themselves.

As already hinted, however, it is only on condition of being conducted with adequate capital that large farming can succeed. True, with deficient capital small farming could succeed no better, perhaps indeed not so well; but then there is much more danger of the needful capital being wanting to a large farmer than a small one. Whatever, from £5 to £20, be the desirable proportion per acre, the number of persons possessing the £50 or £200 required for stocking a farm of ten acres is likely to be everywhere many times more than fifty-fold that of those possessing the £2500 or the £10,000 which a single farm of 500 acres would require. Besides, in countries abounding with fortunate individuals able to count their pounds sterling by the thousand, promising modes of investing such considerable sums abound proportionally; and even in a country so exceptionally rich as our own, the number of capitalists prepared to invest their thousands in farming is sadly below the number of farms which would be all the better for having the same thousands so invested. We are justified then by experience in saying, that wherever large farming is the rule, there will probably be very many farmers without adequate capital. Now, in agriculture, inadequate capital means, among other things, insufficient live stock and insufficient manure, and, as an inevitable consequence, defective crops. It means, in short, imperfect cultivation.

Small farms.

III. From these premises it would apparently result that small farmers will generally be more nearly provided with the capital required for their business than large ones; and such seems to be actually the fact wherever peculiar circumstances have not been at work as preventives. It is not indeed so in Ireland, where feudal oppression or anarchy, alternating with alien misrule, has in all generations made destitution the heritage of the peasantry. Neither is it so in France, where the swarms of petty landholders had little of either precept or example to teach them that to employ their spare napoleons in thoroughly cultivating the few acres they already possess, would be a much better investment of their money than the purchase with it of an additional acre or two to be as imperfectly cultivated as the rest. In England the system of small cultivation, strictly so called, has probably ceased to exist, now that amateur farming has come so much into fashion, and that the instances have become comparatively so numerous of men of considerable substance turning to farming for a livelihood. It will not, however, help us much, when endeavouring to ascertain the relative merits of two rival agricultural systems, to contrast good specimens of the one and bad specimens of the other. If we would accurately gauge their respective capabilities, we should take them both at their best, and the comparison here of large with small farming will accordingly be of the former as it presents itself in England, and of the latter as developed in Flanders. Now, in the territory first named the average capital of occupants of 100 acres and upwards would certainly not be understated, and would probably be materially overstated, at £6 per acre; yet M. de Laveleye, while giving £8 as the average for Flanders (where the medium size of farms is but 7½ acres in the western, and no more than 5 acres in the eastern province), adds that good farmers, judging of others by themselves, would call that sum much too low even for an average; and further remarks that, although a small tenant may, on entering, have only £8 an acre, the additions he is continually making to his live stock, and his continually increasing purchases of manure, commonly raise the £8 to £16 before the expiration of his lease. He also informs us that in other Belgian districts—in the Hesbayan portions of Brabant and Hainault, whereof one-sixth is occupied by farms of 100 acres and upwards, and in the Condrusian portion of the province of Namur, where farms of 250 acres and upwards are pretty numerous—a farmer's average capital is estimated at between £5, 12s. and £6, 8s., and between £3 and £4 per acre respectively. True, as already intimated, there are certain descriptions of stock on which the small farmer's expenditure must necessarily somewhat exceed his rival's—ten Flemish farmers of 10 acres each being probably obliged to keep ten horses, while an English farmer of 100 acres might not perhaps have occasion for more than a pair, reducing also his number of carts, ploughs, and the like, in similar proportion. But after all reasonable deduction on this account, the balance of capital remaining for the purchase and maintenance of those animals and materials of which no farmer ever has too many or too much, is in general much greater in the Fleming's case than in the Englishman's. "It would startle the English farmer of 400 acres of arable land," said Mr Rham forty years ago, "to be told that he should constantly feed 100 head of cattle, yet this would not be too large a proportion if the Flemish system were strictly followed, a beast for every 3 acres being a common Flemish proportion, and *on very small occupations*, where spade husbandry is used, the proportion being still greater." "That the occupier," he proceeds, "of only 10 or 12 acres of light arable soil should be able to maintain four or five cows may appear astonishing, but the fact is notorious throughout the Waes country." These statements are of somewhat ancient date, but are still as applicable as ever. During a recent tour through Belgium, the present writer visited two farms near St Nicolas, in the Pays de Waes—the first two that came in his way. On one, of 10 acres, he found four cows, two calves, one horse, and two pigs, besides rabbits and poultry. On the other, of 38 acres, one bull, six cows, two heifers, one horse, and seventy-five sheep—these last, however, being allowed, in addition to what they got on their owner's ground, the run of all the stubbles in the commune; the whole commune, on the other hand, being allowed the use of the bull gratis. A few days later the writer went over a farm a few miles from Ypres. On this, of 32 acres in extent, he counted eight cows, six bullocks, a calf eight weeks old, and four pigs. To possess plenty of live stock is to possess in an equal abundance the first requisites of sustained fertility. "No cattle, no dung; no dung, no crop," is a Flemish adage; and the wealthiest of English agriculturists are less prodigal of manure than the Flemish peasantry. Mr Caird, in his instructive and interesting treatise on *English Agriculture*, cites as something extraordinary that, for a farm six miles from Manchester, manure should have been bought at the rate of 12 or 13 tons an acre; but this, which in England passes for lavishness, might seem more like niggardliness in Flanders; for there from 10 to 15 tons of good rotten dung and 10 hogsheads of liquid from the urine tank, per acre, are quite common sacrifices and libations to the Sterculine Saturn, and some 30s. worth of purchased fertilisers—bones, wood-ashes, linseed-cake, and guano—are not unfrequently superadded. Nay, when potatoes are the crop for whose increase the deity is invoked, 60 tons of manure per acre are no unusual quantity to lay on. The holder of the farm of 32 acres near Ypres, just alluded to, assured the writer, in his landlord's presence, that, over and above what his own cattle supply, he purchases manure to the value of no less than £200 annually.

One of the respects in which small culture has been admitted to stand at some disadvantage in comparison with large is that of division of labour; but against whatever loss of time or even inferiority of skill may result from the necessity there is for each of the labourers engaged in the former culture to occupy himself with a variety of operations instead of confining himself to one, are to be set the additions voluntarily made to the labour employed, and also its superior heartiness. The tillage of a small farm is executed often entirely, and always in great measure, by the farmer himself and the members of his family; and when these have adequate security that the entire increase of the soil, over and above a specified

quantity, will belong to themselves, they generally do their utmost to make the increase as large as possible. Not, indeed, always. Industry, in common with other virtues, is greatly influenced by example; and small leaseholders, or even small freeholders, thinly interspersed among numerous tenants-at-will, are much more likely to accept as their standard of becoming exertion the habitual listlessness of the latter than to set up an independent standard of their own. Where, however, small farmers are in a decided majority, they are, unless some extraordinary circumstances are in operation to depress their energy, sure to appear as models of diligence. Their activity is not then restricted within set hours of work. Whenever a thing requires to be done is with them the proper time for doing it, and early and late, consequently—long before the hired journeyman comes in the morning and long after he has gone home in the evening—they may be seen afield, doing, too, whatever they do, not only with all their might, but with all the heed which people usually bestow on their own affairs, even though they bestow it on nothing else. In particular, they waste nothing—least of all anything that can be used as manure. Now, there are no crops which would not be the better for such special attention, and there are some to which it is an almost indispensable condition of excellence. Flax, hemp, hops, wine, oil, and tobacco furnish instances of culture in which the individual plants require, or at any rate abundantly repay, separate care. But such minute attention no supervision can ensure—no rate of hire can command. It is habitually rendered by those only who are directly interested in rendering it, or otherwise directly stimulated—by the small farmer and the small farmer's wife and children all working with their own hands for their own behoof, and by his servants, if he have any; for that must be a pitiful creature indeed who, with his employer working by his side, will let his employer work harder than himself. Herein, then—(in the greater quantity and better quality of work which the same number of persons will do in small as compared with large farming)—consisting the distinctive excellence of the former system, how far does this counterbalance the superiority of large farming in regard to the saving of labour and implements? There can be no more conclusive mode of answering this question than by contrasting the substantial results of the two systems, adopting as tests the respective amounts both of gross and of net produce. Now, in England the average yield of wheat per acre was in 1837 only 21 bushels, the highest average for any single county being no more than 26 bushels. The highest average since claimed for the whole of England is 32 bushels; but this is pronounced to be much too high by the best, perhaps, of all authorities, Mr Caird, who gives 26½ bushels as "the average of figures furnished to him by competent judges in all parts of the kingdom," adding, as the result of his own observation, that 32 bushels, as an average produce, is to be met with "only on farms where both soil and management are superior to the present average of England." In Jersey, however, where the average size of farms is only 16 acres, the average produce of wheat for the five years ending with 1833 was, by official investigation, ascertained to be 40 bushels. In Guernsey, where farms are still smaller, 32 bushels per acre was, according to Inglis, considered, about the same time, "a good, but still a common, crop;" and the light soil of the Channel Islands is naturally by no means particularly suitable for the growth of wheat. That of Flanders, originally a coarse silicious sand, is particularly unsuitable, and accordingly little wheat is sown there, but of that little the average yield, at least in the Waes district, is, according to a very minute and careful observer, from 32 to 36 bushels. Of barley, a more congenial cereal, the average is in Flanders 41 bushels, and in good ground 60 bushels; while in England it is probably under 33, and would certainly be overstated at 36 bushels. Of course the English averages are considerably exceeded in particular localities—on such farms, for instance, as those of Mr Paget, near Nottingham, and of Mr Stansfeld, in the West Riding of Yorkshire, wheat crops of 46 bushels per acre being not extraordinary, and of 56 bushels not unknown; but these exceptional cases may be more than matched in Guernsey, where the largest yield of wheat per acre, in each of the three years ending with 1847, was proved to the satisfaction of the local agricultural society to have been not less than 76, 80, and 72 bushels respectively. Of potatoes, 10 tons per acre would anywhere in England, even on the rich "warp lands" bordering the tidal affluents of the Humber, be considered a high average crop; but in Jersey the average is reckoned at 15 tons, and near Tamise, in eastern Flanders, Mr Rham found a cultivator of 8 acres of poor land raising nearly 12 tons from one of them. Clover, again, "the glory of Flemish farming," "is nowhere else found in such perfect luxuriance" as in Flanders, where it exhibits "a vigour and weight of produce truly surprising," especially when it is discovered "that such prodigious crops are raised from 6 ℔ of seed per acre." Most of the other green crops, and also most of the root crops, grown in Flanders deserve to be spoken of in similar terms; and to the extraordinary number of cattle fed upon these green and root crops reference has already been made. If any reliance may be placed on these statistics, it cannot, however startling at first hearing, be too much to affirm that in the Channel Islands and in Flanders the average of gross produce is greater than in England by fully one-fourth, or say by the equivalent of 9 bushels of wheat per acre.

Gross produce, however, is not the only thing to be considered, for there is no doubt that on equal areas small farming employs more hands than large; and it might be that the entire produce of a small farm was not more than sufficient to feed the extra mouths. This would not necessarily be an evil, unless on the assumption that the condition of agricultural labourers is necessarily so wretched that an increase in their number is tantamount to an increase of wretchedness. Possibly, however, the extra produce might be less than sufficient to feed the extra mouths, so that the quantity of net produce remaining available for sale to the non-agricultural portion of the community would be diminished; and, if this were really the fact, it might be conclusively condemnatory of small farming. Nor, to prove that it is not the fact, will it suffice to urge that land, when divided among numerous occupants, commonly fetches a much higher rent than when united into a few extensive holdings—that whereas, for example, 30s. an acre would in England be considered a fair and even a high rate for middling land, it must be very middling land indeed which in Guernsey will not let for at least £4, while in Switzerland, another territory of *petite culture*, the average rent is £6. For these higher rents might be the results of an incident, not of culture, but of tenure—of that excessive competition for land which is unhappily a too frequent accompaniment of small farming. Neither will it suffice to show that, although the agricultural population of a minutely-divided territory is always far denser than that of one of large farms, certain territories of the former description are nevertheless among those which maintain the largest manufacturing and commercial population—Belgium, for instance, being second to England alone in that respect, and Switzerland and Rhenish Prussia being likewise cases in point. For it may obviously be replied that the non-agricultural classes of a community need not be entirely dependent for food on home produce, but may derive part of their supplies from abroad, and it may generally be impossible to ascertain what is the proportion imported. This objection does not, indeed, apply to the Channel Islands; and Mr W. T. Thornton has, in a new edition of his *Plea for Peasant Proprietors*, been at considerable pains to prove that in Guernsey two, and in Jersey four, non-agricultural inhabitants are maintained on the produce of every acre and a half of cultivated land, whereas in England only one such person is so fed. Be this as it may, a preferable, or at any rate more generally applicable, test is the proportion between the extra production of small farming and the consumption of the extra labourers therein employed. Now, in Flanders and in the two principal Channel Islands the agricultural population is about four times as dense as in England, being at the rate of about one person for every 4 acres, instead of one for every 17; but cause has also been shown for believing that in Flanders and in the same islands the average produce of the soil is greater than in England by the equivalent of 9 bushels of wheat per acre, or of 153 bushels for every 17 acres. But 153 bushels, or say 19 quarters, of wheat is much more than three persons—and these not all adult males, but, more likely, a man, a woman, and a child—would consume, even if it were supplied to them, and there were nothing else for them to eat, and is fully three times as much as three such persons of the farm labourers' class in any part of Europe have the means of procuring. After deduction, therefore, of their consumption, there would still remain available for sale to non-agriculturists, from the produce of

17 acres under small culture, the equivalent of nearly 100 bushels of wheat more than could be spared for the same purpose from an equal extent of land under a large farmer. These conclusions are not put forward as more than roughly approximate, nor, indeed, in the present disgracefully defective state of British agricultural statistics, are any but rough approximations on the subject possible. But, unless very wide indeed of the truth, they must be acknowledged to furnish adequate reason why rural magnates should not engross all our praises, and why the honest agricultural muse should reserve a share of commendation for small leaseholding farmers also.

Peasant proprietors.

IV. And while so much can be said for small leaseholders, it is obvious that every one of the arguments adduced in favour of that class applies with redoubled force to small freeholders cultivating their own freeholds. A peasant proprietor, whose whole produce belongs to himself, is of course richer than he would be if he had to pay rent —can more easily bear the expenses of cultivation, of procuring proper implements and manure, of drainage and irrigation, and of the keep of live stock. Small leaseholders, as a class, lay out more money on their land, in proportion to its extent, than large occupiers; but a small freeholder has more money to lay out than a leaseholder of the same degree, and has besides stronger motives for laying it out on improvements. "A small proprietor," says Adam Smith, "who knows every part of his little territory, who views it with all the affection which property, especially small property, naturally inspires, and who, upon that account, takes pleasure not only in cultivating but in adorning it, is generally of all improvers the most industrious, the most intelligent, and the most successful." It might have been added, that he is likewise the most enterprising. He need not carefully calculate whether his outlay will be fully recovered by him within a certain term of years; he has only to consider whether the increased value of his land will be equal to fair interest on the sum which the improvements will cost. He does not require that the principal should ever be returned. He is satisfied to sink it for ever in his own land, provided that, in that safest of all investments, it promise to yield a perpetual annuity equal to what would be its annual increase in another employment.

Again, the peasant proprietor has the strongest possible incentives to diligence. A man never works so well as when paid by the piece; but even then, the more he is paid, the better he works. The small leaseholder, not less than the small proprietor, is paid in proportion to his labour; but the latter is paid at a higher rate, for he takes to himself the whole fruit of his labour, while the former must content himself with part. The proprietor, too, knows that, so long as his labour continues equally productive, his remuneration will remain the same; while that of the tenant, though augmented solely by his own exertions, may be diminished at the expiration of his lease. Besides, many rural operations yield no profit until after a long lapse of time; and the annual profit of others is so small that the enjoyment of it in perpetuity is requisite to recompense the labour expended. Such operations are seldom undertaken except by proprietors. No tenant would think of planting an orchard such as Arthur Young saw near Sauve on a tract consisting "seemingly of nothing but bare rocks;" or, as in the mountains of Languedoc, would "carry earth in baskets on the back to form a garden where nature had denied it;" or would enclose and till fields and gardens on a "wretched blowing sand naturally as white as snow." But, as Young exclaims, "give a man the secure possession of a bleak rock, and he will turn it into a garden!" There is "no way so sure of carrying tillage to a mountain-top as by permitting the neighbouring villagers to acquire it in property. The magic of property turns sand to gold." It may perhaps be objected that the gold does not repay the cost of transmutation, and that therefore the labour expended upon it has been wasted; and no doubt a monied speculator, who should engage in such alchemy with hired labour, might never recover the amount of his outlay. But—and here comes a conclusive answer to those who, instead of admiring such achievements, condemn them as mere waste of power—the peasant who performs them on his own account performs them with labour which would otherwise be valueless at that particular time. When the hired journeyman has earned his day's wages, and gives himself up to rest or amusement, the little landowner is content to recreate himself by turning to some lighter work. It is sufficient amusement for him to weed or water his cabbages, or to train or prune his fruit-trees; and, in wet or wintry weather, when outdoor work is scarce worth paying for, and when the day-labourer must often remain idle because no one will employ him, then it is that the independent cottager builds up terraces on the steep hillside, or lays the site of a garden among rocks. It is, in short, one prime excellence of peasant proprietorship that it stirs into activity labour which otherwise would not have been exerted—in other words, would not have existed, and the fruits of which, consequently, however insignificant, are at any rate all pure gain.

The pastoral tribes, by which most civilised countries were originally occupied, have almost invariably been followed, either immediately or after a certain interval, by a race of peasant proprietors. The revolution has taken place at different stages of national progress, but scarcely an instance can be mentioned in which it has not occurred sooner or later. In territories of very small extent, very barren or much intersected by mountains, rivers, or other natural barriers, it has commonly been coeval with the first appropriation of land by individuals. In such situations, the original tribes of nomad herdsmen must necessarily have been small for want of pasture; and the same cause must have prevented any individual from acquiring very great numbers of cattle, and from very greatly surpassing his companions in wealth and power. All must have been nearly equal in rank; and, whenever a partition of their common territory was resolved upon, every one, no doubt, made good his claim to a share. On the other hand, in countries containing abundance of good pasture, separate tribes might expand indefinitely, and the cattle of single proprietors be counted by thousands and tens of thousands. Great wealth would then imply great disparity of rank, and rich herdsmen would have many poor retainers entirely indebted to their bounty, and consequently entirely devoted to their service. Such dependants, when the community passed from a migratory and pastoral to a stationary and agricultural condition, could put forward no pretensions on their own behalf. Their relation to their masters would remain the same as before, or rather would be exchanged for a more stringent form of bondage. From servants they would become serfs, and the duty assigned to them would be that of tilling their masters' fields, as they had previously tended his herds. In the course of ages, however, they would imperceptibly acquire some important privileges. Residing for many successive generations on the lands allotted to them for their own subsistence, and paying to their lord always the same, or nearly the same, portion of the produce, they would come at length to be regarded as conditional proprietors of their respective holdings, or as perpetual lessees at a quit and almost nominal rent. Their proprietary title, although at first merely prescriptive, would be eventually legalised; and thus it is that from villeins and serfs has descended a progeny no less respectable than English copy-holders and German bauers.

Métayage.

V. In one or other of these ways almost every country on the face of the globe which has passed regularly through the various stages that separate barbarism from civilisation, has been at some period, as many are still, occupied in great measure by peasant proprietors. In those countries, however, in which peasant proprietorship has been evolved from serfdom, there must have been, intermingled with the lands held by servile tenure, others, not less extensive, in the immediate occupation of a rural aristocracy. These seignorial domains would long continue to be cultivated by the serfs or slaves of their respective owners, but as feudal and domestic slavery fell

into desuetude, the landlords, in order to get their lands tilled, would be reduced to the necessity of holding out inducements to free husbandmen to lend their assistance. In England, where, thanks to the comparative security enjoyed by industry, plebeians of some substance were already not rare, it might suffice to offer tenancies for terms of years or for lives; but, in those continental countries in which feudal misrule had given way, only to be replaced by monarchical tyranny, it was generally necessary for the landowner, who desired that his farms should be tolerably stocked, to stock them himself. Hence arose a system which, having never existed in England, has no English name, but which in certain provinces of Italy and France, where it was once almost universal, and is still very common, is called *mezzeria* and *métayage*, or halving—the halving, that is, of the produce of the soil between landowner and landholder. These expressions are not, however, to be understood in a more precise sense than that in which we sometimes talk of a larger and a smaller half. They merely signify that the produce is divisible in certain definite proportions, which must obviously vary with the varying fertility of the soil and other circumstances, and which do in practice vary so much that the landlord's share is sometimes as much as two-thirds, sometimes as little as one-third. Sometimes the landlord supplies all the stock, sometimes only part—the cattle and seed perhaps, while the farmer provides implements; or perhaps only half the seed and half the cattle, the farmer finding the other halves—taxes too being paid wholly by one or the other, or jointly by both.

Now, with whatever virtue a system like this may be conditionally credited, it plainly can have no virtue at all except on condition of its being believed to be permanent. The *métayer* must have full confidence that the landlord, although authorised by law, will be prevented by respect for custom, from increasing his exactions; but even on this condition the system is open to the serious objection, that the metayer will deem it his interest to lay out on the land as little as possible, if anything, of his own, except labour. If in England, previously to tithe commutation, a farmer was discouraged from spending money on improvements by the knowledge that the parson would claim one out of every ten additional sheaves of corn or pounds of butter produced in consequence, what chance is there of a metayer risking a similar expenditure, while knowing that the landlord's share of the consequent produce would be a moiety or more instead of a tenth? In this particular, metayage closely resembles English tenancies at will, which practically render it almost equally incumbent on the landlord to bear the entire expense of all costly improvements, and over which métayage, in another and nearly allied particular, possesses a marked advantage. Although the métayer may, for one very cogent reason—a reason, however, likely to be somewhat counteracted by belief, whether well or ill founded, in the fixity of his tenure—be reluctant to use in his business any capital of his own, he will, for the converse of that same reason, be anxious to make the most of the capital entrusted to him by his landlord. He is his landlord's partner, entitled to a moiety or thereabout in his landlord's gains. It is his interest, then, to get the most out of the land that can be brought out of it by means of the landlord's stock. Virtually, indeed, he is himself, in a qualified sense, a peasant proprietor, possessing in a minor degree all the stimulants to diligence, heedfulness, and thrift, incidental to that character; and there can scarcely, therefore, be inherent in his constitution any such incurable vice as would warrant his being condemned *a priori*. Equally with other people he is entitled to be judged by his behaviour. As to this the testimony of experience is very conflicting. English writers who see nothing of métayage at home, and may be suspected of looking with not wholly unprejudiced eyes at what they see of it abroad, were, until Mr J. S. Mill adopted a different tone, unanimous in condemning it. They judged it, however, by its appearance in France, where it has never worn a very attractive aspect. In that country every form of agriculture still retains many of the traditions of the ante-Revolutionary period, and métayage, in particular, labours under great difficulties in consequence. Under the *ancien régime* not only were all direct taxes paid by the métayer, the noble landowner being exempt, but these taxes, being assessed according to the visible produce of the soil, operated as penalties upon all endeavours to augment its productiveness. No wonder, then, if the métayer fancied that his interest lay less in exerting himself to augment the total to be divided between himself and his landlord, than in studying how to defraud the latter of part of his rightful share; nor any great wonder either if he has not yet got entirely rid of habits so acquired. Rather would it be strange if he had, especially when it is considered that he still is, as his predecessors were formerly, destitute of the virtual fixity of tenure without which métayage cannot reasonably be expected to prosper. French métayers, in Arthur Young's time, were "removable at pleasure, and obliged to conform in all things to the will of their landlords," and so in general they are still. Yet even in France, according to M. de Lavergne, although "métayage and extreme rural poverty usually coincide," there is one province, Anjou, where the contrary is the fact, as it is also in Italy. Indeed, to every tourist who has passed through the plains of Lombardy with his eyes open, the knowledge that métayage has for ages been there the prevailing form of tenure ought to suffice for the triumphant vindication of métayage in the abstract. Its perfect compatibility with the most flourishing agriculture must be clear to any one who, noting the number and populousness of the cities in the Lombard provinces, is at the same time aware how much of agricultural produce those provinces export and how little they import. An explanation of the contrasts presented by métayage in different regions is not far to seek. Métayage, in order to be in any measure worthy of commendation, must be a genuine partnership, one in which there is no sleeping partner, but in the affairs of which the landlord, as well as the tenant, takes an active part. If he do this, he cannot be an absentee. He must be on the spot to judge when and what advances are required from him, and to watch over their proper application; to that end conferring habitually with the métayer, and taking as well as giving counsel on the subject, as on one in which both are equally concerned. This exhibition of common interest on one side is sure to beget it, if previously wanting, on the other; feelings of mutual attachment insensibly spring up, and the spirit which governs the mutual relations becomes one of friendly and almost affectionate association. Such is, or at any rate used to be, the state of affairs in Piedmont, in Lombardy, and in Tuscany; and wherever the same description applies, the results of métayage appear to be as eminently satisfactory, as they are decidedly the reverse wherever the landlord holds himself aloof, contenting himself, as it were, with putting out his stock to usury, and never intervening except to carp at the smallness of the returns. Instead of community, there is then conflict, of interests. Antagonism takes the place of association. The landlord grudges the scantiest advances, and even of those the farmer does his best to cheat the soil, which, starved by them who ought to feed it, leaves them to starve in return.

On the whole, and according to preponderance of testimony, métayage must perhaps be admitted to be everywhere showing a tendency to degenerate after the above fashion; yet even so, the worst that need be said of it is, that it is becoming an anachronism; this, moreover, being perhaps a reproach less to itself than to the age in which we live. It is the present generation of mankind who are chiefly to blame if the ties which anciently linked together employers and employed in more or less kindly fellowship, are now-a-days, in agriculture as in other departments of industry, visibly decaying, and if each section of the agrarian class, bidding the others keep their distance, prefers to perform its own functions separately, and without more of natural intercourse than business obligations, arranged beforehand, render indispensable. But whenever, from whatever cause, landowners have come to be regarded by landholders as mere receivers of rent, métayage cannot possibly thrive, and it is accordingly dying out, even in the quarters to which it has hitherto appeared most congenial. Even in the Milanese, where the minute and assiduous attention to details which métayers, next after peasant proprietors, can best be depended on for bestowing, is in especial demand for sericulture and viticulture, métayage is undergoing changes which M. de Laveleye (*Economie Rurale de la Lombardie*) describes as follows:—

"The primitive conditions of contract which fixed, according to local and traditional usage, the cultivator's share, are daily more and more departed from. For a considerable time past, in the parts about Como and Milan, to the arrangement for sharing by halves, which now applies only to plantation crops, grasses, and cocoons, has been added a clause providing for the annual payment of a determinate quantity of corn; and, as this quantity is settled no longer by local custom, but by the demands of the proprietors and the offers of intending tenants, it follows that métayage is losing its character of fixity, and falling under the law of increase which governs farming rent. The clause in question is continually becoming more and more of a habit; and, even where it has not yet been adopted, the ancient contract has undergone other and not less regretable modifications. The high price of commodities, particularly of silk, having markedly augmented the profits of the métayers, the landlords have availed themselves of this circumstance to introduce new stipulations—sometimes taking more than half of the cocoons, sometimes claiming a quantity of mulberry leaves to sell for their own profit, sometimes taking tithes first and then halving the residue. All this is done with the same aim and the

same result, the aim being to secure to the landlord the whole benefit of continually rising prices, the result that of depriving the métayer of the security which the primitive agreement gave him, and of subjecting him to all the disadvantages of a leaseholder without any of the latter's compensations."

Agricultural co-operation.

VI. The plan of industrial partnerships, wherever it has had a fair trial, has invariably been attended by the happiest results; but it has hardly yet been fairly tried in farming, where, however, its application would in one respect be comparatively easy. In most other kinds of business, to determine to the satisfaction of both parties concerned how much, if any, of extra profits had been due to extra zeal on the part of the employed, might be an operation of some difficulty; but there need never be any doubt whether the crops of a given acreage were or were not above the average, or what, therefore, if any, was the surplus in which, according to the agreement, the employed were entitled to participate. That farmers would risk but little and only occasional loss, and in the long run would be sure to gain considerably, by permitting their labourers to share with them in a surplus which the labourers would have by voluntary exertion to create before they could share in it, may perhaps to an indifferent bystander seem a self-evident proposition. Farmers in general, however, may long be prevented from recognising its truth by an intervening haze of traditional prejudice, which must first be cleared away, and the removal may occupy so much time that not improbably another and more advanced form of agricultural co-operation, not needing the farmers' concurrence, may in the mean time come into vogue.

Intermingled with the multitudinous peasant proprietary of France are not only a much larger number of well-to-do country gentlemen than is commonly supposed, but also a not inconsiderable sprinkling of rural magnates, who, even beside English dukes, might well pass for extensive landowners. Among these latter are representatives of some of the oldest and noblest French families—men rejoicing in the grand historic names of Rochefoucauld, Noailles, Luynes, Montemart, D'Usez, and the like—who having at the restoration been partially reinstated in the domains of which the first revolution had despoiled them, disappeared, on the second expulsion of the Bourbons, from court and office, and, returning to their country seats, betook themselves, under the Orleanist dynasty and second empire, to the improvement of their estates. A difficulty which here confronted them was that of finding tenants possessed of capital enough for any but very small farms, and this they have latterly endeavoured to obviate by devising, under the name of *métayage par groupes*, an expanded modification of a discredited tenure. This consists in letting a considerable farm, not to one *métayer*, but to an association of several, who work together for the general good, under the supervision either of the landlord himself, or of a manager or bailiff of his appointment. This plan is by no means the novelty it may perhaps appear, its near counterpart having within the present century existed in some singular patriarchal communities —Jaults, Guittards, and Garriotts (see Thornton *On Labour*, 2d edition, pp. 488–90), in Nivernais and Auvergne, and still existing among the *massari* of the subalpine districts of northern Italy. Its merit consists in its tendency to excite among the associates the generous emulation and other healthy stimulating and controlling influences of co-operative fellowship; but as yet it has scarcely been long enough in operation to show very decisively how it is likely to work. In the event of its proving a marked success, it may become the starting-point of much further progress. One easy and important step in advance would be for a body of métayers to persuade their landlord to let them have their farm on lease, and at a fixed rent, thus raising themselves to that higher stage of agricultural co-operation of which an imperfect but encouraging example has been afforded among ourselves by Mr Gurdon's well-known experiment at Assington in Suffolk. Of the two or three scores of labourers who are there parties to the leases by which two farms—one of 130, the other of 212 acres—are held, not more than ten or a dozen have regular work in their own fields, the rest being therefore little more than passive capitalists, sleeping partners in the concern, while the active members receive, in addition to wages at the rates current in the neighbourhood, no larger shares in the profits than the members who do not exert themselves to increase those profits. Nevertheless, to sum up in a single phrase of especial significance for our present purpose the praises of the results achieved, Mr Gurdon declares that "he has no other land so well farmed" as that on which the co-operative principle is even thus partially applied. It would seem, therefore, that the adoption of the same principle in its integrity would result in better farming still, and it may be hoped that the question will, at Assington or elsewhere, be ere long put to the proof. (W. T. T.)

ALPHABETICAL CONTENTS.

AGRIGENTUM, in *Ancient Geography*, a city on the south coast of Sicily, part of the site of which is now occupied by a town called *Girgenti*, from the old name. (See GIRGENTI.) It was founded by a colony from Gela, 582 B.C. An advantageous situation, a free government, and an active commercial spirit raised the city to a degree of wealth and importance unknown to the other Greek settlements, Syracuse alone excepted. The prosperity of Agrigentum was interrupted by the usurpation of Phalaris which lasted about fifteen years. He met with the common fate of tyrants, and after his death the Agrigentines enjoyed their liberty for sixty years; at the expiration of which term Theron usurped the sovereign authority. The moderation, justice, and valour of this prince preserved him from opposition. He joined his son-in-law Gelon, king of Syracuse, in a victorious war against the Carthaginians. Soon after his decease, 472 B.C., his son Thrasydeus was deprived of the diadem, and Agrigentum restored to her old democratical government, which she retained till the Carthaginian invasion in 406 B.C. During this interval of prosperity were executed most of those splendid public works which excited the admiration of succeeding ages, and caused Empedocles to remark "that the Agrigentines built their dwellings as though they were to live for ever, and indulged in luxury as if they were to die on the morrow." The total number of the inhabitants at this period was estimated by Diodorus at 200,000. The power of the Agrigentines now experienced a terrible reverse. They were attacked by the Carthaginians in 406 B.C., their armies routed, their city taken, and their race almost extirpated, scarcely a vestige of their material greatness being left. Although some of the fugitive inhabitants availed themselves of permission to return to the ruined city, and after a few years were even able to shake off the yoke of Carthage, Agrigentum never fully recovered from this fatal disaster. Such was the condition of the city 340 B.C. that Timoleon, after his triumph over the Carthaginians, found it necessary to recolonise it with citizens from Velia in Italy. During the first Punic war Agrigentum was the headquarters of the Carthaginians, and was besieged by the Roman consuls, who, after eight months' blockade, took it by storm. It nevertheless changed masters several times during the contest, and in every instance suffered most cruel outrages. At the close of the war Agrigentum finally fell under the dominion of Rome.

The profuse luxury and display for which the Agrigentines are celebrated in history were supported by a fertile territory and an extensive commerce, by means of which the commonwealth was able to resist many shocks of adversity. It was, however, crushed in the fall of the Eastern Empire, and the Saracens obtained possession of the city.

Agrigentum occupied a hill rising between the small rivers Agragas and Hypsas, and was remarkable for its strength as a fortress. The whole space comprehended within the walls of the ancient city abounds with traces of antiquity. Of its many celebrated edifices, the most magnificent was the temple of Olympian Jupiter. Of this vast structure nothing remains except the basement and a few fragments of the columns and entablature; but these and many other monuments attest the ancient magnificence of the Agrigentines.

AGRIONIA, festivals celebrated annually by the Bœotians in honour of Dionysus, in which the women, after playfully pretending for some time to search for that god, desisted, saying that he had hidden himself among the Muses. They were solemnised at night by women and the priests only. The tradition is that the daughters of Minyas, having despised the rites of the god, were seized with frenzy and ate the flesh of one of their children, and that the Agrionia were celebrated in expiation of the offence.

AGRIPPA, HEROD, the son of Aristobulus and Berenice, and grandson of Herod the Great, was born about 11 B.C. Josephus informs us that, after the death of his father, Herod, his grandfather, sent him to Rome to the court of Tiberius. The emperor conceived a great affection for Agrippa, and placed him near his son Drusus, whose favour he very soon won, as well as that of the empress Antonia. On the death of Drusus, Agrippa, who had been recklessly extravagant, was obliged to leave Rome, overwhelmed with debt, and retired to the castle of Malatha. After a brief seclusion, Herod the tetrarch, his uncle, who had married Herodias, his sister, made him principal magistrate of Tiberias, and presented him with a large sum of money; but his uncle grudging to continue his support, and reproaching him with his bad economy, Agrippa left Judea, and soon after returned to Rome. There he was received with favour by Tiberius, and commanded to attend Tiberius Nero, the son of Drusus. Agrippa, however, chose rather to attach himself to Caius, who at that time was universally beloved, and so far won upon this prince that he kept him continually about him. Agrippa being one day overheard by Eutyches, a slave whom he had made free, to express his wishes for Tiberius's death and the advancement of Caius, was betrayed to the emperor and cast into prison. Tiberius soon after died, and Caius Caligula ascended the throne 37 A.D. The new emperor heaped wealth and favours upon Agrippa, changed his iron fetters into a chain of gold, set a royal diadem upon his head, and gave him the tetrarchy of Batanæa and Trachonitis, which Philip, the son of Herod the Great, had formerly possessed. To this he added that held by Lysanias; and Agrippa returned very soon into Judea to take possession of his new kingdom. On the assassination of Caligula, Agrippa, who was then at Rome, contributed much by his advice to maintain Claudius in possession of the imperial dignity, to which he had been advanced by the army; and while he made a show of being in the interest of the senate, he secretly advised Claudius to maintain his position with firmness. The emperor, as an acknowledgment of his services, gave him the government of Judea; and the kingdom of Chalcis, at his request, was given to his brother Herod. Thus Agrippa became of a sudden one of the greatest princes of the East, the territory he possessed equalling in extent that held by Herod the Great, his grandfather. He returned to Judea, and governed it to the great satisfaction of the Jews. But the desire of pleasing them, and a mistaken zeal for their religion, impelled him to acts of cruelty, the memory of which is preserved in Scripture (Acts xii. 1, 2, &c.) About the feast of the Passover, 44 A.D., James the elder, the son of Zebedee and brother of John the evangelist, was seized by his order and put to death. He proceeded also to lay hands on Peter, and imprisoned him, delaying his execution till the close of the festival. But God having miraculously delivered Peter from prison, the designs of Agrippa were frustrated. After the Passover, he went from Jerusalem to Cæsarea, where he had games performed in honour of Claudius, and the inhabitants of Tyre and Sidon waited on him to sue for peace. Agrippa having come early in the morning to the theatre to give them audience, seated himself on his throne, dressed in a robe of silver tissue, which reflected the rays of the rising sun with such lustre as to dazzle the eyes of the spectators. When the king had delivered his address, the parasites around him shouted out that it was not the voice of a man but of a god. The vain Agrippa received the impious flattery with complacent satisfaction; but in the midst of his elation, looking upwards, he saw,

with superstitious alarm, an owl perched over his head. During his confinement by Tiberius he had been startled by a like omen, which had been interpreted as portending his speedy release, with the warning that whenever he should behold the same sight again, his death was to follow within the space of five days. Seized with terror, he was immediately smitten with disease, and after a few days of excruciating torment, died, according to the Scripture expression, "eaten of worms," 44 A.D.

AGRIPPA, HEROD, II., son of the preceding, born about 27 A.D., was made king of Chalcis on the death of his uncle Herod, 48 A.D.; but three or four years after he was deprived of that kingdom by Claudius, who gave him other provinces instead of it. In the war which Vespasian carried on against the Jews Herod sent him a succour of 2000 men, by which it appears that, though a Jew in religion, he was yet entirely devoted to the Romans, whose assistance indeed he required to secure the peace of his own kingdom. He died at Rome in the third year of Trajan, 100 A.D. He was the seventh and last king of the family of Herod the Great. It was before him and Berenice, his sister, that St Paul pleaded his cause at Cæsarea (Acts xxvi.)

AGRIPPA, MARCUS VIPSANIUS, according to Tacitus, was born of humble parents about 63 B.C. At the age of eighteen he was the chosen companion of Octavius (afterwards Octavianus), the nephew and successor of Julius Cæsar, many of whose successes were mainly due to the courage and military talents of Agrippa. On the assassination of Cæsar, 44 B.C., Agrippa accompanied his friend to Italy, and rendered essential service in the conduct of the first war against M. Antonius, which terminated in the capture of Perusia in 40 B.C. Three years after this Agrippa was made consul, and had the command in Gaul, when he defeated the Aquitani, and led the Roman eagles beyond the Rhine to punish the aggressions of the Germans on his province. But Agrippa was soon summoned to Italy by the critical state of the affairs of Octavianus, the whole coast being commanded by the superior fleets of Sex. Pompeius. His first care was the formation of a secure harbour for the ships of Octavianus, and this he accomplished by uniting the Lucrine lake with the sea. He made an inner haven also by joining the lake Avernus to the Lucrine. In these secure ports the fleet was equipped, and 20,000 manumitted slaves were sedulously trained in rowing and naval manœuvres until they were able to cope with the seamen of Pompeius. Agrippa was thus enabled in the following year to defeat Pompeius in the naval action of Mylæ; and soon after won a more signal victory near Naulochus. These victories gave Octavianus the empire of the Mediterranean, and secured to him Sicily, the granary of Rome, after an easy triumph over his feeble colleague Lepidus; and they prepared the way for the overthrow of the power of M. Antonius, the other triumvir. The merit of all these successes was very much due to the skill, resolution, and sagacity of Agrippa.

Agrippa was chosen ædile 33 B.C., and signalised his tenure of office by great improvements in the city of Rome, in the repair and construction of aqueducts and fountains neglected or injured during the civil wars, and in the enlargement and repair of the sewers. He appears also to have introduced an effectual mode of *flushing* the sewers by conducting into them the united waters of several different streams. From these useful labours Agrippa was again called away in 31 B.C. to command the Roman fleet, which, by the victory at Actium, fixed the empire of the world on Octavianus. The services of Agrippa made him a special favourite with Octavianus, who gave him his niece Marcella in marriage, 27 B.C., when he was consul for the third time. In the following year the servile senate bestowed on Octavianus the imperial title of AUGUSTUS. Agrippa, in commemoration of the naval victory of Actium, dedicated to Jupiter and all the other gods the Pantheon, now called *La Rotonda*. The inscription on its portico still remains, M. AGRIPPA L. F. COS. TERTIUM FECIT. In 25 B.C. we find this eminent man employed in Spain, where he reduced the insurgent Cantabri, the ancestors of the present Biscayans.

The friendship of Augustus and Agrippa seems to have been clouded by the jealousy of Marcellus, which was probably fomented by the intrigues of Livia, the second wife of Augustus, in dread of his influence with her husband. The consequence was that Agrippa left Rome; and though, to cloak his retirement, he was appointed proconsul of Syria, he went no farther than Mytilene. Marcellus dying within a year, Agrippa was recalled to Rome, and being divorced from Marcella, became the husband of the widowed Julia, who was no less distinguished by her beauty and abilities than afterwards by her shameless profligacy.

In 19 B.C. Agrippa again led an army into Spain, where he subdued the Cantabri, who had been for two years in insurrection against the Romans. While in Gaul, where he also pacified the insurgent inhabitants, he constructed four great public roads, and the splendid aqueduct at Nemausus (now Nismes), the ruins of which even yet excite admiration. On his return to Rome, 18 B.C., he was invested with the tribunician power, along with the emperor, for five years. After that he was a second time made governor of Syria, 17 B.C., where, by his just and wise administration, he obtained general commendation, especially from the Hebrew population of his province, of which Judea formed a part. This resulted from his having, at the request of Herod the Great, gone up to Jerusalem, and granted special privileges for their religious worship to the Jewish subjects of the empire. In this journey, too, he colonised Berytus (now Beyrout) as a military and commercial settlement.

The last military employment of Agrippa was in Pannonia, 13 B.C., where his character for equity was of itself sufficient to put down insurrection without bloodshed. Returning to Italy, he lived there in retirement, greatly honoured, and died at Campania, 12 B.C., two years before his imperial father-in-law. He was the greatest military commander of Rome since the days of Julius Cæsar, and the most honest of Roman governors in any province.

Under the care of Agrippa, Julius Cæsar's design of having a complete survey of the empire made was carried out. He had a chart of the entire empire drawn up, and projected a great work on the geography of its provinces. His materials were placed in the public archives, where Pliny consulted them (*Nat. Hist.*, iii.) Agrippa also wrote an account, now lost, of the transactions in which he had taken part.

Agrippa left several children: by his first wife he had Pomponia Vipsania, who became the first wife of Tiberius, and was the mother of Drusus; and by Julia he was the father of Caius and Lucius Cæsar, who were adopted by Augustus: of Julia, married to Lepidus; of Agrippina the elder; and of Agrippa Posthumus. (See Dio Cassius; Appianus; Suetonius; Velleius Paterculus; Fergusson's *Rom. Rep.*; Merivale's *Romans under the Empire.*)

AGRIPPA, HENRY CORNELIUS (VON NETTESHEIM), knight, doctor, and by common reputation a magician, was born of a noble family at Cologne on the 14th Sept. 1486. Educated at the university of Cologne, he entered when still very young into the service of the Emperor Maximilian, who sent him on a diplomatic mission to Paris in 1506.

During the next three years he was engaged in a military expedition to Catalonia, and then in the formation of a secret society of theosophists, the first of those alternations between the career of the knight and the career of the student in which his whole life was passed. In 1509 he went by invitation to the university of Dôle in Burgundy, and read lectures on Reuchlin's *De Verbo Mirifico*, which gained for him the degree of doctor of divinity and a stipend. It was these lectures that first stirred against him that malignant hatred of the monks which embittered his life and blackened his memory. He was denounced as an impious and heretical cabalist by an obscure monk named Catilinet, in lectures delivered at Ghent (1510) before Margaret of Burgundy, and his hopes of securing the patronage of that princess were thus for the time disappointed. To win her favour, he had composed (1509) and dedicated to her a treatise, *De Nobilitate et Præcellentia Fœminei Sexus*, the publication of which was delayed from motives of prudence until 1532. For the same reason the same course was followed in regard to his treatise *De Occulta Philosophia*, which, though completed in the spring of 1510, did not appear until 1531. In writing it he had the advice and assistance of the abbot Trithemius of Würzburg. Failing to receive encouragement as a man of letters, Agrippa was forced again to enter the diplomatic service. In 1510 the emperor sent him on a mission to London, where he became the guest of Dean Colet at Stepney. Soon after his return home he was summoned to follow his imperial master to the war in Italy, where he won his spurs—probably at the battle of Ravenna. In the autumn of 1511, on the invitation of the Cardinal de Santa Croce, he attended the schismatic council of Pisa as theologian, and by so doing still further provoked the hostility of the papal party. After a period spent in the service of the Marquis of Montferrat, during which he visited Switzerland, Agrippa was invited in 1515 to the university of Pavia, where he delivered lectures on the *Pimander* of Hermes Trismegistus, the first of which is preserved among his published works, and received a doctor's degree in law and medicine. He was still doomed, however, to a harassed, unsettled life. Three years were spent in the service of the Marquis of Montferrat and the Duke of Savoy. In 1518 he became syndic at Metz, where he was involved in disputes with the monks, and especially with the inquisitor Nicolas Savin, before whom he boldly and persistently defended a woman accused of witchcraft. He was, chiefly in consequence of this, compelled to resign his office, and quitted Metz for Cologne in January 1520. After two years spent in seclusion in his native city, he went to Geneva, where he practised medicine for a short time. In 1523 he removed to Friburg, having been appointed town physician. In the following year he was induced to go to Lyons as court physician to the queen-mother, Louisa of Savoy, but the change did not better his condition, since, though he received several empty honours, his salary remained unpaid. It was probably amid the privations of poverty that he composed, in 1526, his *De Incertitudine et Vanitate Scientiarum et Artium atque Excellentia Verbi Dei Declamatio*, which was first published in 1530. The work is remarkable for the keenness of its satire on the existing state of science and the pretensions of the learned, and when published furnished fresh occasion for the malicious misrepresentation of his enemies. A quarrel with the queen compelled Agrippa to leave Lyons and betake himself to the Netherlands. In 1529 he was appointed historiographer to the Emperor Charles V., and in that capacity wrote a history of the emperor's reign. The salary attached to the office was, however, left unpaid, and Agrippa was consequently imprisoned at Brussels, and afterwards banished from Cologne, for debt. He died at Grenoble in 1535.

The character of Agrippa has been very variously represented. The earlier accounts are grossly disfigured by the calumnies of the Dominicans, whose hatred, following him even to the grave, placed over it an inscription that is probably unique in its spiteful malignity. In later times full justice has been done to his memory. A Life of Agrippa by Henry Morley (London 1856) contains a detailed analysis of his more important works. A complete edition of his writings appeared in two volumes at Leyden in 1550, and has been several times republished.

AGRIPPINA (THE ELDER), the virtuous and heroic but unfortunate offspring of M. Agrippa by a very abandoned mother, and herself the parent of a still more profligate and guilty daughter of the same name. She was early married to Germanicus, the son of Drusus and Antonia, the niece of Augustus. On the death of Augustus she joined her husband in his German campaigns, where she had several opportunities of showing her intrepidity, sharing with Germanicus his toils and his triumphs. The love which the army showed for this leader was the cause of his recall from the Rhine by the suspicious Tiberius He was soon afterwards sent into Syria, where he died at Antioch from the effects, as was believed, of poison administered to him by Piso, the governor of Syria.

On his deathbed Germanicus implored his wife, for the sake of their numerous children, to submit with resignation to the evil times on which they were fallen, and not to provoke the vengeance of the tyrant Tiberius. But, unhappily, this prudent advice was not followed by the high-spirited woman, who, on landing at Brundusium, went straight to Rome, entered the city bearing the urn of her deceased husband in her arms, and was received amid the tears of the citizens and the soldiery, to whom Germanicus was dear. She boldly accused Piso of the murder of her husband; and he, to avoid public infamy, committed suicide. She continued to reside at Rome, watched and suspected by Tiberius, who for some time dreaded to glut his vengeance on the widow and family of so popular a prince as Germanicus. She soon had the temerity to upbraid the tyrant with his hypocrisy in pretending to worship at the tomb of Augustus. He began by putting to death both men and women who had shown attachment to the family of Germanicus; and finally he arrested Agrippina and her two eldest sons, Nero and Drusus, and transported them to the isle of Pandataria, where her mother Julia had perished; and there she was starved, or starved herself, to death in the 33d year of our era. Tiberius also ordered the execution of her two eldest sons; yet it is remarkable that by his will the emperor left her youngest son Caius, better known by the name of *Caligula*, as one of the heirs of the empire.

AGRIPPINA, daughter of Germanicus and Agrippina the elder, sister of Caligula, and mother of Nero, was born about 15 A.D., at Oppidum Ubiorum, which was at that time the headquarters of her father's legions, and which was after her named *Colonia Agrippina Ubiorum* (now Cologne). She wrote memoirs of her times, which Tacitus quotes and Pliny commends; but her life is notorious for intrigue and perfidy. In 28 A.D. she became the wife of Cn. Dom. Ahenobarbus, who died 40 A.D. Her next husband was Crispus Passienus, whom some years afterwards she was accused of poisoning. For flagitious conduct, Caligula banished her to the isle of Pontia; but on the accession of her uncle Claudius, 41 A.D., she was set free, and began to succeed in her ambitious schemes. After Messalina had been put to death, 48 A.D., Agrippina was raised by Claudius to her place as his imperial consort, 49 A.D. She prevailed upon him to discard Britannicus,

his own son, and to adopt her son Domitius in his stead. She removed from her path all whom she feared or envied, and in 54 A.D. poisoned Claudius at Sinuessa that she might reign as regent for her son. Nero in a short time grew tired of her interference, and when she first intrigued against and then frowned upon him, he ordered her to be slain at her villa on the Lucrine lake. After having been slightly wounded by Anicetus, she perished by the sword of a centurion, 60 A.D.

AGROTERAS THUSIA, an annual festival at Athens in honour of Artemis or Diana, in fulfilment of a vow made by the city before the battle of Marathon to offer in sacrifice a number of goats equal to that of the Persians slain in the conflict. The number was afterwards restricted to 500.

AGTELEK, a village of Hungary, in the county of Gömör, near the road from Pesth to Kaschau. In the neighbourhood is the celebrated stalactite grotto of Baradla, one of the most remarkable in Europe. The entrance is extremely narrow, but the interior spreads out into a labyrinth of caverns, the largest of which, called the Flower Garden, is 96 feet high and 90 feet wide, and extends nearly 900 feet in a straight line. In these caverns there are numerous stalactite structures, which, from their curious and fantastic shapes, have received such names as the Image of the Virgin, the Mosaic Altar, &c.

AGUA, VOLCANO DE, a huge mountain in Central America, 25 miles S.W. of Guatemala. It is of a conical shape, and rises to a height of 15,000 feet above the level of the sea. At the summit there is a crater, measuring about 140 yards by 120, from which stones and torrents of boiling water are occasionally discharged. In close proximity to Agua are the volcanoes of Pacaya, on the S.E., and Fuego on the W., and the three present together a scene of great magnificence.

AGUADO, ALEXANDER MARIA, one of the most famous bankers of modern times, was born of Jewish parentage at Seville in 1784. He commenced life as a soldier, fighting with distinction in the Spanish war of independence on the side of Joseph. After the battle of Baylen (1808) he entered the French army, in which he had risen to be colonel and aide-de-camp to Marshal Soult, when he took his discharge in 1815. He immediately commenced business as a commission-agent in Paris, and chiefly through his connection with Spain and the Spanish colonies, acquired in a few years wealth enough to enable him to undertake banking. The Spanish government gave him full powers to negotiate the loans of 1823, 1828, 1830, and 1831; and Ferdinand VII. rewarded him with the title of Marquis de las Marismas del Guadalquiver, and the decorations of several orders. Aguado also negotiated the Greek loan of 1834. In 1828, having become possessed of large estates in France, including the Chateau Margaux, famous for its wine, he was naturalised as a French citizen. He died in 1842, leaving a fortune computed at 60,000,000 francs. The designs of the leading pictures in an extensive and admirable art collection which he had formed were published by Gavard under the title *Galerie Aguado* (1837–42).

AGUAS CALIENTES, a town in Mexico, capital of the state of the same name, situated 270 miles N.W. of the city of Mexico, in 22° N. lat., and 101° 45′ W. long. It takes its name from the hot springs in its vicinity. The climate is fine, and the extensive and beautiful gardens surrounding the town produce an abundance of olives, figs, grapes, and pears. It has a large manufactory of woollen cloth, and the general trade is considerable. Population, 22,534.

AGUILAR, GRACE (1816–47), an admired English authoress, was the daughter of a Jewish merchant in London. She was educated wholly by her parents, and commenced her literary career at an early age. Her works, written in a pleasing, elegant, and impressive style, consist chiefly of religious fictions, such as *The Martyr* and *Home Influence*. She also wrote, in defence of her faith and its professors, *The Spirit of Judaism*, and other works. Her services in the latter direction were acknowledged gratefully by the "women of Israel," in a testimonial which they presented shortly before her death. In 1835 she had a severe attack of measles, from the effects of which her constitution never wholly recovered. After a long struggle with increasing bodily infirmities, she died at Frankfort, on her way to Schwalbach, in the autumn of 1847.

AGUILAR DE LA FRONTERA, a town of Spain, stands near the river Cabra, 22 miles S.S.E. of Cordova. The houses are well built, and distinguished by their cleanness and regularity. The town has three handsome public squares, and the principal buildings are the parish church, the chapter-house, a new town-hall, the prison, and the markets. Near the church are the ruins of a once magnificent Moorish castle. The district produces excellent wines, which go by the name of Montilla, and there is also some trade in corn and oil. Population, 12,000.

AGUILLON, FRANÇOIS D', an eminent mathematician, born at Brussels in 1566. He entered the Society of Jesus in 1586, and was successively professor of philosophy at Douay and rector of the Jesuit College at Antwerp. Eminent for his skill in mathematics, he was the first to introduce the study of that science among the Jesuits in the Low Countries. He wrote a treatise on Optics in six books (Antwerp, 1613), and was employed in finishing another on Catoptrics and Dioptrics when he died, in 1617.

AGUIRRA, JOSEF SAENZ D', a distinguished Spanish ecclesiastic and theological writer, was born at Logrogno on the 24th March 1630. He belonged to the Benedictine order, and was abbot of St Vincent, professor of theology at the university of Salamanca, and afterwards secretary to the Spanish Inquisition. For a work (*Defensio Cathedræ S. Petri adversus Declarationes Cleri Gallici*, 1682), which he wrote in support of the papal authority against the four propositions of the Gallican Church, he was promoted to the rank of cardinal by Pope Innocent XI. in 1686. Of his other works the chief are a *Collection of the Councils of Spain* (1693–4), and a *Treatise on the Theology of Anselm*, only three volumes of which appeared, the fourth and last being still incomplete when the author died, August 19th, 1699. To judge from a warm eulogium of Bossuet, his opponent in controversy, Aguirra had a very high reputation for piety.

AGULHAS, CAPE, the most southern point of Africa, 100 miles E.S.E of the Cape of Good Hope, in 34° 51′ 30″ S. lat., and 19° 56′ 30″ E. long. At a distance of a mile from the sea it rises to a height of 455 feet. In 1849 a lighthouse was opened on it nearer the shore, the light in which stands 128 feet above high-water mark. An immense bank, the *Agulhas Bank*, extends from the Cape of Good Hope along the coast to the great Fish River, a distance of 560 miles, with a breadth, opposite to the Cape, of 200 miles. The great oceanic current from the Indian Ocean to the Atlantic sets along its outward edge, and has sharply defined it. This current has such velocity that ships are often carried far to the westward, and round the Cape of Good Hope, even against a smart breeze. The bank abounds with fish; and the approach to it is denoted by the appearance of many whales, sharks, and seals, and innumerable sea-birds.

AHAB, king of Israel, was the son and successor of Omri. He ascended the throne in the 38th year of Asa, king of Judah, *i.e.*, 918 B.C., and reigned over Samaria 22 years. Having married Jezebel, daughter of Ethbaal, king of the Sidonians, he was brought into closer connec-

tion with the neighbouring powers in the north, and strengthened himself considerably, so that he was able to consolidate the disunited kingdom, and render it powerful against Judah. Some notices out of Menander, preserved by Josephus, lead to the conclusion that Ethbaal, father of Jezebel, was identical with Ithobal, priest of Astarte, who usurped the throne of Tyre after murdering Pheles the king. It is not improbable that Ahab's marriage with such a princess was the means of procuring him great riches, which brought pomp and luxury in their train, along with the material and social influence that give a certain security to monarchy. We read of his building an ivory palace and founding new cities, the effect perhaps of a share in the flourishing commerce of Phœnicia. But his matrimonial connection with Tyre and Sidon, however fruitful in wealth, was in many respects detrimental. His wife was a strong-minded, passionate devotee of idolatry, who exercised an injurious influence over him. Led by her, he gave a great impulse to the worship of Baal and Astarte in his kingdom. For the former he built a temple with an altar; of the latter he made the well-known image which existed long after. Under the patronage of Jezebel, the Phœnician cultus assumed important dimensions, for Baal is said to have had 450, Astarte 400 priests and prophets. The infatuated queen was especially hostile to the prophets and priests of Jehovah, whom she tried to exterminate; but the former in particular, though sore pressed, were not entirely cut off. They still held their ground; and Elijah, the most conspicuous of them, came off victor in the contest with Baal's ministers. Jehovism triumphed in the person of the intrepid Tishbite, whom the queen was unable to get into her power. Ahab was a public-spirited and courageous monarch. He defeated the Syrians twice, and concluded a peace with Benhadad on favourable terms. Mesha, king of Moab, paid him a large yearly tribute. In conjunction with Jehoshaphat, king of Judah, he went forth to battle a third time against the Syrians, and was slain at Ramoth-Gilead. It speaks favourably for his disposition that he repented of the cruel measures taken against Naboth, and that he humbled himself before the Lord. Though he feared Elijah and Micaiah, he was not insensible to their utterances; nor could he have suffered so many as 400 prophets to live in his kingdom without some little regard for their office. The prophetic voice, held as it was in small esteem, must have had some influence upon his administration, especially when political grounds coincided with it. His evil courses were due much more to the influence of Jezebel than to his own vicious impulses.

As the accounts of Ahab are fragmentary, it is not always easy to make out from them a clear or connected history of his reign. There is room for conjecture and misconception. Thus Ewald represents him as building a splendid temple, with an oracle-grove of Astarte near his favourite palace at Jezreel, on the basis of 1 Kings xvi. 32, xviii. 19; but this is imaginary, since the original does not speak of *a grove* but of *Astarte* (xviii. 19); nor is it probable that a second structure of the kind mentioned existed elsewhere in addition to Baal's temple in Samaria. Neither can it be held as likely that a large statue of Baal was set up in front of his temple, and small statues of him in the interior, merely because we read in 2 Kings x. 26, 27, first of bringing forth the *images* of Baal, and then of breaking *the image* of the same sun-god. Rather were the smaller images in the porch and the chief one in the interior, so that the reading or punctuation of verse 26 should be slightly altered. Whether the 450 or 400 prophets were distinct from the priests is doubtful. Identifying them, we believe that the priests acted as prophets, procuring for themselves greater renown among the ignorant people by their arts of necromancy and magic.

For the biography of this monarch we are indebted almost exclusively to the books of Kings, where the writers consider him in a theocratic rather than a political aspect. Viewing him from their later prophetic standpoint, their portrait is somewhat one-sided, though correct in the main. It is observable that the portions of the Kings in which he is spoken of are somewhat different in character and expression, betraying the use of different sources by the compiler. 1 Kings xvi. 29-33, xxii. 39, 2 Kings x. 25-28, are more historical than the rest, which contain almost all that is related of Ahab, and were derived from tradition. It has been conjectured by Hitzig that the 45th psalm owes its origin to Ahab, being the joyous poetical expression of a matrimonial connection with Tyre, which augured unusual prosperity for the distracted kingdom. But the assumption is improbable, because, as De Wette observes, an event belonging to Ephraim was hardly a fitting subject for a poem included in the canon.

Another Ahab, a false prophet in the time of the Babylonian exile, is mentioned by Jeremiah (xxix. 21), and threatened with terrible punishment. (S. D.)

AHALA, a noble Roman family of the gens Servilia, which produced many distinguished men. Of these the most celebrated is C. Servilius Structus Ahala, master of the horse to the dictator Cincinnatus, B.C. 439. He signalised himself by his boldness in slaying in the forum with his own hand the popular agitator Sp. Mælius, for refusing to appear before the dictator on a charge of conspiracy against the state. For this act Ahala was brought to trial. He saved himself from condemnation by retiring into exile.

AHANTA, a territory on the Gold Coast of Africa, lying on the second parallel of W long. It is one of the richest and most fertile districts in that part of the continent. Axim, the chief settlement, was founded by the Dutch, but now belongs to Britain.

AHASUERUS, the Latinised form of the Hebrew *Ahashverosh*, אֲחַשְׁוֵרוֹשׁ (in the LXX. Ἀσσούηρος, once in Tobit Ἀσύηρος), occurs as a royal Persian or Median name in three of the books of the canonical Scriptures, and in one of the books of the Apocrypha. In every case the identification of the person thus named with those found in profane history is matter of controversy. The hypothesis of Fürst and others, that in all the passages one and the same person is meant, viz., the well-known Xerxes, may be set aside as quite inapplicable to the facts; and it becomes necessary to glance at the particular places.

In Dan. ix. 1, Ahasuerus appears as the father of Darius the Mede, who "was made king over the realm of the Chaldeans" after the conquest of Babylon and death of Belshazzar. Who this Darius was is one of the most difficult and disputed questions of ancient history. If, as is very generally supposed, he is Astyages, the grandfather of the great Cyrus, and the last independent king of Media, then Ahasuerus is to be identified with Cyaxares, the father of Astyages. The passage in Tobit where the name occurs (xiv. 15) lends confirmation to this view. It is there stated that Nineveh was captured and destroyed by "Nabuchodonosor and Assuerus." According to Herodotus (i. 106 *cf.* Rawlinson's *Her.*, vol. i. 412), it was the Medes under Cyaxares who took Nineveh.

In Ezra iv. 6 Ahasuerus is mentioned as a king of Persia, to whom the enemies of the Jews sent representations opposing the rebuilding of the temple at Jerusalem. Here the sequence of the reigns in the sacred writer and in the profane historians—in the one, Cyrus, Ahasuerus, Artaxerxes, Darius; in the other, Cyrus, Cambyses, Smerdis, Darius—leads naturally to the identification of Ahasuerus with Cambyses. Other circumstances, especially the known policy of the usurper Smerdis, and its reversal by Darius (see Inscr. of Behistun, col. i. § 14), corroborate this conclusion.

In the Book of Esther, Ahasuerus is the name borne by that king of Persia, certain events of whose court and empire (which will be noticed elsewhere, see Esther) form the subject of the whole narrative. (Throughout this book the LXX. render the name by Ἀρταξέρξης.) The hypothesis of certain writers, that this Ahasuerus is the Cyaxares, king of Media, already referred to, may be at once dismissed. That of others, identifying him with Artaxerxes Longimanus, the son and successor of Xerxes, though countenanced by Josephus, deserves scarcely more consideration. Recent inquirers are all but universally of opinion that he must be a monarch of the Achæmenian dynasty, earlier than this Artaxerxes; and opinion is divided between Darius Hystaspis and his son and successor Xerxes. In support of the former view it is alleged, among other things (see Tyrwhitt's *Esther and Ahasuerus*, p. 162), that Darius was the first Persian king of whom it could be said, as in Esther i. 1, that he "reigned from India even unto Ethiopia, over an hundred and seven and twenty provinces;" and that it was also the distinction of Darius that (Esther x. 1) he "laid a tribute upon the land and upon the isles of the sea" (*cf.* Herod. iii. 89). In support of the latter view it is alleged—(1.) That the Hebrew

Ahashverosh is the natural equivalent of the old Persian *Khshayarsha*, the true name of the monarch called by the Greeks Xerxes, as now read in his inscriptions; (2.) That there is a striking similarity of character between the Xerxes of Herodotus and the Ahasuerus of Esther; (3.) That certain coincidences in dates and events corroborate this identity, as, *e.g.*, "In the third year of his reign Ahasuerus gave a grand feast to his nobles, lasting one hundred and eighty days (Esther i. 3); and Xerxes in *his* third year also assembled his chief officers to deliberate on the invasion of Greece (Herod. vii. 8). Again, Ahasuerus married Esther at Shushan in the seventh year of his reign; in the same year of *his* reign Xerxes returned to Susa with the mortification of his defeat, and sought to forget himself in pleasure. Lastly, the tribute imposed on the land and isles of the sea also accords with the state of his revenue, exhausted by his insane attempt against Greece" (Kitto's *Cyclopædia*, *s.v.* Ahasuerus). To this it may be added that the interval of four years between the divorce of Vashti and the marriage of Esther is well accounted for by the intervention of an important series of events fully occupying the monarch's thoughts, such as the invasion of Greece. It may be added that by the advocates of both views appeal is made, with more or less of confidence, to the names of the queens of the respective sovereigns; Atossa, wife of Darius, answering to Hadassah, and Amestris, wife of Xerxes, to Esther (Esther ii. 7); and also to the number of generations indicated in the genealogy of Mordecai from the deportation of the Jews into Babylon (Esther ii. 5; *cf.* Tyrwhitt, p. 95, with Rawlinson, *Bampton Lect.*, p. 186). If, as seems probable, the name Ahasuerus is the transcription of the Persian *Khshayarsha* (written *Hisiarsa* in Babylonian) which, according to Sir H. Rawlinson, means "venerable king" (see Rawlinson's *Her.* iii. 863), then this name may be reasonably supposed to have been originally an appellative, and its application, especially by foreigners like the Jews, to different royal persons, is explained.

AHAZ (literally *Possessor*), son of Jotham, and the eleventh king of Judah, reigned 16 years, from 741 to 725 B.C. He was the most weak-minded and corrupt of all the kings that had hitherto reigned over Judah. About the time of his accession, Pekah, king of Israel, and Rezin, king of Syria, had formed an alliance with the view of acquiring the kingdom of Judah by conquest. They invaded the country, laid siege to Jerusalem, and carried away an immense number of captives, though they failed to secure their ultimate object. At the same time incursions were made by the Edomites and Philistines, and Ahaz was fain to call in the aid of Tiglath-Pileser, king of Assyria, who destroyed the power of Syria, but took care to exact heavy tribute for the service thus rendered. Ahaz was even compelled to appear as a vassal at Damascus, and so to bring his kingdom to the lowest point of political degradation. In religion Ahaz was a heathen. He broke in pieces the vessels of the temple of God, and at last ventured to close its gates altogether. He sacrificed to Syrian deities, erected altars on which incense was to be offered, and caused his son to pass through the fire to Moloch. He was succeeded by his son Hezekiah. In the inscriptions of Tiglath-Pileser II., king of Assyria, *Yahukhazi Jahudai*, that is, Joahaz or Ahaz of Israel, appears among the names of those who acknowledged his sovereignty and paid tribute. (Schrader's *Die Keilinschriften und das Alte Testament.*)

AHAZIAH (lit. *Whom the Lord sustains*), son and successor of Ahab, and eighth king of Israel, reigned scarcely two years, from 897 to 896 B.C. He continued in the idolatrous practices of his father, worshipping Baal and Astarte. Upon his accession the Moabites revolted, and refused any longer to pay the tribute which had been exacted from them since the establishment of Israel as a separate kingdom. Before Ahaziah could take measures to subdue them, he was seriously injured by a fall from the lattice of an upper chamber in his palace. He immediately sent messengers to the oracle of the god Baalzebub at Ekron to inquire the issue of his illness. While on their way they were met by Elijah the prophet, who bade them return and tell the king that he would surely die.

AHAZIAH, son of Jehoram and Athaliah, daughter of Ahab, and sixth king of Judah, reigned one year, 885 B.C. Under the evil influence of his mother, he walked in the ways of Ahab's house, and was an idolatrous and wicked king. He was slain by Jehu, the son of Nimshi.

AHENOBARBUS, the name of a plebeian Roman family of the gens Domitia, which rose in the course of time to considerable distinction. The name was derived from the red beard and hair by which many of the family were distinguished. The emperor Nero was of this family.

AHITHOPHEL (lit. *Brother of Foolishness*, i.e., *foolish*), the very singular name of one of the sagest politicians in Old Testament history. In regard to his family relationships it is almost beyond doubt that he was the grandfather of Bathsheba, and it has been suggested as probable that he was first introduced at court through this connection. He was one of David's most trusted counsellors, and his defection to the cause of Absalom was a severe blow to the king, who prayed that God would bring his counsel to "foolishness," probably alluding to his name. David's grief at the desertion is expressed in Ps. xli. 9, lv. 12–14. Ahithophel's advice was at first acceptable to Absalom's party, and probably laid down the policy which alone was likely to be successful; but Hushai's counsel of delay, given in the secret interest of David, was ultimately adopted. Ahithophel's political foresight enabled him to see that this resolution would prove fatal to the rebel cause, and he at once returned to his home at Giloh, "put his household in order, and hanged himself." This is the only case of *deliberate* suicide that is mentioned in the Old Testament.

AHMADÁBÁD, a district and city of British India, in the province of Gujrát, within the jurisdiction of the governor of Bombay. The DISTRICT lies between 21° 4′ and 23° 5′ N. lat., and between 71° 2′ and 73° 25′ E. long. It is bounded by the province of Kátiwár on the N. and W., by the Mahi Kánta on the N. and E., by the Kaira collectorate on the E. and S., and by the gulf of Cambay on the S. The area of the district is returned at 3844 square miles. The river Sábarmatí and its tributaries, flowing from north-east to south-west into the gulf of Cambay, are the principal streams that water the district. The north-eastern portion is slightly elevated, and dotted with low hills, which gradually sink into a vast plain, subject to inundation on its western extremity. With the exception of this latter portion, the soil is very fertile, and some parts of the district are beautifully wooded. The total population of Ahmadábád is returned at 829,637 souls, the average density, as compared with the area, being 216 to the square mile, and the proportion of females 891 to every 1000 males. About 86 per cent. of the population are returned as Hindus, 10 per cent. as Mahometans, and 4 as Buddhists. The percentage of persons of other denominations is infinitesimal, their total number being only 1237 souls.

The hamlets for the most part consist of substantial houses of bricks and tiles, with only a small proportion of huts. Some of the larger villages contain houses with upper stories, and the general appearance of the inhabitants indicates prosperity. The principal agricultural products are rice, wheat, bajrá, and cotton, with a little sugar-cane, tobacco, and oil-seeds. Silk manufacture forms an important industry of the city. The total revenue of the district in 1872 amounted to £152,344, of which £147,283 was derived from the land; the total net expenditure on civil administration in the same year amounted to £21,700. The fiscal system consists for the most part of settlements direct with the husbandman, technically known as rayatwárí; but some villages are "*tálukdárí*," in which the "tálukdár" or landholder collects the revenue, and pays 70 per cent. of it to Government, retaining the remaining 30 per cent. for himself. The excise revenue is generally farmed out, but a government distillery exists in the city. The land settlement is fixed for a period of thirty years, and expires in different parts of the district between the years 1884 and 1888. Seventy-five per cent. of the total area of the district is cultivable, of which 55 per cent. is actually under cultivation, the other 20 per cent. remaining fallow. The principal marts in Ahmadábád are Dhollerá, Gogo, Dholká, and Víramgáon. Municipalities have been established in

the towns of Ahmadábád, Dholká, Mandú, Gogo, Dhandúka, Prántej, and Moráshá; the rate of municipal taxation per head of population varies from 2s. 6½d. in Ahmadábád to 4½d. in Moráshá, the average throughout the eight towns being 1s. 7¾d. per head. The municipal income is chiefly derived from octroi duties, which in some of the towns are farmed. Thirteen towns are returned as containing a population exceeding 5000 souls, namely, Ahmadábád, population 116,873; Dholká, 20,854; Vírамgáon, 19,661; Dhollerá, 12,468; Dhandúka, 9782; Gogo, 9571; Prántej, 8341; Moráshá, 7436; Sanand, 7229; Mandú, 6774; Patrí, 6320; Barwálá, 5813; and Ranpur, 5796. The district contains 145 schools, in eight of which English is taught. The police force numbers 1189 men. The Kolís contribute most largely to the criminal population.

Ahmadabad City, the capital of the district, is situated on the east or left bank of the river Sábarmatí, in 23° N. lat., and 72° 36′ E. long. It was formerly one of the largest towns in India, celebrated for its commerce and manufactures of gold and silver, silk and cotton fabrics, articles of gold, silver, steel, enamel, mother of pearl, lacquered ware, and fine wood-work. Excellent paper was also manufactured, and a large trade carried on in indigo, cotton, and opium. With the rise of the Marhattá power, however, Ahmadábád became the scene of repeated struggles between the Marhattás and the Mussulmans, whose power was then on the wane, and from this period its prosperity declined. It was captured by the Marhattás in 1755, and again by the British in 1780. The latter soon afterwards gave the town back to the Marhattás, who held it till it finally came into the hands of the English in 1818. The present state of the city is flourishing. It contains a population of 116,873 souls, and is a large and important station on the Bombay, Baroda, and Central India Railway. It is the seat of important silk manufactures, and has two cotton-mills worked by steam-power.

The principal objects of architectural interest are the Jain temple of Seth Hathisinh and the Juma Masjid or Great Mosque. The Jain temple is a modern edifice, having been erected about twenty-five years ago by Hathi Sinh, a rich Jain merchant, who dedicated it to Dharmnáth. This modern style shows that the Jain style of architecture has hardly degenerated from its ancient excellence. The external porch, between two circular towers, is of great magnificence, most elaborately ornamented, and leads to an outer court, with sixteen cells on either side. In the centre of this court is a domed porch of the usual form, with twenty pillars. The court leads to an inner porch of twenty-two pillars, two stories in height, with a roof of a shape very fashionable in modern Jain temples, though by no means remarkable for beauty. This inner porch conducts to a triple sanctuary. The exterior of the temple expresses the interior more completely than even a Gothic design; and whether looked at from its courts or from the outside, it possesses variety without confusion, and an appropriateness of every part to the purpose for which it was intended. The Juma Masjid or Great Mosque of Ahmadábád, although not remarkable for its size, is one of the most beautiful mosques in the East, the Jain style of architecture being plainly visible in its construction. Its external dimensions are 382 feet by 258 feet.

AHMADNAGAR, a district and city in British India, in the province of Gujrát, within the jurisdiction of the Governor of the Presidency of Bombay. The collectorate extends from 18° 6′ to 19° 50′ N. lat., and from 73° 40′ to 75° 37′ E. long., and contains the following eleven tálukás or sub-districts:—Nagar, Jámkhair, Párnair, Srígonda, Karjat, Newasa, Kopargám, Sangamnair, Rahurí, Siogám, and Ankolá. A natural boundary is formed on the west of the Ankolá táluká by the Western Gháts, and, further south, by the edge of the table-land of Párnair; on the S.W. the district is bounded by the Gor river; on the S. by the Bhímá and Sholápur collectorates; on the E. by the Nizám's dominions; on the N.E. by the Godávarí river; and on the N. by the Násik district. The total area of the district is returned at 4,209,036 acres, or 6576·62 square miles. Of the total area, 3,068,162 acres, or 4794·00 square miles, are cultivated; 121,474 acres, or 189·80 square miles, are cultivable, but not actually under tillage; and 1,019,400 acres, or 1592·81 square miles, are uncultivable. The last portion includes (besides unarable lands) village sites, roads, tanks, rivers, &c. The population of the district, according to the census taken on the night of the 21st February 1872, numbered 773,938 souls, divided into the following five classes:—Hindus, 716,820, or 92·62 per cent. of the total population; Mahometans, 42,435, or 5·49 per cent.; Buddhists, 12,547, or 1·62 per cent.; Christians, 941, or 0·12 per cent.; and other denominations, 1195, or 0·15 per cent. The bulk of the population consists of Marhattás and Kunbís, the latter being the agriculturists. On the north the district is watered by the Godávarí and its tributaries the Prawara and the Múlá; on the north-east by the Dor, another tributary of the Godávarí; on the east by the Séphaní, which flows through the valley below the Bálá Ghát range; and in the extreme south by the Bhímá and its tributary the Gor. The Siná river, another tributary of the Bhímá, flows through the Nagar and Karjat tálukás. The collectorate on the whole is fairly well watered, although in some villages among the hills and spurs of the Western Gháts the supply is insufficient. The district is intersected by the Bombay and Agra road; a second road connects Puná *via* Serur with the town of Ahmadnagar, and is continued thence towards Máligám; a third road leads from Puná to Náráyangám, besides various cross-tracts and minor roads connecting the different towns of the district.

The only important industry is weaving. The principal agricultural products are wheat, gram, bajrá, joár, and tur dál. The early or spring crop is bajrá and tur dál; wheat, gram, and joár being sown later in the season. Several other food grains are also raised; and sugar-cane, betel leaves, a little cotton, and all descriptions of vegetables are sown on suitable soils. The staple food of the people is bajrá and joár (coarse kinds of millet). The total revenue of the district is returned at nearly £170,000; about £140,000 being derived from the land revenue. The total annual expenditure is returned at £50,000. The present land settlement was introduced about 1844–45, and the thirty years' leases are now beginning to fall in. In a few villages which were transferred to Ahmadnagar from the Násik collectorate the leases have already expired, and a revision of the settlement is in progress (1873). The following eight towns are returned as containing a population of upwards of 5000 souls:—Ahmadnagar, population 32,841; Sangamnair, 9978; Páthardí, 7117; Khurdá, 6889; Srigonda, 6175; Bhingar, 5752; Karjat, 5535; and Sonái, 5254. The municipal system has been introduced into the towns of Ahmadnagar, Sangamnair, and Bhingar. In the two first named, the municipal revenue is derived from a house tax and octroi duties on goods and articles imported into the town for consumption. In Bhingar the municipal revenue is raised by the levy of a classified tax on professions and trades carried on within the town. The municipal revenue and expenditure in 1872, together with the incidence of municipal tax per head of the population in each of the three towns, was as follows:—Ahmadnagar, municipal income, £3611, 18s.; municipal expenditure, £3557, 12s.; incidence per head of population, 2s. 2½d. Sangamnair, municipal income, £275, 4s.,—6¼d. per head; expenditure, £217. Bhingar, municipal revenue, £259, 18s.—8¾d. per head; expenditure, £259, 18s. Ahmadnagar district contains 1 high school, 1 first-grade Anglo-vernacular school, 3 middle-class schools, 164 lower-class schools, and 1 girls' school. Education is making fair progress, and the number of schools is annually increasing as funds become available. For the protection of person and property, a regular police force of 594 men of all grades is maintained, at a cost, during 1872–73, of £9869. A village police, numbering 2042 men, is also kept up, at a cost of £1978 per annum. There are no special criminal classes in the district except a few Bhils, and they are now much less troublesome than formerly.

Ahmadnagar City, the capital of the district of the same name, is situated in 19° 6′ N. lat., and 74° 46′ E. long. It is a town of considerable antiquity, having been founded, in 1494, by Ahmad Nizám Sháh, on the site of

a more ancient city, Bhingar. This Ahmad established a new monarchy, which lasted until its overthrow by Sháh Jahán in 1636. In 1759 the Peshwá obtained possession of the place by bribing the Mahometan commander; and in 1797 it was ceded by the Peshwá to the Marhattá chief Daulat Ráo Sindhiá. During our war with the Marhattás in 1803 Ahmadnagar was invested by a British force under General Wellesley, and captured. It was afterwards restored to the Marhattás, but again came into the possession of the British in 1817, according to the terms of the treaty of Puná. The town has rapidly advanced in prosperity under British rule. It now contains a population of 32,841 souls, is an important station on the Great Indian Peninsular Railway, and has been created a municipality, as is mentioned above.

AHMED SHAH, founder of the Duráni dynasty in Afghanistan, born about 1724, was the son of Sammaun-Khan, hereditary chief of the Abdali tribe. While still a boy Ahmed fell into the hands of the hostile tribe of Ghilzais, by whom he was kept prisoner at Kandahar. In March 1738 he was rescued by Nadir Shah, who soon afterwards gave him the command of a body of cavalry composed chiefly of Abdalis. On the assassination of Nadir in 1747, Ahmed, having failed in an attempt to seize the Persian treasures, retreated to Afghanistan, where he easily persuaded the native tribes to assert their independence, and accept him as their sovereign. He was crowned at Kandahar in October 1747, and about the same time he changed the name of his tribe to Duráni. Two things may be said to have contributed greatly to the consolidation of his power. He interfered as little as possible with the independence of the different tribes, demanding from each only its due proportion of tribute and military service; and he kept his army constantly engaged in brilliant schemes of foreign conquest. Being possessed of the Koh-i-noor diamond, and being fortunate enough to intercept a treasure on its way to the Shah of Persia, he had all the advantages which great wealth can give. He first crossed the Indus in 1748, when he took Lahore; and in 1751, after a feeble resistance on the part of the Mahometan viceroy, he became master of the entire Panjáb. In 1750 he had taken Nishapúr, and in 1752 he subdued Kashmir. His great expedition to Dehli was undertaken in 1756 in order to avenge himself on the Great Mogul for the recapture of Lahore. Ahmed entered Dehli with his army in triumph, and for more than a month the city was given over to pillage. The Shah himself added to his wives a princess of the imperial family, and bestowed another upon his son Timur Shah, whom he made governor of the Panjáb and Sirhind. As his viceroy in Dehli he left a Rohilla chief in whom he had all confidence, but scarcely had he crossed the Indus when the Mahometan vizier drove the chief from the city, killed the Great Mogul, and set another prince of the family, a tool of his own, upon the throne. The Mahratta chiefs availed themselves of these circumstances to endeavour to possess themselves of the whole country, and Ahmed was compelled more than once to cross the Indus in order to protect his territory from them and the Sikhs, who were constantly attacking his garrisons. In 1758 the Mahrattas obtained possession of the Panjáb, but on the 6th January 1761 they were totally routed by Ahmed in the great battle of Pánipat. In a later expedition he inflicted a severe defeat upon the Sikhs, but had to hasten westwards immediately afterwards in order to quell an insurrection in Afghanistan. Meanwhile the Sikhs again rose, and Ahmed was now forced to abandon all hope of retaining the command of the Panjáb. After lengthened suffering from a terrible disease, said to have been cancer in the face, he died in 1773, leaving to his son Timur the kingdom he had founded.

AHRIMAN or Arimanes (*Angra-Mainyus*, Hostile or Destroying Spirit), in the *Zend-Avesta*, the principle of evil, opposed to *Ormuzd*, the principle of good, the one being symbolised by darkness and the other by light. Both were visible manifestations of the *Zervan-Akerene* (Infinite Time), and existed from all eternity, according to the doctrine of the Magians. Zoroaster himself, however, seems to have taught that Ormuzd alone was eternal, while Ahriman was created. In the *Avesta* this world is represented as the theatre of a fierce conflict between the two spirits, which is to last for 12,000 years. In the end Ahriman is to acknowledge the supremacy of Ormuzd. (See Zoroaster.)

AHWAZ, a town in Persia, on the left bank of the river Karoon, about 100 miles N.E. of Bassorah. Though now an insignificant place, it occupies the site of what was once an extensive and important city. Of this ancient city vast remains are left, extending 12 miles along the bank of the river. Among the most remarkable are the ruins of a bridge and a palace, besides vestiges of canals and water-mills, which tell of former commercial activity. There is also, in a ruined state, a bund or stone dyke of great strength thrown across the river for purposes of irrigation. It extends 100 feet in length, and many single blocks in it measure from 8 to 10 feet in thickness. Ahwaz reached the height of its prosperity in the time of the earliest Mahometan caliphs.

AI (Sept. Ἀγγαί, Ἀγγαί, and Γαί; Vulg. *Hai*), a royal city of the Canaanites, east of Bethel. It existed in the time of Abraham, who pitched his tent between the two cities (Gen. xii. 8; xiii. 3); but it is chiefly noted for its capture and destruction by Joshua (vii. 2–5; viii. 1–29), who made it "a heap for ever, even a desolation." At a later period Ai was, however, rebuilt, and is mentioned by Isaiah (x. 28), and also after the captivity. The site was known, and some scanty ruins still existed, in the time of Eusebius and Jerome (*Onomast.*, s.v. Ἀγγαί). Dr Robinson was unable to discover any certain traces of either. He remarks (*Bib. Researches*, ii. 313), however, that its situation with regard to Bethel may be well determined by the facts recorded in Scripture. That Ai lay to the east of Bethel is distinctly stated; and the two cities were not so far distant from each other but that the men of Bethel mingled in the pursuit of the Israelites as they feigned to flee before the king of Ai, and thus both cities were left defenceless (Josh. viii. 17). A little to the south of a village called Deir Diwan, and one hour's journey from Bethel, the site of an ancient place is indicated by reservoirs hewn in the rock, excavated tombs, and foundations of hewn stone. This, Dr Robinson thinks, may mark the site of Ai, as it agrees with all the intimations as to its position. In this view more recent authorities generally coincide. Kiepert's map gives it a place near these ancient ruins. Stanley places it at the head of the *Wady Harith.*

AIDAN, a king of Scottish Dalriada, who reigned about the close of the 6th century. He usurped the succession from the son of Conall, and was crowned by Columba, who personally preferred another, and, it is said, was compelled to perform the ceremony by an interposition of divine power. During Aidan's reign the Scottish Dalriada was completely freed from subjection to the Irish monarchs. (See Adamnan, lib. iii., c. 5; and Bede.)

AIDAN, St, first bishop of Lindisfarne or Holy Island, embraced a religious life in the monastery of Iona. Oswald, king of Northumbria, having requested a mission of monks from Iona to labour for the conversion of his subjects, Aidan was chosen by the abbot as leader of the expedition, and was consecrated a bishop about 634–5 A.D. Bede speaks of the holiness of his life, of the influence of his preaching as seen in the conversion of multitudes, and also

of numerous miracles which he performed. Aidan died on the 31st August 651.

AIDE-DE-CAMP, a confidential officer attached to the "personal" or private staff of a general. In the field he is the bearer of his chief's written or verbal orders, and when employed as the general's mouthpiece, must be implicitly obeyed. In garrison and quarters his duties are more of a social character—he superintends the general's household, writes and answers invitations, &c. To increase their state, colonial governors and the Lord-Lieutenant of Ireland have aides-de-camp with functions analogous to those of equerries to royalty. Officers above the rank of captain are seldom taken as aides, and none of less than two years' service. The sovereign, as head of the army, may have an indefinite number of aides-de-camp. In 1874 there were thirty-three military aides-de-camp; of these, twelve, taken from the militia, were honorary, the remainder, from the regular army and marines, were chosen for distinguished war services. The appointment carries with it promotion to the army rank of "full" colonel. The Queen has also at present (1874) eleven naval aides-de-camp, in compliment to the sister service; but the appointment is more especially of a military character. An admiral's aide-de-camp is his flag-lieutenant.

AIDIN, or GUZEL-HISSAR, a town of Turkey in Asia, in the pashalic of Anatolia, about 70 miles S.E. of Smyrna. It is beautifully situated near the river Meander, and is the residence of a pasha. Since 1866 it has been connected with Smyrna and Ephesus by rail. On a neighbouring height are to be seen the ruins of the ancient *Tralles*. Aidin is a place of very extensive trade, and is celebrated for its figs, which are grown in great abundance in the beautiful orchards between the town and the river, and form an important article of export. The streets of the town, overshadowed by trees, and having numerous well-frequented bazaars, present a very picturesque appearance. Among the inhabitants are considerable numbers of Greeks, Armenians, and Jews; and there are several churches and synagogues in addition to the fine Turkish mosques. Population, 30,000.

AIDS (*Auxilia*), a pecuniary tribute under the feudal system, paid by a vassal to his lord on particular occasions; originally a voluntary grant which in process of time became exigible as a right. The aids of this kind were chiefly three, viz.:—1*st*, When the lord made his eldest son a knight; 2*d*, To provide a dower when he gave his eldest daughter in marriage; 3*d*, To ransom the person of the lord when taken prisoner. The amount of the first two was definitely fixed by 3 Ed. I., c. 36, but that of the last was of course uncertain. The right of levying aids was abolished by 12 Car. II., c. 24.

AIKIN, JOHN, M.D. (1747–1822), was born at Kibworth-Harcourt, received his elementary education at the dissenting academy of Warrington, where his father was tutor, and prosecuted his medical studies in the university of Edinburgh, and in London under the celebrated Dr William Hunter. He commenced his professional career as a surgeon at Chester; but being unsuccessful, he removed to Warrington. Finally, he went to Leyden, took the degree of M.D. in that university (1780), and attempted to establish himself as a physician in London. His success in this new field does not seem to have been considerable; chiefly, no doubt, because he concerned himself more with the advocacy of liberty of conscience than with his professional duties. He therefore began at an early period to devote himself to literary pursuits. Dr Aikin's reputation chiefly rests on his endeavour to popularise scientific inquiries. In conjunction with his sister, Mrs Barbauld, he commenced the publication of a series of volumes on this principle, entitled *Evenings at Home* (6 vols., 1792–5), a popular and interesting work, chiefly commendable for the purity of the principles it inculcates, and the pleasing views it gives of human nature. It has been translated into almost every European language. His love of nature, and his power in delineating its features, are well illustrated in *The Natural History of the Year*, as well as in his miscellaneous *Essays*. In 1798 Dr Aikin retired from professional life, and devoted himself with great industry to literary undertakings of numerous and varied kinds, among which his valuable *Biographical Dictionary* (10 vols. 1799–1815) holds a conspicuous place. Besides these, he published *Biog. Memoirs of Medicine* (1780); *Lives of John Selden and Archbishop Usher; Memoirs of Huet, Bishop of Avranches; Geographical Delineations of All Nations*, &c. He edited the *Monthly Magazine* from 1796 to 1807, and started the *Athenæum* in 1807. The latter was discontinued, however, in 1809.

AIKIN, LUCY, daughter of the preceding, a well-known historical writer, was born at Warrington on 6th Nov. 1781. After rendering valuable assistance to her father in several of his later works, she commenced her own career as an authoress by the publication of several books for the young, the most important of which were the *Adventures of Rolando*, a translation, and *Lorimer*, a tale. In 1818 she published her *Memoirs of the Court of Queen Elizabeth*, the first and best of the series of historical works on which her reputation rests. It was very popular, and passed through several editions. The *Memoirs of the Court of King James I.* (1822) was highly commended in the *Edinburgh Review*, which pronounced it "a work very nearly as entertaining as a novel, and far more instructive than most histories." Her *Memoirs of the Court of Charles I.* (1833) showed a falling off; and her latest work, the *Life of Addison* (1843), was declared disappointing by Macaulay in the *Edinburgh Review*, vol. lxxviii. Miss Aikin died at Hampstead, where she had resided for forty years, on the 29th Jan. 1864. A Life by P. H. le Breton appeared in a volume entitled *Memoirs, Miscellanies, and Letters of Lucy Aikin* (Lond. 1864).

AIKMAN, WILLIAM, a celebrated portrait-painter, born at Cairney, Forfarshire, on the 24th Oct. 1682. He was intended by his father for the bar, but followed his natural bent by becoming a pupil under Sir John Medina, the leading painter of the day in Scotland. In 1707 he went to Italy, resided in Rome for three years, afterwards travelled to Constantinople and Smyrna, and in 1712 returned home. In Edinburgh, where he practised as a portrait-painter for some years, he enjoyed the patronage of the Duke of Argyll; and on his removal to London in 1723 he soon obtained many important commissions. Perhaps his most successful work was the portrait of the poet Gay. He also painted portraits of himself, Fletcher of Saltoun, William Carstairs, and Thomson the poet. The likenesses were generally truthful, and the style was modelled very closely upon that of Sir Godfrey Kneller. Aikman held a good position in literary society; and counted among his personal friends Swift, Pope, Thomson Allan Ramsay, Somerville, and Mallet. He died in June 1731, leaving unfinished a large picture of the royal family.

AILRED, EALRED, ETHELREDUS, ALUREDUS, an English ecclesiastic and historian, born at Hexham in 1109. He was educated at the Scotch court with Henry the son of King David. The king is said to have offered him a bishopric, which he refused, preferring to become a monk in the Cistercian abbey of Rievaulx, Yorkshire. In 1146 he was chosen abbot, and he held that position till his death in 1166,—the accounts which state that he was transferred to Revesby in Lincolnshire being probably founded on a confusion of names. Leland says that he had seen his tomb at Rievaulx adorned with gold and silver ornaments.

Ailred was the author of a large number of historical and theological works. The former are of little value, owing to his credulity, except for the occasional glimpses they give of contemporary life and manners. His theological works, including a volume of homilies, a treatise on charity, and a treatise on friendship, are somewhat in the style of St Bernard. (For a full account of the historical writings see Sir T. D. Hardy's *Descriptive Catalogue.*)

AILSA CRAIG, a remarkable island-rock at the mouth of the Firth of Clyde, off the coast of Ayrshire, Scotland. It is of a conoidal form, with an irregular elliptic base, and rises abruptly from the sea to the height of 1139 feet. The only side from which the rock can be ascended is the east; the other sides being for the most part perpendicular, and generally presenting lofty columnar forms, though not so regular as those of Staffa. The rock is a greenstone or syenite, with a basis of grayish compact felspar traversed by numerous trap veins. A columnar cave exists towards the north side, and on the eastern are the remains of a tower, with several vaulted rooms. Two springs occur on the island, and some scanty grass affords subsistence to numerous rabbits. The precipitous parts of the rock are frequented by large flocks of solan geese and other aquatic wild fowl. It is situated in 55° 15′ N. lat., 5° 7′ W. long.

AIN, a department on the eastern frontier of France, bounded on the N. by the departments of Jura and Saône-et-Loire, on the W. by Saône-et-Loire and Rhône, on the S. by Isère, and on the E. by the departments of Savoie and Haute Savoie and the Swiss cantons Geneva and Vaud. It extends at the widest points 52 miles from N. to S., and about the same distance from E. to W., with an area of 2241 square miles. The east of the department is very mountainous, being traversed by the southern portion of the Jura range, but in the north-west the surface is comparatively level, and in the south-west flat and marshy. Ain is wholly within the basin of the Rhône, that river itself being the boundary on the east and south, while it receives the Ain, which passes southward through the centre, and the Saône, which forms the western boundary of the department. The climate is usually cold, but on the whole healthy, except in the damp marshy districts on the west. The soil in the valleys and plains of the department is fertile, producing wheat, barley, maize, rye, and fruits of various kinds, as well as wine of excellent quality; the tops of many of the mountains are covered with forests of fir and oak, and the lower slopes yield excellent pasture for sheep and cattle. The chief mineral product is asphalt, besides which potter's clay, iron, building-stone, and the best lithographic stone in France, are produced in the department. There are many corn and saw mills on the mountain streams; and cotton, linen, and silk fabrics, coarse woollen cloth, paper, and clocks, are manufactured to a limited extent. Ain, which formed a part of the ancient province of Burgundy, is divided into five arrondissements—Bourg and Trevoux in the west, and Gex, Nantua, and Belley in the east; containing in all 36 cantons and 452 communes. Bourg is the capital, and Belley is the seat of a bishop. Population of Ain in 1872, 363,290, of whom 185,074 were males, and 178,216 were females. Of the total population, 115,407 could neither read nor write, and 46,450 more could not write.

AINAD, a town of Arabia, in the province of Hadramaut, about 207 miles N.E. of Aden. Near it is the tomb of a Moslem prophet much frequented by pilgrims, at which a great annual fair is also held. The population is said to be about 10,000.

AINMULLER, MAXIMILIAN EMMANUEL, founder of a new school of glass-painting, was born at Munich on the 14th February 1807. He was induced, by the advice of Gärtner, director of the royal porcelain manufactory, to devote himself to the study of glass-painting, both as a mechanical process and as an art, and he made such progress that in 1828 he was appointed director of the newly-founded royal painted-glass manufactory at Munich. The method which he gradually perfected there was a development of the enamel process adopted in the Renaissance, and consisted in actually painting the design upon the glass, which was subjected, as each colour was laid on, to carefully-adjusted heating. The fault of this new style is its production of transparent pictures seen by transmitted and not by reflected light; but the popular verdict in its favour has been, notwithstanding, proved by the extent to which it has been adopted. The earliest specimens of Ainmüller's work are to be found in the cathedral of Ratisbon. With a few exceptions, all the windows in Glasgow cathedral are from his hand. Specimens may also be seen in St Paul's cathedral and St Peter's College, Cambridge. On the Continent it must suffice to mention Cologne cathedral as containing some of his finest productions. Ainmüller had considerable skill as an oil-painter, especially in interiors; and his pictures of the Chapel Royal at Windsor and of Westminster Abbey have been much admired. He died 9th December 1870.

AINOS, the name of a small but remarkable tribe in Japan, found chiefly in the island of Yesso. They are different in race and character from the ordinary Japanese, and seem to have been the earliest inhabitants of the country. Since the invasion of the islands by the Japanese, however, the Ainos have been gradually supplanted by the invaders, and are now completely subject to them, although they still preserve the appearance of internal self-government, living in societies of from ten to twenty families, under a hereditary chief. Their language is quite distinct from the Japanese, and intercourse between the two peoples is carried on by a sort of mongrel dialect. The Ainos are not tall, averaging a little over 5 feet; but they are well-proportioned and strongly-built, with a type of countenance European rather than Asiatic. They are distinguished by an exuberance of hair on the head and body, a circumstance which has given rise to their name of "Hairy Kuriles." The women are ugly, and are much addicted to tattooing. The dress of the Ainos consists of a robe of skin or cotton, reaching to the knees and secured by a girdle; their huts are small and uncomfortable, with little or no furniture; and their food is mostly the produce of fishing and hunting, together with rice got by barter from the Japanese. They are probably less than 50,000 in number.

AINSWORTH, HENRY, divine and scholar, was born "about 1560" at Pleasington, near Blackburn, Lancashire, having been second son of Lawrence Ainsworth of Pleasington Hall. Young Henry Ainsworth is believed to have received his education at Queen Elizabeth's Grammar School in Blackburn, of which his father was an original founder. According to tradition, he was a Roman Catholic, and a younger brother, John, a Protestant; and the two brothers, entering into a written controversy, mutually converted each other—Henry having embraced Protestantism, and John, Popery. The subsequent earlier history of Ainsworth is still obscure. No record survives; but various authorities concur in stating that he passed from Blackburn to Cambridge. He associated with the Puritan party in the Church of England, and eventually adopted the platform of the Independents as represented by the Brownists. He was driven from his native country by the state proscription of the sectaries before the year 1593. He is found resident in "a blind lane at Amsterdam" about 1595–6. His exile must have reduced him to extreme poverty. He is stated to have been a "porter" to a scholarly bookseller in Amsterdam, who, on discovering his skill in the Hebrew language, made him known to his countrymen. Roger

Williams, in one of his fiery tractates, reproaches Ainsworth as "living upon ninepence a week and some boiled roots." When the Brownists erected a church in Amsterdam, Francis Johnson was chosen for their pastor, and Henry Ainsworth for their doctor or teacher. In 1596 these two divines drew up a confession of their faith (in Latin), which was reprinted in 1598, and dedicated to the various universities of Europe (including St Andrews, Scotland). The separations and controversies which ensued at Amsterdam and at Leyden belong to church history. Of Ainsworth it may be said, that while he never put himself forward or sought notoriety, he was beyond comparison the most steadfast and most resolute and most cultured champion of those principles of civil and religious freedom represented by the now large and influential body of Nonconformists in Britain and America called Independents or Congregationalists. The personal squabbles and temporary animosities have long passed away; and it is recognised that in Henry Ainsworth Nonconformity had a man of saintly worth, of intellectual power, and of uncompromising intrepidity. Amid the strifes and clamours of controversy he pursued steadfastly his rabbinical studies. The combination was so unique that Moreri and Zedler, like others, made two Henry Ainsworths—one Dr Henry Ainsworth, a learned biblical commentator; the other H. Ainsworth, an arch-heretic, and "the ringleader of the Separatists at Amsterdam." Kindred mistakes are found regarding his writings in Hornbeck's *Summa Controversiarum*, and more recent bibliographical authorities. In 1608 our Ainsworth defended the Separation against Richard Bernard and William Crashaw (father of the poet). But his ablest and most arduous minor work in controversy was his crushing reply to the notorious Smyth, entitled *A Defence of the Holy Scriptures, Worship, and Ministry, used in the Christian Church separated from Antichrist, against the Challenges, Cavils, and Contradictions of M. Smyth* (1609). His memory abides through his rabbinical learning. The ripe fruit of many years' diligence appeared in his Notes on Genesis, 1616; Exodus, 1617; Leviticus, 1618; Numbers, 1619; Deuteronomy, 1619; Psalms, 1612, 2d edition 1617; Song of Solomon, 1623. These were collected in folio in 1627, and again in 1639, and later in various forms. From the outset the *Annotations* have taken a commanding place, especially among Continental scholars, as witness Clement, Dornius, Voght, Lilienthal, and Simon, the last urging Catholics to study and value them. Perhaps nothing more clearly shows even his home repute than the praiseworthy zeal with which Vice-Chancellor Dr John Worthington endeavoured to recover certain posthumous MSS. of Ainsworth. These, it is to be feared, have irrecoverably disappeared. Moreri mentions a current report that the famous Lightfoot "pillaged the best of his observations" from Ainsworth. A comparison of the *Exercitations* with the *Annotations* shows, however, that the two scholars worked independently. Moreri's groundless remark has been transmuted into an imputation as groundless—that Lightfoot had got into his possession the MSS. of Ainsworth. The character and learning of the great rabbinist ought to have silenced such an unworthy suspicion. There is nothing more striking in the career of Ainsworth than the reported manner of his death, which took place at Amsterdam in 1622–3. It is stated that, having found a diamond of great value, he advertised it; and when the owner, who was a Jew, came to demand it, he offered the finder any gratuity he sought. Ainsworth, though poor, requested only of the Jew that he would procure him a conference with some of his rabbis upon the prophecies of the Old Testament relating to the Messiah, which the Jew promised; but not having interest to obtain such a conference, it is thought that he contrived to get Ainsworth poisoned (Neal, *Puritans*, ii. 47). Another account says that he attended the conference, and so confounded the Jews that, from spite and malice, they in this manner put a period to his life (Brook, *Puritans*, ii. 302). There is an air of improbability about the narrative; but it is certain he was dead in 1623, for in that year was published his *Seasonable Discourse, or a Censure upon a Dialogue of the Anabaptists*, in which the editor speaks of him as a departed worthy. For a pretty complete list of his writings, lesser and larger, see Chalmers, Brook, and Hanbury. Many are now extremely rare and high-priced. (See Worthington's *Diary* [Chetham Society], by Crossley, i. 263–6; Hanbury's *Memorials*, s.v.; Works of Robinson, iii., Appendix, and *supra*.) (A. B. G.)

AINSWORTH, Robert (1660–1743), author of a well known Latin dictionary, was born at Woodvale, near Manchester. After teaching for some time in Bolton, he removed to London, where he conducted a boarding-school, first at Bethnal Green, and then at Hackney. At a comparatively early period of his life he had realised a competency, and was able to retire. Proposals for the preparation of a Latin dictionary were made to him in 1714, but the work was not published till 1736. It was long extensively used in schools, and often reprinted, the later editions being revised and enlarged by other hands. Ainsworth's *Dictionary* was, however, radically imperfect, containing a mere register of words, with no scientific classification or complete and exact definition of their various meanings, and necessarily wanting the results of modern philological research. Later works have now entirely superseded it.

AINTAB, a large garrison town on the northern frontier of Syria, 65 miles N.N.E. of Aleppo, in 36° 58′ N. lat., 37° 13′ E. long. It has a considerable trade, chiefly in hides and leather, and cotton of coarse quality is grown in the district. Population, about 20,000.

AIR was the name formerly given to all gaseous substances. The gas now known as oxygen, for instance, was named by Priestley *dephlogisticated air*, in contradistinction to nitrogen or azote, which was *phlogisticated air*. So hydrogen gas was known to the early chemists as *inflammable air*, carbonic acid gas as *fixed air*, &c. The name is now ordinarily restricted to what is more accurately called atmospheric air—the air we breathe—the invisible elastic fluid which surrounds the earth, extending to an unknown height. The properties of this fluid will be fully considered under such headings as Atmosphere, Barometer, Chemistry, Ventilation, &c. Reference may be made here to the mechanical use of air as a moving power, or rather as a means for transferring power, just as it is transferred by a train of wheelwork. Compressed air can be employed in this way with great advantage in mines, tunnels, and other confined situations, where the discharge of steam would be attended with inconvenience. The work is really done in these cases by a steam-engine or other prime mover in compressing the air. In the construction of the Mont Cenis tunnel the air was first compressed by water-power, and then carried through pipes into the heart of the mountain to work the boring machines. This use of compressed air in such situations is also of indirect advantage in serving not only to ventilate the place in which it is worked, but also to cool it; for it must be remembered that air falls in temperature during expansion, and therefore, as its temperature in the machines was only that of the atmosphere, it must, on being discharged from them, fall far below that temperature. This fall is so great that one of the most serious practical difficulties in working machines by compressed air has been found to be the formation of ice in the pipes by the freezing of the moisture in the air, which frequently chokes them entirely up.

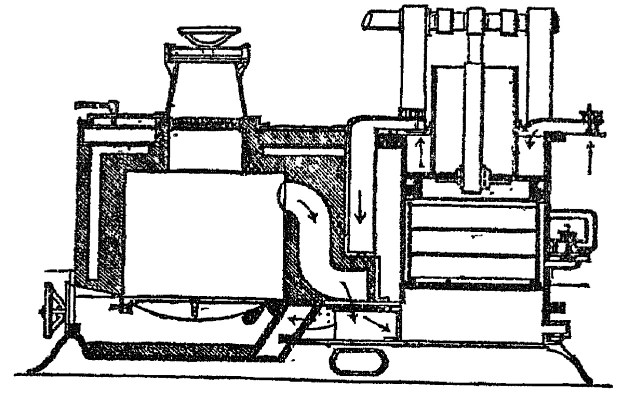
AIR-ENGINE. Engines which have for their working fluid heated air instead of steam are called "air-engines." The name "caloric engine" has also been applied to them, but is not to be commended, for they have no more right to that title than steam-engines—the useful effect of both machines being due to the transformation of heat into mechanical energy, the air in the one case and the steam in the other being merely convenient media through which to effect that transformation.

The utilisation of the expansion of heated air for driving an engine has for many years been a subject which has exercised the ingenuity of inventors. The history of air-engines has, however, been little more hitherto than a history of failures, and they are as far now from superseding steam-engines as they were fifty years ago. This is owing mostly to the fact that the inventors have too often worked empirically, without any real knowledge of the conditions under which, and under which only, the real advantages of the fluid could be attained, and have therefore continually violated these conditions. There are also certain constructive difficulties in the way of making a successful air-engine which have never been fully overcome. It should be distinctly understood that, regarded simply as a medium for transforming heat into work, air possesses *no* advantage over steam or any other fluid. Its advantage is, that it can be used with safety at much higher temperatures than steam (and therefore a larger proportion of the heat given to it can be transformed into work), and that by employing the gases of combustion in the cylinder much heat can be utilised which with steam-engines is necessarily wasted.

Of the air-engines which have actually worked we have—(1.) Those in which the changes of temperature take place at a pair of constant volumes; (2.) those in which the changes of temperature take place at a pair of constant pressures; and (3.) those in which heat is received and rejected at a pair of constant pressures. The first two classes, fitted with "economisers," are in theory "perfect" engines; that is, they are theoretically capable of transforming into work the largest fraction the limits of temperature allow of the heat received from the fuel. The third class are not perfect engines, but possess certain practical advantages which will be afterwards mentioned.

The well-known engine invented by the Rev. Dr Stirling in 1816, and subsequently improved by him, in conjunction with his brother, Mr James Stirling, C.E., of Edinburgh, belongs to the first class. In this engine the same mass of air is used again and again, and is compressed at starting to a pressure of 7 to 10 atmospheres. A cylindrical air-receiver, in which a plunger can be moved up and down, is placed over the flue of the furnace. The annular space between the plunger and the sides of this receiver is occupied by an immense number of thin sheets of metal, which form the "economiser." In the upper part of the receiver, which communicates freely with one end of a working cylinder of the usual construction, is a "refrigerator," consisting of a coil of tubing through which cold water continually circulates. The plunger is alternately raised and lowered by suitable mechanism, and in its motion causes the great body of air in the machine to occupy alternately the bottom or heating end and the top or cooling end of the receiver. It thus undergoes alternate expansion and contraction, and thereby gives motion to the piston of the working cylinner, and thence to a crank shaft in the usual way. The advantages of this engine were, that the air in the cylinder was always cool, and that the great pressure which could be used rendered the size of the machine for a given power very moderate. It was ultimately abandoned because of the failure of the receiver to stand the destructive action of the heat.

The most familiar example of the second class of air-engines is that invented by Captain Ericsson. It differed from Stirling's in many respects, and does not seem in any one particular to have been an improvement on it. Fresh air was drawn from the atmosphere at every stroke, and a very low pressure used, and what was the receiver in Stirling's engine became the working cylinder of Ericsson's. It was thus excessively bulky in proportion to its power, and all the working parts were exposed to the destructive action of intense heat. It is chiefly interesting on account of the enormous scale on which its construction was actually carried out. The engines of the steamship "Ericsson" had four working cylinders, each 14 ft. in diameter, with other parts in proportion. The trials of this vessel were conducted in a manner which did not allow any confidence to be placed in the results said to be obtained, and steam-engines replaced those of Ericsson within two years.



To the third class of air-engines belong those of Sir George Cayley and several of the older inventors. The best known modern example is, however, the engine of Mr Philander Shaw, which is shown in our engraving, and which was exhibited at the Paris Exhibition of 1867. The most important feature of this type of engine is the use of the products of combustion themselves, instead of merely the air heated by them, to drive the piston. The construction of the engine is very simple: the working piston is fitted with a trunk on its upper side, which, thus reduced in area, serves as a compressing pump, and the products of combustion act directly upon its under side, which is protected by a large drum filled with non-conducting material from the heat. The furnace stands beside the cylinder, and is entirely closed up, means being provided for feeding it with fuel without allowing any air to enter. The air compressed by the pump is delivered into the furnace, where it combines with the fuel to form the gases of combustion, and in this way receiving additional heat, expands, and raises the piston of the working cylinder for a portion of its stroke. The admission-valve of the latter is then closed, and the gases expand, without addition of heat, until the piston has completed its stroke, and are then discharged into the atmosphere. By the addition of an "economiser," the efficiency of this type of engine may be very greatly increased; but its principal advantage is that, by actually using the products of combustion inside the engine, much heat is saved which in other engines is unavoidably sent up the chimney and lost.

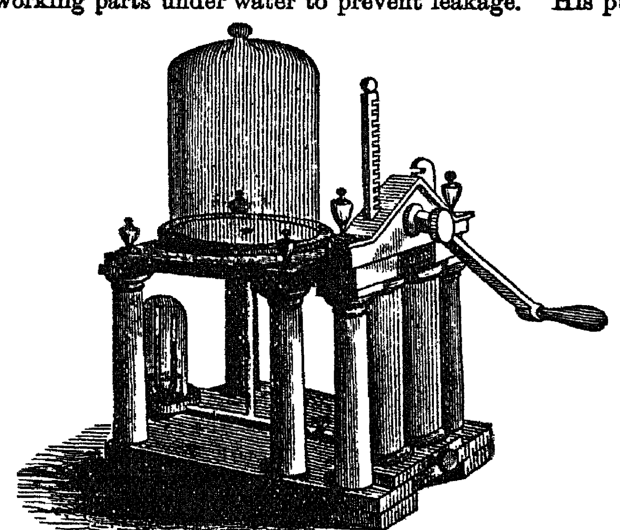
One of the principal features of all air-engines is the "economiser" (sometimes erroneously called the "regenerator"), an invention of Mr Stirling's. The object of this apparatus is to store up the heat rejected by the fluid when it falls in temperature, and subsequently to raise the temperature of the fluid by re-storing the same heat, so that the only heat which the furnace has to supply is the latent heat of expansion, together with the amount of sensible heat which may be lost through the imperfection of the economiser.

(For a popular explanation of the theory of air-engines, see an admirable paper by the late Professor Rankine in the *Edinburgh Philosophical Journal* for January 1855; and for a complete account of the same, involving the use of the higher mathematics, see the same author's *Steam-Engine*, pp. 345, *et seq.* See also Prof. Clerk Maxwell's *Theory of Heat*, and a series of papers on the subject in *Engineering*, 1874.) (A. B. W. K.)

AIR-GUN, a weapon like a common gun in shape, in which the force employed to propel the bullet is the elasticity of condensed atmospheric air. It has attached to it, or constructed in it, a strong metal chamber, into which air is forced by a condensing syringe (see PNEUMATICS). In this way a pressure may be obtained of several hundred atmospheres. When a trigger is touched, the condensed air rushes into a space behind the bullet with such force as to propel it from the barrel to a considerable distance. If only a little air be allowed to escape each time, a single charge will propel a number of bullets in succession, with

a constantly diminishing force. Sometimes the weapon is made in the form of a walking-stick, and is then called an *air-cane*. The air-gun is little else than a scientific toy, and has no practical value. The apparatus is costly, the process of condensation requires considerable labour, and the propulsive force of the air is, at its maximum, less than that of an ordinary charge of gunpowder. The only advantage it can be said to have in any way is the questionable one of its use being unattended by the explosive noise that accompanies the discharge of a common gun.

AIR-PUMP, an apparatus by means of which a closed vessel can have the air it contains removed from it. It consists essentially of two parts—a receiver, from which the air is to be exhausted; and a pump, to perform the work of exhaustion. The receiver is in general made of glass, in order that the condition of objects placed within it for the purpose of experiment may be readily seen by the operator. It is open at the bottom, and has its lower edge accurately ground; when in its place in the air-pump it stands upon a smooth brass plate. The pump itself is a brass cylinder, having a piston in it, which can be moved backwards and forwards by means of a rod, in the usual way. At the end of the cylinder nearest the receiver is placed a small valve, in the piston itself is another (or some mechanism which serves the purpose of a valve), and there is frequently a third in the outer end of the cylinder. All these valves open outwards from the receiver. The action of the pump, when arranged in this way, is exactly similar to the action of an ordinary well-pump, with air as the fluid instead of water. The air-pump was invented about 1654 by Otto von Guericke, a magistrate of Magdeburg, and a man who devoted great attention to various problems in pneumatics.[1] The first description of his pump was published in 1657 in the *Mechanica Hydraulico-pneumatica* of Gaspar Schottus, professor of mathematics at Wurtemberg. He used a spherical glass receiver, with a pumping syringe attached, and kept the whole of the working parts under water to prevent leakage. His pump



was very imperfectly constructed, but he did eventually succeed in getting a very good vacuum with it. The method of producing the Torricellian vacuum, by filling a vessel with liquid and then removing the liquid without permitting ingress of air, was previously known; but a vacuum produced in this way was obviously useless for experiments with any objects but those which could previously be immersed in the liquid used. Guericke was, however, the first to recognise that, by virtue of its perfect elasticity, or tendency to expand indefinitely, air could be pumped out of a closed space as well as water; and this is the principle of his and all succeeding air-pumps. Although the invention of the air-pump is due to a German, almost all the improvements made in it from time to time have come from Englishmen. Dr Boyle contributed so much to its perfection that for a long time the state of the air in an exhausted receiver was called *vacuum Boyleanum*, and the air-pump itself *machina Boyleana*. Dr Hook, Hawkesbee, John Smeaton, and others brought the air-pump externally to very much the same form as that in which it is commonly seen at present, and which is shown in the annexed woodcut. The pump here has two cylinders, which are worked by a winch handle, the pump rods having toothed racks on the upper part of their length. Professor Tate is the inventor of a double-action air-pump, now much used where a very perfect vacuum is required. It has two pistons in one barrel, the air being drawn from the receiver at the centre of the barrel, and discharged into the atmosphere at its extremities. Very complete air-pumps have two or three barrels, arranged as shown in the woodcut, for rapid exhaustion, until the pressure in the receiver is equal to (say) half-an-inch of mercury; and in addition to these a horizontal Tate's barrel, which can then be put into action to bring the vacuum down to $\frac{1}{25}$ inch of mercury (1-600th of the pressure of the atmosphere), or even less at low temperatures. See PNEUMATICS.

AIR-PUMP, in steam-engines, is the pump which draws the condensed steam, along with the air which is always mixed with it, and also the condensing water (except where a surface condenser is used), away from the condenser, and discharges it into the hot well. See STEAM-ENGINE. (A. B. W. K.)

AIR, or ASBEN, a country of central Africa, lying between 15° and 19° N. lat. and 6° and 10° E. long. The northern and best known portion of this region is of a very diversified character. It has numerous mountain ranges, some of which rise to a height of 5000 feet, with richly-wooded hollows and extensive plains interspersed. The mimosa, the dum-palm, and the date are abundant; and the valleys are covered with the exuberant vegetation of the tropics. Some of the plains afford good pasturage for camels, asses, goats, and cattle; others are desert table-lands. In the less frequented districts wild animals abound, notably the lion and the gazelle. The country generally is of sandstone or granite formation, with occasional trachyte and basaltic ranges. There are no permanent rivers; but during the rainy season, from August to October, very heavy floods convert the water-courses in the hollows of the mountains into broad and rapid streams. Numerous wells supply the wants of the people and their cattle. To the south of this variegated region lies a desert plateau, 2000 feet above the level of the sea, destitute of water, and tenanted only by the wild ox, the ostrich, and the giraffe. Still further south is the district of Damerghu, nominally tributary to Air, undulating and fertile, and yielding rich crops. Notwithstanding the fertility of the valleys in the northern portion of the country, there is little of the soil under cultivation except in the neighbourhood of the villages, where slaves are employed in tillage. Millet, dates, indigo, and senna are the principal productions. The great bulk of the food supplies is brought from Damerghu, and the whole materials for clothing are also imported. Were it not for the traffic in salt between Bilma and the Hansa states of Soudan, the country could scarcely maintain its present limited number of inhabitants. A great caravan annually passes through Air, consisting of several thousand camels, carrying salt from Bilma to Sokoto. Air was called Asben by the native tribes until they were conquered by the Berbers. The present inhabitants are for the most

[1] He was also the inventor of the "Magdeburg hemispheres."

part of a mixed race, combining the finer personal traits of the Berbers with the characteristics of the negro. The king or sultan of Air occupies a very precarious position, being to a great extent dependent on the chiefs of the Tawarek tribes inhabiting a vast tract of the Sahara to the north-west, who are continually at war among themselves. A large part of the revenue of the king is derived from tribute exacted from the salt caravan. His authority does not seem to be great in the outlying parts of his dominions. The chief town of Air is AGADES (*q.v.*) (See Dr Barth's *Travels in Central Africa*, vol. i.)

AIRAY, HENRY, D.D. This celebrated Puritan president of Queen's College, Oxford, was born at Kentmere, near Windermere, but no record remains of the date of either birth or baptism. Anthony à Wood names Westmoreland as his birthplace. In the well-known *Life of Bernard Gilpin* it is told that when he was making preparations for martyrdom, he "received the account with great composure; and immediately after called up *William Airay*, a favourite domestic, who had long served him as his almoner and steward." From the great kindness shown to our Airay by Gilpin, and from the vicinity of Kentmere to the Rectory, it does not appear to be hazarding too much to assume that this William Airay was his father, and that the family tradition is right in assigning Kentmere, not Barton or Wilford, as his birthplace. The truly apostolic man's bounty showed itself in sending Henry and a (probable) brother Ewan or Evan to his own endowed school, where they were fully educated "in grammatical learning," and were in attendance at Oxford when Gilpin lay a-dying. From the *Athenæ* we glean the details of Airay's college attendance. He was "sent," says Wood, "to St Edmund's Hall in 1579, aged nineteen or thereabouts." "Soon after," he continues, "our author, Airay, was translated to Queen's College, where he became *pauper puer serviens;* that is, a poor serving child that waits on the fellows in the common hall at meals, and in their chambers, and do other servile work about the college." His transference to Queen's College is explained by its having been Gilpin's own college, and by his Westmoreland origin giving him a claim on Eaglesfield's foundation. He proceeded B.A. on June 19, 1583. On June 15, 1586, he passed M.A.; B.D. in 1594; and D.D. on June 17, 1600—all in Queen's College. "About the time he was master" (1586), "he entered holy orders, and became a frequent and zealous preacher in the university." His Commentary on the Epistle to the Philippians (1618), reprinted 1864, is a specimen of his preaching before his college, and of his fiery denunciation of Popery, and his fearless enunciation of that Calvinism which Oxford, in common with all England, prized then. In 1598 he was chosen provost of his college, and in 1606 was vice-chancellor of the university. In the discharge of his vice-chancellor's duties, he came into conflict with Laud, who even thus early was betraying his Romish tendencies. He was also rector of Otmore (or Otmoor), near Oxford, a living which involved him in a trying litigation, whereof present incumbents reap the benefit. He died on 6th October 1616. His character as a man, preacher, divine, and as an important ruler in the university, will be found portrayed in the Epistle by Potter, prefixed to the *Commentary*. He must have been a fine specimen of the more cultured Puritans—possessed of a robust common-sense in admirable contrast with some of his contemporaries. (*Lectures on the whole Epistle of Paul to the Philippians*, 1618, 1864; Wood's *Athenæ*, by Bliss, ii. 177, 178, &c.; Laud's Works; Wills (Surtees Society.) (A. B. G.)

AIRDRIE, a parliamentary and municipal burgh and market-town of Scotland, in the parish of New Monkland, Lanarkshire, 11 miles E. of Glasgow and 32 W. of Edinburgh. The high road between these cities passes through Airdrie, forming its principal street, from which others diverge at right angles. It is well built, paved, and lighted with gas, but it contains little that is beautiful or attractive. It possesses a fine town-hall and a handsome edifice erected as the county buildings, as well as two places of worship belonging to the Church of Scotland, three to the Free Church, two to the United Presbyterians, and one each to the Reformed Presbyterians, the Congregationalists, the Baptists, the Wesleyan Methodists, and the Roman Catholics; five branch banks, with excellent places of business constructed or in course of construction; a mechanics' institute, and several schools. The extensive coal and iron mines in the vicinity give employment to a large part of the population of Airdrie, and have been the means of raising it, since the commencement of the century, from the insignificance of a village to its present prosperity. In the town itself there are manufactories of cotton goods and iron wares, besides foundries, engineering shops, saw-mills and other branches of industry. A branch of the North British Railway from Glasgow, passing through Airdrie to Edinburgh, connects it by a direct line with both cities. It is also connected with Glasgow by the Monkland Canal, which comes within a mile of the town. By the Reform Act of 1832 Airdrie was created a parliamentary burgh, uniting with Falkirk, Hamilton, Lanark, and Linlithgow in sending one member to parliament. Its municipal corporation, which dates from 1821, consists of twelve councillors, including a provost and three bailies. There are weekly courts held by the magistrates, and courts are held twice a week by the sheriff-substitute and the justices of the peace respectively. The market-day is Tuesday, but the market is of little importance. By the census of 1871 the population of Airdrie was 13,488, the number of inhabited houses 1167, and the parliamentary constituency 1702, increased in 1873 to 1932. The annual value of real property in the burgh, not including railways, is £26,145; and the corporation revenue for 1873, £3401.

AIRE, an English river which rises in the West Riding of Yorkshire and pursues a south-easterly course through the populous "clothing district" of which Leeds is the capital. At Castleford, below Leeds, it receives a small tributary, the Calder, and it joins the Ouse shortly before that river's expansion into the estuary of the Humber above Hull. It is navigable to Leeds for small craft.

AIRE, a fortified town of France, on the river Lys, in the department of Pas-de-Calais, 10 miles S.E. of St Omer. Although its situation is low and marshy, the town is neat and well built. It possesses extensive barracks; and the Church of St Paul is a handsome Gothic structure. Its manufactures consist of hats, cotton and woollen goods, hardware, yarn, soap, and oil. Population, 8803.

AIRE, a town in the south of France, in the department of Landes, on the left bank of the Adour, 14 miles S.S.E. of St Sever. At one time it was the capital of the Visigoths, and since the fifth century it has been the seat of a bishopric. It has a college and cathedral; and there are manufactories of leather and hats. Population, 5144.

AISLE, sometimes written ISLE, YLE, and ALLEY (Lat. and Ital. *Ala*, a wing; Fr. *Aile*, *Bas côté;* Ger. *Seitenschiff*, *Seitenchor*), in its primary sense, the wing of a house, but generally used to describe the alleys or passages at the sides of the naves and choirs of churches. In reckoning their number, the nave is usually counted. Thus a nave with an aisle on each side is generally called a three-aisled church; if with two aisles on each side, a five-aisled church. In England there are many churches with one side-aisle only; but there is only one cathedral with five aisles, that at Chichester. There are, however, very

many such on the Continent, the most celebrated of which are at Milan and Amiens. Others have three aisles on each side, or seven aisles in all, as the cathedrals at Antwerp and Paris. The most extraordinary, however, is that at Cordova, originally erected for a mosque. It was first built with a nave and five aisles on each side, and eight others afterwards were added, making nineteen aisles in all. Old English writers frequently call the transepts "the cross isle, or yle," and the nave the "middle ile."

AISNE, a frontier department in the north-east of France, bounded on the N. by the department of Nord and the kingdom of Belgium, on the E. by the department of Ardennes, on the S.E. by that of Marne, on the S. by that of Seine-et-Marne, and on the W. by those of Oise and Somme; extending at the widest points 75 miles from N. to S., and 53 from E. to W., with an area of 2838 square miles. The surface of the department consists of fine undulating plains, diversified in the north by hilly ground which forms a part of the mountain system of the Ardennes. The chief rivers are the Somme, the Escaut, and the Sambre in the north; the Oise, traversing the north-west, with its tributaries the Serre and the Aisne, the latter of which joins it beyond the limits of the department; and the Marne and the Ourcq in the south. The soil of Aisne is, as a whole, fertile, and in some parts very rich, yielding wheat, barley, rye, oats, hops, flax, fruit, beetroot, and potatoes; there is good pasturage, and much attention is paid to the rearing of cattle, sheep, and horses. Wine is produced, but, except in the valley of the Marne, its quality is inferior. Large tracts of the department are under wood, the chief forests being those of Nouvion and St Michel in the north, Coucy and St Gobain in the centre, and Villers-Cotterets in the south. There are no minerals of importance in the department, but good building-stone and slates of a fair quality are found. Aisne is an important manufacturing department; its chief industrial products being shawls and muslin—as well as other cotton, linen, and woollen goods—glass, including the famous mirrors of St Gobain, iron wares, beetroot sugar, leather, and pottery. It has a good trade, which is much facilitated by railroads (the most important being those between Paris and Strasbourg, and Paris and Mons), canals, and the navigable portions of the rivers. Aisne, which is composed of parts of the ancient provinces of Picardy and the Isle of France, is divided into five arrondissements—St Quentin and Vervins in the north, Laon in the centre, and Soissons and Chateau Thierry in the south. It contains in all 37 cantons and 837 communes. Laon is the capital, and Soissons the seat of the bishop. The other towns of importance are Chauny, St Quentin, Vervins, Hirson, Suise, Villers-Cotterets, and Chateau Thierry. Population in 1872, 552,439, of whom 183,104 could neither read nor write, and 28,651 could read, but could not write.

AITON, William (1731–1793), an eminent botanist and gardener, was born near Hamilton in Scotland. Having been regularly trained to the profession of a gardener, he travelled to England in the year 1754, where he became assistant to Philip Miller, then superintendent of the physic garden at Chelsea. In 1759 he was appointed director of the newly-established botanical garden at Kew, in which office he continued till his death. The garden at Kew, under the auspices of King George III., was destined to be the grand repository of all the vegetable riches which could be accumulated by regal munificence, from researches through every quarter of the globe. Aiton's care and skill in cultivation, and intelligence in arrangement, gained for him high reputation among the lovers of the science, and the particular esteem of his royal patrons. Under his superintendence many improvements took place in the plan and edifices of Kew gardens, which rendered them the principal scene of botanical culture in the kingdom. In 1783 his merit was rewarded with the lucrative office of manager of the pleasure and kitchen gardens of Kew, which he was allowed to hold along with the botanical direction. In 1789 he published his *Hortus Kewensis*, a catalogue of the plants cultivated in the Royal Botanical Garden at Kew, in 3 vols. 8vo, with 13 plates—a work which had been the labour of many years. The *Hortus*, in which the Linnæan system of arrangement, with some modification, was adopted, was very favourably received by students of science, and a second edition was issued (1810–3) by W. T. Aiton, his eldest son and successor. He was for many years honoured with the friendship of Sir Joseph Banks, the president of the Royal Society, and was aided by the Swedish naturalists, Solander and Dryander, in the preparation of his *Hortus Kewensis*.

AITZEMA, Leon van, Dutch historian and statesman, was born at Doccum, in Friesland, on the 19th November 1600, and died at the Hague on the 23d February 1669. In his youth he published a volume of Latin poems under the title of *Poemata Juvenilia*. He subsequently devoted himself almost entirely to political life, and held for a lengthened period the position of resident at the Hague for the towns of the Hanseatic League. His most important work was the *Historie oft Verhaal van Saäken van Staet in Oorlogh* (14 vols 4to, 1657–71), embracing the period from 1621 to 1668. It contains a large number of state documents, and is an invaluable authority on one of the most eventful periods of Dutch history.

AIX, an ancient city of France, the chief town of the arrondissement of the same name, in the department of the Bouches-du-Rhone. It was the *Aquæ Sextiæ* of the Romans, and between this and *Arelate* (Arles) is the field on which Marius gained his great victory over the Teutons. Under the counts of Provence, Aix became celebrated as a seat of learning; and it still retains many relics of its former splendour, and is distinguished by the number and excellence of its literary institutions. It has a library of 100,000 volumes, an academy of law, science, and theology, a museum, and a chamber of commerce. The cathedral—the baptistry of which is said to have been constructed from the remains of a Roman temple—the "Palais," the town-hall, and the clock-tower, are fine specimens of ancient architecture. There are numerous public fountains, on one of which is sculptured a figure of King René by David. The hot springs, from which the city derives its name, are not now in much repute. Aix is the seat of a court of justice and an archbishopric. The chief manufactures are cotton, silk, thread, and hardware; and olives and almonds are cultivated on the surrounding hills. There is considerable commerce in corn, wine, and oil. The naturalists Adanson and Tournefort, and the painter Vanloo, were born at Aix. Population (1872), 29,020.

AIX, or Aix-les-Bains, a town of France, in the department of Savoie, near Lake Bourget, 8 miles north of Chambéry. It was a celebrated bathing-place in the time of the Romans, and possesses numerous ancient remains. The hot springs, which are of sulphureous quality, and have a temperature of from 109° to 113° Fahr., are still much frequented, attracting annually above 2000 visitors. They are used for drinking as well as for bathing purposes. Population, 4430.

AIX-LA-CHAPELLE, the German Aachen, the capital of a district of the same name in Rhenish Prussia, situated near the Wurm, a tributary of the Meuse, in a pleasant and fertile valley about 40 miles west of Cologne, with which it is connected by railway. It is well built, and is enclosed by ramparts that have been converted into promenades, and its appearance is rather that of a prosperous modern town than of an ancient city full of historical

associations. Its town-house, built in 1353 on the ruins of Charlemagne's palace, contains the magnificent coronation hall of the German emperors, 162 feet long by 60 feet wide. Near the town-house are two ancient towers, one of which, called the *Granusthurm*, is sometimes said to be of Roman origin; and a fountain, with a statue of Charlemagne, which was erected in 1620. The cathedral of Aix-la-Chapelle consists of two parts, distinct both as to the time of their erection and their style of architecture. The older portion may be said to date either from 796 A.D., when it was erected by Charlemagne as the palace chapel, or from 983, when it was rebuilt on the old model by Otho III., after having been almost entirely destroyed by the Normans. It consists of an octagon, planned after that of St Vitale at Ravenna, surrounded by a sixteen-sided gallery, and terminating in a cupola. It contains the tomb of Charlemagne, which was opened in the year 1000, when the body of the emperor was found seated on a marble throne which was afterwards used in the imperial coronation ceremonies. The Gothic choir, which forms the more modern portion of the cathedral, was added during the latter half of the 14th and the beginning of the 15th centuries. The cathedral possesses many relics, the most sacred of which are exhibited only once every seven years, when they attract large crowds of worshippers. Besides these buildings, almost the only other of any antiquity is the corn exchange, probably of the 12th century. Of modern edifices, Aix-la-Chapelle possesses a theatre, a public library, a gymnasium, and several churches and hospitals. The chief manufactures of Aix-la-Chapelle are woollen cloths, stockings, shawls, silks, leather, glass, needles, pins, machines, general ironmongery, carriages, beer, brandy, tobacco, and chemicals. There is a good trade in these articles, not only with Germany and other continental countries, but also, in the case of cloth especially, with the United States of America. The hot sulphur springs of Aix-la-Chapelle are another important source of revenue to the inhabitants. These springs were known to the Romans, and have long been celebrated for the cure of rheumatism and gout. There are six in all, of which the Kaiserquelle is the chief, with a temperature reaching as high as 136° Fahr. There are also two cold chalybeate springs. Aix-la-Chapelle is the *Aquisgranum*, or *Civitas Aquensis*, of the Romans. Charlemagne, who perhaps was born and certainly died in the town, made it the second city of his empire and the capital of his dominions north of the Alps. He conferred numerous privileges upon its citizens, exempting them from military service and from all taxes, even when they were living in other parts of the empire. From 813 to 1531 the emperors of Germany were crowned at Aix-la-Chapelle, which during that period became one of the most important free imperial cities, although it was ravaged by the Normans in 851, and again in 882. By the removal of the coronations to Frankfort, Aix-la-Chapelle lost its leading position in Germany, and its internal prosperity was much injured by a disastrous fire in 1656. During the revolution it for a time belonged to France, but in 1815 it was ceded to Prussia, and has now become one of the chief seats of commerce in that kingdom. Population of Aix-la-Chapelle (1871), 74,238.

AIX-LA-CHAPELLE, *Congresses and Treaties of*. The first congress of Aix-la-Chapelle concerned the succession of Maria Theresa to the empire. It was held in 1748, and resulted in the treaty of Aix-la-Chapelle, signed in the same year, by which Maria Theresa was left in possession of most of her hereditary dominions, the chief exception being Silesia, which was ceded to Prussia. The second congress, held in 1818, resulted in the convention of Aix-la-Chapelle. The object of this congress was the regulation of the affairs of Europe, especially of France, after the war. A treaty of peace between France and Spain was also signed in this city in 1668, whereby Louis XIV. gave up his claim to the Spanish Netherlands, but was left in possession of much that he had already conquered.

AJACCIO, the chief town of Corsica, one of the departments of France. It is a seaport, situated on the west coast of the island, in 41° 54′ N. lat., and 8° 44′ E. long. The harbour is commodious, and sheltered on all sides save the south-west. The town is well built, and its principal buildings are the cathedral, the town-house, and the citadel. It is the seat of a bishop and a court of justice, and has a commercial college, a school of hydrography, a large library, and a botanic garden. Wine, fruits, and olive oil are the chief articles of trade; and anchovy and coral fisheries are extensively prosecuted along the coast. Ajaccio is celebrated as the birthplace of Napoleon Bonaparte. The house where he was born (15th August 1769) is still standing in good preservation. A marble statue was erected to his honour in 1850, and the people still retain strong Bonapartist sympathies. Population (1872), 16,545.

AJAN (the ancient *Azania*), a tract which forms the eastern horn of Africa, with a coast-line of about 10° of latitude, from Cape Gardafui nearly to the equator. It extends inland to the territory of the Gallas, but its limits cannot be strictly defined, as this part of Africa has been little explored. The coast towards the south is low and sandy, but northward, near Cape D'Orfui, it becomes high and mountainous, with some fertile valleys interspersed. Cape Gardafui, the most eastern point of Africa, is a bold promontory backed by lofty hills. There are no considerable rivers in Ajan, and the land for the most part is barren. The inhabitants, a tribe of the Somali, carry on a trade with the Arabs in ivory and gum, and the country possesses an excellent breed of horses.

AJAX (Αἴας), the son of Telamon. In Greek legend Ajax represents throughout only physical qualities, like Hercules, with whom, indeed, a likeness must have been recognised, or there would have been no sufficient basis for the belief that the child Ajax was born at the prayer of Hercules in behalf of his friend Telamon (the name Αἴας—or Αἴ-ας with digamma—being an allusion to the eagle, αἰετος, which appeared to announce the success of the prayer); and again, that Hercules was present at the birth of the infant, and by wrapping it in his lion's skin made it invulnerable, except in the armpit. In respect of being open to a wound in only one small spot Ajax resembles Achilles, with whom in the usual genealogy he claims to be related as cousin. But of this relationship there is no evidence in the *Iliad*, where Ajax appears of colossal frame (πελώριος), in himself a tower of strength (πύργος Ἀχαιῶν), and, as the simile implies, prepared for defence, not to lead assaults, unmoved by the shafts of enemies as is an ass in a corn-field by the pelting of boys (*Iliad*, xi. 556–566), while Achilles is no less clearly drawn as sensitive to finer passions and tastes, if equally bold in war. Unwarranted as it was by the *Iliad*, the identification of Ajax with the family of Æacus was chiefly a matter which concerned the Athenians, and that not until Salamis had come into their possession, on which occasion Solon inserted a line in the *Iliad* (ii. 557) for the purpose of supporting the Athenian claim to the island. Ajax then became an Attic hero, his name being given to one of the tribes. In this way his deeds came to be a favourite subject of the Attic drama, though they are not always represented in a creditable manner—as, for example, when, contrary to his steady character in the *Iliad* of being respectful to the gods, he is charged with insult to Athena, to account for her having influenced the decision against him in his competition with Ulysses for the armour of Achilles. It was Athena, also, who made him insane then, and led him to take his own life. From his blood

sprang a flower, as at the death of Hyacinthus, which bore the initial letter of his name. In later times the people of Novum Ilium believed him to have been wronged by the decision, and told how, when Ulysses had been shipwrecked, the armour of Achilles was wafted by the tide upon the shore near the tomb of Ajax. (A. S. M.)

AJAX OILEUS, or the LESSER AJAX, was a son of the King of Locri, whose subjects he led before Troy, contributing a contingent of forty ships. In boldness he was in the first rank among the Greeks there, equal to make a stand against Hector, and swift of foot next to Achilles. But, compared with the other leaders, he is impatient and overbearing. Like the Telamonian Ajax, he appears as an enemy of Ulysses, and as the victim of Athena's vengeance. It was due to her influence that he, known for his speed, lost the race with Ulysses at the games in honour of Patroclus (*Iliad*, xxiii. 754–784); and again it was through her that on his return homeward his ship was wrecked upon the mythical Gyræan rock (*Odyssey*, iv. 499). As it stands in later story, he had drawn down Athena's anger by his assault upon Cassandra at the image of the goddess. Ulysses charged him with this offence, and demanded that he should be stoned. But, according to another version of the legend, he had only carried her off to his tent without any harm, when Agamemnon took her from him, and spread a report that Athena would destroy the whole army unless Ajax were slain; upon which, thinking of the unjust verdict given against his namesake, he went to sea in a frail vessel and perished. The news was received in the camp with grief, a funeral pile was erected on the ship which had conveyed him to Troy, sacrifice was offered, and when the evening wind came on, the burning ship was cut adrift. (A. S. M.)

AJEHO, or A-SHE-HOH, also called ALCHUKU, a considerable and rapidly increasing city of Manchuria, 30 miles south of the river Soongari, and about 120 north of Kirin. It is advantageously situated on the slopes of a gentle descent leading to the river. The country around is very fertile, producing in abundance various kinds of grain, besides pulse and opium. The population of the district consists entirely of Chinese immigrants, who are engaged in the reclamation and cultivation of the soil, which is given to them at a nominal price. A large trade is done in the town; and although the shops are of mean appearance, quantities of porcelain and other ornamental articles exposed for sale indicate its growing wealth. The population is about 40,000, and includes a considerable number of Mahometans.

AJMÍR, a district and town of British India, in Rájputáná. The DISTRICT lies between 25° 43′ and 26° 42′ N. lat., and 74° 22′ and 75° 33′ E. long., measuring 80 miles in length from north to south, by 50 miles in breadth, and comprising an area of 2057 square miles. It is bounded on the E. by the states of Krishnagar and Jaipur, on the S. by Mewár, on the W. by the British district of Mairwárá, and on the N.W. by the state of Jodhpur. The population in 1865 was returned at 426,268; of whom 363,539, or 85 per cent., were Hindus, and the remainder chiefly Mahometans. The eastern portion of the district is generally flat, broken only by gentle undulations, but the north and north-western parts are intersected by the great ARAVALLI range (*q.v.*) Many of the valleys in this region are mere sandy deserts, with an occasional oasis of cultivation, but there are also some very fertile tracts; among these is the plain on which lies the town of Ajmír. This valley, however, is not only fortunate in possessing a noble artificial lake, but is protected by the massive walls of the Nág-páthar range or Serpent rock, which forms a barrier against the sand. The only hills in the district are the Aravalli range and its offshoots. Ajmír is almost totally devoid of rivers, the Banás being the only stream which can be dignified with that name, and it only touches the south-eastern boundary of the district so as to irrigate the Parganá of Samur. Four small streams—the Ságar-matí, Saraswatí, Kharí, and Daí—also intersect the district. In the dry weather they are little more than brooks. The Ságar-matí and Saraswatí unite at Gobindgarh, the united waters flowing on under the name of the Luní (or salt water) river. There are two first-class roads in Ajmír, viz., one from Ajmír city to Gangwana, and thence through the Krishnagarh and Jaipur states to Agra; and another from the city to the cantonment station of Nasírábád, a distance of 14 miles. There is also a second-class road from Ajmír to Nayá Nagar, a distance of 36 miles, besides sixteen third-class tracks connecting the principal towns and villages with the city. The principal products of the district are wheat, barley, rice, sugar-cane, peas, bajrá, maize, til (oil-seed), tobacco, and cotton. With the exception of woollen blankets, turbans, &c., manufactures can be scarcely said to exist in Ajmír. Salt is made in a rude method at Rámsur, from the saline exudations of the soil, to the extent of 3000 cwt. per annum. After supplying local wants, the surplus is exported towards Málwa and Ságar. The principal trade is in wool, cotton, opium, printed cloths, and tobacco. A large quantity of cotton is exported to Nayá Nagar, in Mairwárá district, whence it finds its way into the Bombay market. Oil is also a profitable article of trade. The domestic animals are sheep, horses, bullocks, camels, and goats. Cattle, and especially bullocks, are much valued, but are very scarce, owing partly to the want of sufficient pasturage and partly to frequent droughts. When these occur, the cattle are sent away to the neighbouring states, where better pasture can be procured, and very few find their way back. The imperial revenue obtained from the district in 1867 amounted to £61,791, 8s., exclusive of local funds raised by a road, tank, and postal cess.

The tenures of the agricultural village communities in Ajmír are of a very simple and uniform kind. They all belong to the type known as "imperfect patídárí," by which the better descriptions of land are held in severalty by each member of the proprietary body. Each member is responsible for the amount of revenue allotted on his holding; but in event of the default of any shareholder, the whole community is collectively liable for the total sum. The inferior and waste lands remain the property of the whole village, and the income derived from them is credited to the common account. The cultivators are nearly all proprietors of the land they till. A large portion of Ajmír district is parcelled out into estates, varying in size from a single village to a large *parganá* (or fiscal division). These estates are held by Rájput chiefs, some of whom descend from the original ruling families, while others owe their position to force or to the favour of the reigning power. They have all been confirmed in their estates by the British on payment of a fixed annual quit rent. Three towns are returned as containing a population of upwards of 5000 inhabitants in 1867—viz., Ajmír city (the capital and the only municipality in the district), population 34,763; Kekrí, 6357; and Pisangun, 5055. There is also a military cantonment at Nasírábád, the garrison of which in 1867 consisted of a battery of European artillery, a European infantry regiment, a squadron of native cavalry, and a regiment of native infantry. In 1867 there were eighteen government schools in the district, attended by 647 pupils, and a government college at Ajmír city attended by 320 students. Besides these there were three mission schools for boys and one for girls in Ajmír city, and eight others in its neighbourhood. The average attendance at the mission schools amounted to 347.

AJMÍR CITY, the capital of Ajmír district, is situated in a picturesque and fertile valley surrounded by mountains, in 26° 29′ N. lat. and 74° 43′ E. long. The town is partly built on the lower slope of the Táragarh hill, and is surrounded by a stone wall with five handsome gates. To the north of the city is a large artificial lake called the Anaságar, whence the water supply of the place is derived. The town is clean, and possesses several handsome streets, the dwellings of the better classes being large and well built. The population in 1867 numbered 34,763, about

two-thirds being Hindus, and the remainder Mahometans. The city trade chiefly consists of salt and opium. The former is imported in large quantities from the Sambar lake and Rámsur. Oilmaking is also a profitable branch of trade. Cotton cloths are manufactured to some extent, for the dyeing of which the city has attained a high reputation. A municipal income of about £2000 a-year is derived from octroi duties levied on articles consumed in the town. Out of this the police and conservancy arrangements are paid, the balance being spent on roads and in the support of charitable institutions. The Ajmír college, affiliated to the Calcutta university, had 320 pupils in 1867. The college buildings being inadequate to this number of pupils, the foundation-stone of a new structure was laid on the 17th February 1868. The agent to the governor-general for Rájputáná resides at Ajmír, which is also the headquarters of the commissioner of the Ajmír and Mairwárá division. It is likewise a station of a Scotch Presbyterian mission.

The chief object of interest is the *dargá*, or tomb of a famous Mahometan saint named Mayud-ud-dín. It is situated at the foot of the Táragarh mountain, and consists of a block of white marble buildings, without much pretension to architectural beauty. To this place the emperor Akbar, with his empress, performed a pilgrimage on foot from Agra, in accordance with the terms of a vow he had made when praying for a son. The large pillars erected at intervals of two miles the whole way, to mark the daily halting-place of the imperial pilgrim, are still extant. An ancient Jain temple, now converted into a Mahometan mosque, is situated on the lower slope of the Táragarh hill. With the exception of that part used as a mosque, nearly the whole of the ancient temple has fallen into ruins, but the relics are not excelled in beauty of architecture and sculpture by any remains of Hindu art. Forty columns support the roof, but no two are alike, and great fertility of invention is manifested in the execution of the ornaments. The summit of Táragarh mountain, overhanging Ajmír, is crowned by a fort, the lofty thick battlements of which run along its brow and enclose the table-land. The walls are 2 miles in circumference, and the fort can only be approached by steep and very roughly-paved planes, commanded by the fort and the outworks, and by the hill to the west. On coming into the hands of the English, the fort was dismantled by order of Lord William Bentinck, and is now converted into a sanitarium for the troops at Nasírábád. Ajmír was founded about the year 145 A.D. by Ají, a Chohán, who established the dynasty which continued to rule the country (with many vicissitudes of fortune) while the repeated waves of Mahometan invasion swept over India, until it eventually became an appanage of the crown of Dehli in 1193. Its internal government, however, was handed over to its ancient rulers upon the payment of a heavy tribute to the conquerors. It then remained feudatory to Dehli till 1365, when it was captured by the ruler of Mewár. In 1509 the place became a source of contention between the chiefs of Mewár and Márwár, and was ultimately conquered in 1532 by the latter prince, who in his turn in 1559 had to give way before the emperor Akbar. It continued in the hands of the Mughuls, with occasional revolts, till 1770, when it was ceded to the Marhattás, from which time up to 1818 the unhappy district was the scene of a continual struggle, being seized at different times by the Mewár and Márwár rájás, from whom it was as often retaken by the Marhattás. In 1818 the latter ceded it to the British in return for a payment of 50,000 rupees. Since then the country has enjoyed unbroken peace and a stable government.

AJURUOCA, a town of Brazil, in the province of Minas Geraes, 117 miles N. of Rio de Janeiro. It is situated on the Ajuruoca river, which is here crossed by a bridge. Gold was once found in the vicinity, but the soil has been long exhausted of the precious metals; and the people are chiefly engaged in agriculture, and in rearing animals for the markets of Rio. The land is fertile, and produces millet, mandioca, coffee, sugar-cane, and tobacco. The population of the town and district is 12,000.

AKABAH, THE GULF OF, the *Sinus Elanites* of antiquity, is the eastmost of the two divisions into which the Red Sea bifurcates near its northern extremity. It penetrates into Arabia Petræa in a N.N.E. direction, from 28° to 29° 32′ N. lat., a distance of 100 miles, and its breadth varies from 12 to 17 miles. The entrance is contracted by Tiran and other islands, so that the passage is rendered somewhat difficult; and its navigation is dangerous on account of the numerous coral reefs, and the sudden squalls which sweep down from the adjacent mountains, many of which rise perpendicularly to a height of 2000 feet. The only well-sheltered harbour is that called the Golden Port, situated on its western shore about 33 miles from the entrance, and 29 miles E. of Mount Sinai. About 2½ miles from the head of the gulf is the village of AKABAH, with a fortified castle, garrisoned by a few soldiers for the protection of the Moslem pilgrims on their way to Mecca. In the vicinity of the village there are extensive date groves; and there is abundance of good water, fruit, and vegetables. Akabah, though now of small importance, is not devoid of historical interest. It is supposed to occupy the site of the *Elath* of Scripture, which in remote ages carried on an extensive commerce; and some ruins in the sea a short distance southward are surmised to be the remains of *Eziongeber*.

AKBAR, AKHBAR, or AKBER, JELLALADIN MOHAMMED, one of the greatest and wisest of the Moghul emperors, was born at Amerkote in Sindh on the 14th October 1542, his father, Humayun, having been driven from the throne a short time before by the usurper Sher Khan. After more than twelve years' exile, Humayun regained his sovereignty, which, however, he had held only for a few months when he died. Akbar succeeded his father in 1556 under the regency of Bahram Khan, a Turkoman noble, whose energy in repelling pretenders to the throne, and severity in maintaining the discipline of the army, tended greatly to the consolidation of the newly-recovered empire. Bahram, however, was naturally despotic and cruel; and when order was somewhat restored, Akbar found it necessary to take the reins of government into his own hands, which he did by a proclamation issued in March 1560. The discarded regent lived for some time in rebellion, endeavouring to establish an independent principality in Malwah, but at last he was forced to cast himself on Akbar's mercy. The emperor not only freely pardoned him, but magnanimously offered him the choice of a high place in the army or a suitable escort for a pilgrimage to Mecca, and Bahram preferred the latter alternative. When Akbar ascended the throne, only a small portion of what had formerly been comprised within the Moghul empire owned his authority, and he devoted himself with great determination and marvellous success to the recovery of the revolted provinces. Over each of these, as it was restored, he placed a governor, whom he superintended with great vigilance and wisdom. He tried by every means to develop and encourage commerce; he had the land accurately measured for the purpose of rightly adjusting taxation; he gave the strictest instructions to prevent extortion on the part of the tax-gatherers, and in many other respects displayed an enlightened and equitable policy. Thus it happened that, in the fortieth year of Akbar's reign the empire had more than regained all that it had lost, the recovered provinces being reduced, not to subjection only as before, but to a great degree of peace, order, and contentment. Akbar's method of dealing with what must always be the chief difficulty of one who has to rule widely diverse races, affords perhaps the crowning evidence of his wisdom and moderation. In religion he was at first a Mussulman, but the intolerant exclusiveness of that creed was quite foreign to his character. Scepticism as to the divine origin of the Koran led him to seek the true religion in an eclectic system. He accordingly set himself to obtain information about other religions, sent to Goa, requesting that the Portuguese missionaries there would visit him, and listened to them with intelligent attention when they came. As the result of these inquiries, he adopted the creed of pure deism and a ritual based upon the system of Zoroaster. The religion thus founded,

however, having no vital force, never spread beyond the limits of the court, and died with Akbar himself. But though his eclectic system failed, the spirit of toleration which originated it produced in other ways many important results; and, indeed, may be said to have done more to establish Akbar's power on a secure basis than all his economic and social reforms. He conciliated the Hindoos by giving them freedom of worship; while at the same time he strictly prohibited certain barbarous Brahminical practices, such as trial by ordeal and the burning of widows against their will. He also abolished all taxes upon pilgrims as an interference with the liberty of worship, and the capitation tax upon Hindoos, probably upon similar grounds. Measures like these gained for him during his lifetime the title of "Guardian of Mankind," and caused him to be held up as a model to Indian princes of later times, who in the matter of religious toleration have only too seldom followed his example. Akbar was a munificent patron of literature. He established schools throughout his empire for the education of Hindoos as well as Moslems, and he gathered round him many men of literary talent, among whom may be mentioned the brothers Feizi and Abulfazl. The former was commissioned by Akbar to translate a number of Sanscrit scientific works into Persian; and the latter (see ABULFAZL) has left, in the *Akbar-Nameh*, an enduring record of the emperor's reign. It is also said that Akbar employed Jerome Xavier, a Jesuit missionary, to translate the four Gospels into Persian. The closing years of Akbar's reign were rendered very unhappy by the misconduct of his sons. Two of them died in youth, the victims of intemperance; and the third, Selim, afterwards the emperor Jehanghir, was frequently in rebellion against his father. These calamities were keenly felt by Akbar, and may even have tended to hasten his death, which occurred at Agra on the 13th October 1605. His body was deposited in a magnificent mausoleum at Sicandra, near Agra.

AKEN, or ACKEN, a town in Prussian Saxony, situated on the Elbe, 25 miles E.S.E. of Magdeburg, close to the frontiers of Anhalt. It has manufactures of cloth, leather, chemicals, and optical instruments; large quantities of beetroot sugar are produced in the neighbourhood; and there is a considerable transit trade on the Elbe. Population (1871), 5273.

AKENSIDE, MARK. Like young Henry Kirke White, the poet of the *Pleasures of Imagination* was the son of a butcher. He was born at Newcastle-on-Tyne on November 9th, 1721. His school was the free one founded by a former mayor of Newcastle, Thomas Horsley. Later, one of the ministers of the Presbyterians added to his school-acquired knowledge in private. In his sixteenth year he sent to the *Gentleman's Magazine* a copy of verses entitled "The Virtuoso." Sylvanus Urban graciously printed the poem; but the old man was not difficult to please. Other verse contributions succeeded—imitative, yet not without gleams of a true faculty. Some written in the Lake country, while on visits with friends at Morpeth, have Wordsworthian touches. The memories of these visits transfigure the *Pleasures of Imagination*. In his nineteenth year, being intended for the clerical profession, he proceeded to the university of Edinburgh; but within one session, like many others, he changed his purpose, and transferred his name from the theological to the medical classes—although, indeed, then, as still, the opening years were occupied with the same studies for either. On his change he honourably returned certain moneys which his fellow Presbyterians had advanced towards his theological education. He attended the university for only two years. While there, in 1740, a medical society, which combined with it a debating club, gave him a fine field for the exercise of his oratorical powers. Dugald Stewart states that Robertson the historian, then a student of divinity, used to attend the meetings in order to hear Akenside's speeches. Some of his minor poems belong to this period, such as his Ode "for the Winter Solstice," the elegy called "Love," and the verses "to Cordelia." He returned to his native town in 1741, and then his friendship with Jeremiah Dyson had commenced, "a name never to be mentioned by any lover of genius or noble deeds without affection and reverence" (Willmott). In the years 1741 to 1743 he must have been ardent in his wooing of the Muses. In the summer or autumn of 1743 Dodsley carried with him to Pope at Twickenham a MS. for which the writer asked £120. The oracle of Twickenham having read the poem, counselled the publisher to make no niggardly offer, because "this was no every-day writer." It was something for Pope to be thus prescient in the absence of rhyme—albeit Pope's insertions in *The Seasons* remain to attest that, supreme artist as he was in rhyme, he could also manage blank verse with exquisite cunningness. The MS. was the *Pleasures of Imagination*, which Dodsley published in 1744. In his twenty-third year the author, like Byron, awoke to find himself famous. The assaults of Warburton and Hurd were scarcely a deduction from the universal welcome. The poet's "Epistle" to Warburton was effective. He went to Leyden, and there pursued his medical studies with ardour. He obtained the degree of M.D., May 16th, 1744; his inaugural dissertation describing the formation and growth of the human fœtus with original observation and acuteness. He now returned to England, advancing more and more in his friendship with the good and large-hearted Dyson. He chose Northampton as the place wherein he should commence practice. It was an unfortunate selection, as Sir James Stonehouse "possessed the confidence of the town," and it was deemed an intrusion. A not very creditable controversy arose; and we are at a loss whether most to admire the stinging rebuffs in honeyed courtesies or the mutual pretence of ultimate satisfaction and good-will. At Northampton Akenside was on friendly terms with Dr Doddridge. There, too, he wrote his "Epistle to Curio," which Lord Macaulay pronounced his best production, as "indicating powers of elevated satire, which, if diligently cultivated, might have disputed the pre-eminence of Dryden." Willmott traces some of the most nervous lines of the *Pleasures of Hope* to this "Epistle to Curio." Not succeeding in his profession at Northampton, he removed to Hampstead in 1747. The *Odes* had then been published. Dr Akenside came to Hampstead under the ægis of the generous Dyson. Somehow, in Hampstead as at Northampton, he manifested a vanity of self-display and hauteur of manner that made him many enemies. Within three years he had to leave Hampstead for London. He set up in Bloomsbury Square in a "fine house," and with an annuity of £300 from the still ungrudging Dyson. One is pleased to come on these words of a far greater poet a century later, "I am not unfrequently," wrote Wordsworth in 1837, "a visitor on Hampstead Heath, and I seldom pass by the entrance of Mr Dyson's villa at Goulder's Hill, close by, without thinking of the pleasure which Akenside often had there." The generous clerk of the House of Commons and secretary of the Treasury nobly earned his imperishable place in the (revised) *Pleasures of Imagination*. Contemporaneous with his professional duties, the poet became an essayist and reviewer for Dodsley in the now forgotten *Museum*. In 1753 the university of Cambridge bestowed on him the degree of doctor of medicine. In 1754 he was elected a fellow of the College of Physicians. In 1755 he read before the college the Gulstonian Lectures; and in 1756 the Croonian Lectures. In 1759 he was chosen assistant, and two months later chief,

physician of St Thomas's Hospital. In this year he had removed to Craven Street. In 1762 he changed once more to Burlington Street. In 1760 was published the *Harveian Oration* by order of the College of Physicians. In 1761, along with Dyson, he passed from a somewhat noisy Whiggery to the Tories, which added "renegade" to his name. In 1765–6 he was working upon the revised and enlarged copy of the *Pleasures of Imagination*. His fame was widening professionally and poetically, when a putrid fever carried him off suddenly on June 23d, 1770. He was buried at St James's Church on the 28th. As a man, the nearer one gets to Akenside the less is there lovable about him; there seem to have been ineradicable meannesses in his nature. Lavish in his expenditure while practically dependent on Dyson, and remaining dependent after his professional income ought to have released his patron, we cannot think of him as high-minded. His personal vanity was constantly bringing him sorenesses. The "Doctor" in *Peregrine Pickle* was painted from the life, not a mere creation of Smollett's genius. As a poet, the place of Akenside is secure, but it is not very lofty. His imagination is rhetorical rather than subtle, consisting more of pomp of words than greatness of thought. His chief defect is lack of emotion, and especially pathos. The enlarged *Pleasures of Imagination*, notwithstanding some noble additions, was a blunder. Some of his minor pieces have a classical grace and charm of expression. (See the original editions of his writings; Bucke's *Life, Writings, and Genius of Akenside*, 1832; Dyce and Willmott's edition of his *Poems;* Cunningham's Johnson's *Lives of the Poets*, s.v.; *Biog. Brit.; Medical Biog.*, s.v.) (A. B. G.)

AKERBLAD, JAN DAVID (1760–1819), a learned Swede, distinguished for his researches in Runic, Coptic, Phœnician, and ancient Egyptian literature. He entered the diplomatic service as secretary to the Swedish embassy at Constantinople, and utilised the leisure which the situation afforded by visiting Jerusalem (1792) and the Troad (1797). After an interval spent at Göttingen, he was appointed ambassador to Paris. His last years were passed at Rome, where he enjoyed a pension from the Duchess of Devonshire. Akerblad was a diligent student of hieroglyphics; and though he failed to decipher the Rosetta stone, he arrived at certain conjectural conclusions with regard to the true method of interpretation, which were afterwards confirmed by Dr Young. His works include letters on the Coptish cursive writing and on the Rosetta inscription, both addressed to M. de Sacy; and a number of pamphlets on the interpretation of various Runic and Phœnician inscriptions.

AKERMAN (perhaps the ancient *Tyras* or *Julia Alba*), a town of Russia in Europe, in the province of Bessarabia, on a tongue of land projecting into the estuary of the Dniester. Its harbour is too shallow to admit vessels of large size; but the trade of the town is, notwithstanding, very considerable. Large quantities of salt are obtained from the saline lakes in the neighbourhood; and corn, wine, wool, and leather are among the other exports. The town, which is ill-built, contains several mosques and Greek and Armenian churches; it is guarded by ramparts, and is commanded by a citadel placed on an eminence. Akerman derives some historical celebrity from the treaty concluded there in 1826 between Russia and the Porte, securing considerable advantages to the former. It was the non-observance of this treaty by Turkey that led to the war of 1828. Population (1867), 29,609.

AKERMAN, JOHN YONGE, an antiquarian, distinguished chiefly in the department of numismatics, was born in Wiltshire on the 12th June 1806. He became early known in connection with his favourite study, having initiated the *Numismatic Journal* in 1836. In the following year he became the secretary of the newly-established Numismatic Society. In 1848 he was elected secretary to the Society of Antiquaries, an office which he was compelled to resign in 1860 on account of failing health. He died on 18th November 1873. Akerman published a considerable number of works on his special subject, the more important being a *Catalogue of Roman Coins* (1839); a *Numismatic Manual* (1840); *Roman Coins relating to Britain* (1844), for which he received the medal of the French Institute; *Ancient Coins—Hispania, Gallia, Britannia* (1846); and *Numismatic Illustrations of the New Testament* (1846). He wrote also a *Glossary of Words used in Wiltshire* (1842); *Wiltshire Tales, illustrative of the Dialect* (1853); and *Remains of Pagan Saxondom* (1855).

AKHALZIKH, a city of Georgia, in Asiatic Russia, on an affluent of the Kur, 110 miles west of Tiflis, in 41° 40′ N. lat., 43° 1′ E. long. It contains a strong castle, a college and library, and a fine mosque, and has a considerable trade in silk, honey, and wax. Population (1867), 15,977.

AKHISSAR, the ancient *Thyatira*, a town of Turkey in Asia, in Anatolia, 58 miles N.E. of Smyrna. The inhabitants are Greeks, Armenians, and Turks. The houses are built of earth or turf dried in the sun, and are very low and ill-constructed; but there are six or seven mosques, which are all of marble. Remarkable inscriptions are to be seen in several parts of the town on portions of the ruins of the ancient city. Cotton of excellent quality is grown in the neighbourhood, and the place is celebrated for its scarlet dyes. Population, about 6000.

AKHTYRKA, a town of Russia in Europe, in the Ukraine, situated on a river of the same name, 45 miles N.W. of Kharkov. It has eight churches, one of which, containing an image of the Virgin, is held in great veneration. The town is enclosed by ditches; and the environs are fertile, the orchards producing excellent fruit. There are some manufactures of light woollen stuffs, and a great market is held annually in May. Population (1867), 17,411.

AKIBA, BEN JOSEPH, a famous rabbi who flourished about the close of the first and the beginning of the second centuries. It is almost impossible to separate the true from the false in the numerous traditions respecting his life. He became the chief teacher in the rabbinical school of Jaffa, where, it is said, he had 24,000 scholars. Whatever their number, it seems certain that among them was the celebrated Rabbi Meir, and that through him and others Akiba exerted a great influence on the development of the doctrines embodied in the Talmud. He sided with Barchochebas in his revolt, recognised him as the Messiah, and acted as his sword-bearer. Being taken prisoner by the Romans under Julius Severus, he was flayed alive with circumstances of great cruelty, and met his fate, according to tradition, with marvellous steadfastness and composure. He is said to have been a hundred and twenty years old at the time of his death. The Jews were long accustomed to pay visits to his tomb, and he is one of the ten Jewish martyrs whose names occur in a penitential prayer still used once a year in the synagogue service. A number of works commonly attributed to Akiba are of later origin; but the one entitled מִשְׁנַח דְּרַבִּי עֲקִיבָא (*Doctrine of Rabbi Akiba*) is probably genuine.

AKOLÁ, a district and city of British India, in the commissionership of West Berar, within the Haidarábád assigned districts. AKOLÁ DISTRICT lies between 20° 23′ and 21° 10′ N. lat., and between 76° 25′ and 77° 19′ E. long.; its greatest length from N. to S. being 72 miles, and its greatest breadth from E. to W. 63 miles. It is bounded on the N. by the Sátpurá range; on the E. by Elichpur district; on the S. by the Sátmál and Ajantá hills; and on the W. by the Buldáná and Khandesh districts. The total area of the district in 1869 was 2697¾ square miles,

or 1,726,625 acres, of which 1,326,583 acres, or 2072·78 square miles were under cultivation; 127,003 acres, or 198·45 square miles, cultivable but not actually under tillage; 41,198 acres, or 64·37 square miles, alienated land held rent free; the remaining 231,842 acres, or 362·25 square miles, consisting chiefly of unarable land, but including river-beds, tanks, village sites, pasturage land, or land occupied for public uses, &c. The population of the district in 1869 numbered 487,558—viz., Hindus, 433,238; Mahometans, 39,030; aborigines, 15,157; Christians, 78; Pársís, 45; Jews, 10. The district is square in shape and almost of a dead level, with the exception of two conical-shaped hills which stand out quite apart from any other eminences, and rise straight up from the plain. The principal river of Akolá, which, although not navigable, represents the main line of drainage, and into which the other streams discharge themselves, is the Púrná, flowing east and west. The principal tributaries on its south bank are the Kátá Púrná, Murná, Núm, and Bordí; and on its north bank, the Sháhnúr, Idrúpá, and Wún. None of these streams are navigable, and some of them almost dry up after the rainy season.

The extension line of the Great Indian Peninsular Railway from Bhosáwal to Nágpur intersects the district, with stations at Jalam Shegáon, Páras, Akolá, and Borgáon. Of eight main roads, three have been metalled. The first runs from Akolá to Akot, a rising cotton mart, and is 28 miles in length, running north-north-east. It is metalled, and all the smaller water-courses are bridged. The Púrná and Sháhnúr rivers, however, cross the line, and are not bridged, a circumstance which impairs the usefulness of the road during the rainy season. The second road is known as the Básim road, and runs for 24 miles southwards through the district. The third road is 12 miles long, from Khámgáon to Nándurá railway station, and is metalled throughout. The other five lines of road are neither bridged nor metalled, but only marked out and levelled. The district imports piece goods from Bombay, and food grains from the adjoining districts. Its principal exports are cotton to Bombay, clarified butter, dyes (indigo and kusambá), and cattle. Internal trade is chiefly carried on at weekly markets and by annual fairs. The principal manufacture of the district is the weaving of cotton. Carpets and coarse cloths are woven in almost every village, with turbans at Bálápur, and silk cloths for native women at Akolá and in the larger towns. The principal agricultural products are as follows:—The wet weather or kharíf crop consists of joár (eighteen varieties); bajrá (two kinds); cotton (two kinds); túr, urid, and mug (three kinds of pulse); rice and kulkar (a smaller variety of rice); Indian corn; rálá; ganjá; ajwán; indigo; and til (oil-seeds of two kinds). The cold weather or rabí crop consists of—wheat (three kinds); gram; linseed; lakh (a pulse); peas; musuri; tobacco; and mustard. The principal articles of garden produce are the following:—Sugar-cane (two kinds); Indian corn (two kinds); ground nuts; onions; garlic; coriander; pán leaves; chillies; opium; sweet potatoes; grapes; plantains; saffron; and numerous kinds of vegetables. A tenure peculiar to Akolá is that known as *metkari* holdings. These consist of certain strips of land extending along the whole breadth of the district at the foot of the frontier range. They are now of considerable value, and were originally held as payment for the maintenance of a chain of outposts or watch-towers on elevated points in the ridge, with a view to giving warning of the approach of the Bhil or Gond banditti, and warding off their attacks. Seven towns are returned as containing a population exceeding 5000—viz., Akolá (the capital of the district), population 12,236; Akot, one of the principal cotton marts of Berar, and also celebrated for its cotton manufacture, 14,006; Khámgáon, now the largest cotton mart in the province, but which has only sprung into importance within recent times, 9432; Bálápur, one of the chief military stations in the Berars during the Mahometan rule, 12,631; Jalgáon, an important cotton market, 8763; Patur, 6011; Shegáon, a station on the Great Indian Peninsular Railway, and a cotton market, 7450. In 1869 there were 1 higher class, 10 middle class, and 63 lower schools for boys in Akolá district; besides 7 female schools and 1 normal school for training Hindustání and Marhatí masters, making a total of 82 schools in all. For the protection of person and property there were in 1869 13 police stations and 12 outposts, with a regular police force of 536 officers and men, equal to one man to every five miles of the district area, or one man to every 909 of the population.

Akolá Town, the headquarters of the district of the same name, and also of the west Berar division of the Haidarábád assigned territory, is situated on the Nágpur extension of the Great Indian Peninsular Railway, in 20° 6′ N. lat., and 76° 2′ E. long. The town contains three or four wealthy merchants; and two markets are held each week—one on Sundays, the other on Wednesdays. The commissioner's and deputy-commissioner's court-houses, the central jail (capable of holding 500 prisoners), the post-office, and barracks or rest-houses for European troops, close to the station, are the principal public buildings. Besides these, there are a civil hospital, a charitable dispensary, an English high school, a town-hall, and an English church. A detachment of infantry is stationed at the town. Population in 1869, 12,236.

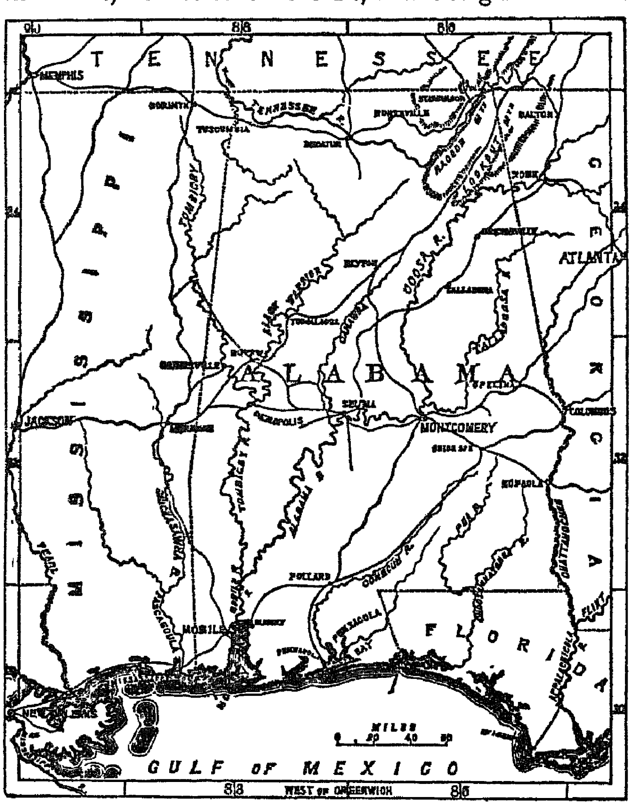
AKRON, a town of the United States, capital of Summit county, Ohio, situated on the Atlantic and Great Western Railway, and on the Ohio and Erie Canal, at its junction with the Pennsylvania and Ohio Canal, 36 miles S. of Cleveland. By means of the canal and the Little Cuyahoga river the town is amply supplied with water-power, which is employed in a variety of manufactures; and its mercantile business is extensive. It has several flour mills, woollen factories, and manufactories of iron goods. Mineral fire-proof paint, immense beds of which are found in the vicinity, and wheat are important articles of export. Akron was founded in 1825, and was made the capital of the county in 1841. Population in 1870, 10,006.

AK-SU, a town of Chinese Turkestan, is situated in 41° 7′ N. lat., 79° E. long., 250 miles N.E. of Yarkand. It has a flourishing trade, and is resorted to for purposes of commerce by caravans from all parts of Central Asia. There are some cotton manufactures; and the place is celebrated for its richly-ornamented saddlery made from deer-skin. A Chinese garrison is stationed here, and copper and iron are wrought in the neighbourhood by exiled Chinese criminals. The district is well cultivated, and sheep and cattle are extensively reared. The population of the town is about 20,000; that of the town and district 100,000.

AKYAB, a district and city within the Arákán division of British Burmah, and under the jurisdiction of the chief commissioner of that province. The District lies along the north-eastern shores of the Bay of Bengal, between 20° and 21½° N. lat., and 92° 12′ and 94° E. long. It forms the northernmost district of British Burmah, and the largest of the three districts of the Arákán division. It is bounded on the N. by the Chittagong district of Bengal; on the E. by the Sumadoung ranges, which separate it from Independent Burmah; on the S. by the Arákán districts of Rámri and Sandoway; and on the W. by the Bay of Bengal. In 1871 the frontier or hill tracts of the district were placed under a special administration, with a view to the better government of the wild tribes which inhabit them. The present area is returned at 4858 square miles, of which 521 square miles are cultivated, 913 cultivable but not actually under tillage, and 3424 square miles uncultivable and waste. The population of the district in 1872 amounted to 263,152, of whom 192,885 were Buddhists or Jains, 47,349 Mahometans, 8687 Hindus, 13,928 aborigines, and 303 Christians. The central part of the district consists of three fertile valleys, watered by the Myu, Koladyne, and Lemyu. These rivers approach each other at their mouths, and form a vast network of tidal channels, creeks, and islands. Their alluvial valleys yield inexhaustible supplies of rice, which the abundant water carriage brings down to the port of Akyab at a very cheap rate. The four chief towns are Khúmgchú in the extreme north-east of the district; Koladyne in the centre; Arákán, further down the rivers; and Akyab on the coast, where their mouths converge. This district passed into the hands of the British, together with the rest of Arákán division, at the close of the first Burmese war of 1825.

Akyab, Town and Port, situated at the point of convergence of the three large rivers Myu, Koladyne, and Lemyu, 20° 9′ N. lat., and 92° 56′ E. long., is the chief town of the district of the same name, and the most flourishing city of the Arákán division. The town is regularly built, with broad streets running at right angles to each other. The port is commodious, is the seat of a large export trade in rice, and possesses steam communication direct with Calcutta once a fortnight, except during the south-west monsoon. The population in 1871–72 numbered 15,281. Akyab monopolises almost the whole sea-borne trade of the province of Arákán, amounting in 1871–72 to £1,345,417; to which the export of rice contributed £105,894. During 1871–72, 256 vessels, of a total burden of 129,061 tons, entered the port; and 262 vessels, of a burden of 130,203 tons, cleared.

Plate IXA. ALABAMA, one of the Southern States of the North American Union, lies between 30° 13′ and 35° N. lat., and between 85° and 88° 35′ W. long. It is bounded by Florida and the Gulf of Mexico on the S., Mississippi on the W., Tennessee on the N., and Georgia on the E.

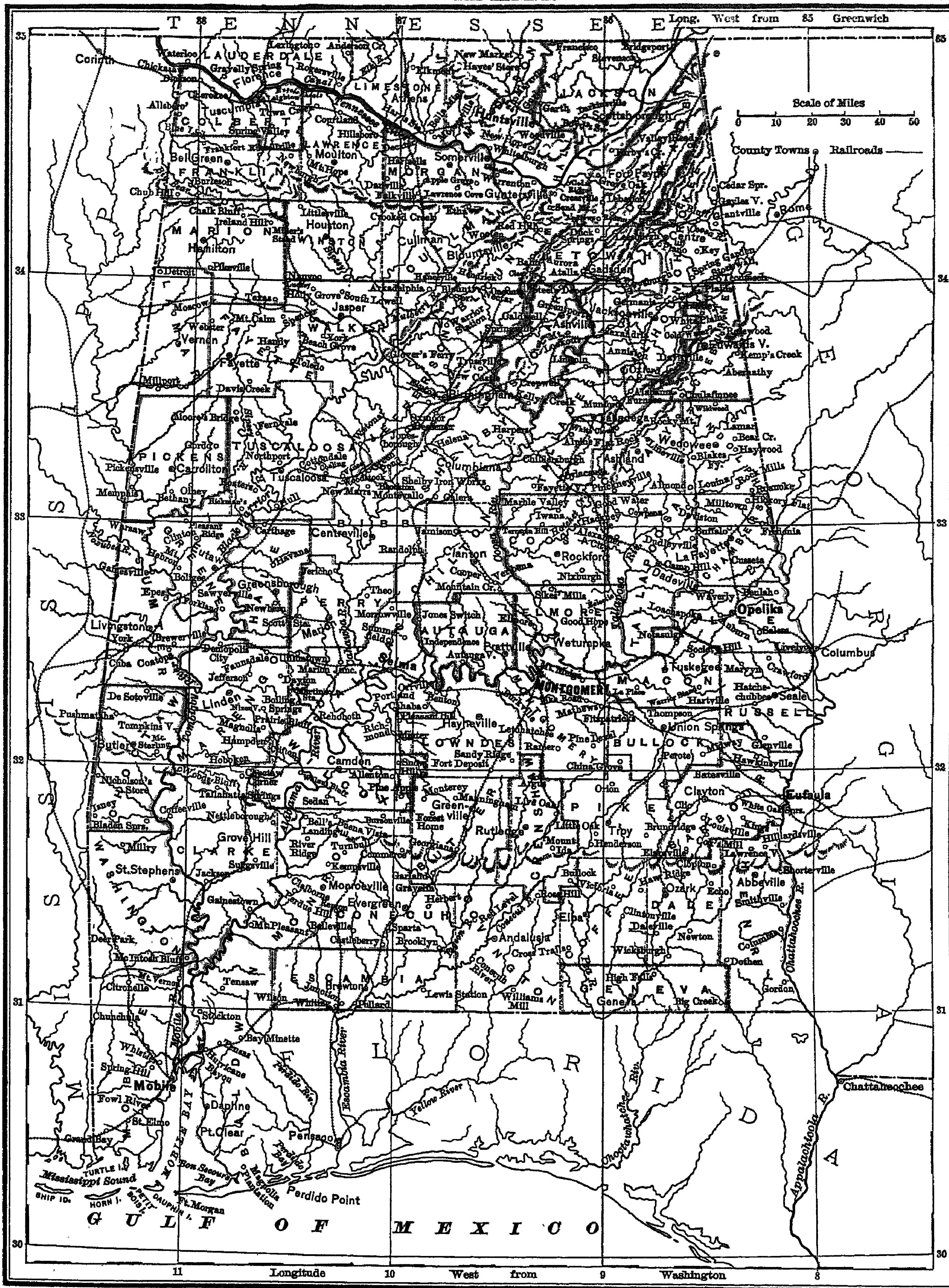


Its length is 330 miles, average breadth 154, and area 50,722 square miles. The Alleghany range stretches into the northern portion of the state, but the elevation is nowhere great; the centre is also hilly and broken; on the south, however, for nearly 60 miles inland, the country is very flat, and raised but little above the sea-level. The Alabama is the chief river of the state. It is formed by the junction of the Coosa and the Talapoosa, which unite about 10 miles above the city of Montgomery. Forty-five miles above Mobile the Alabama is joined by the Tombigbee, and from that point is known as the Mobile River. It is navigable from Mobile to Wetumpka, on the Coosa, some 460 miles. The Tombigbee is navigable to Columbus, and the Black Warrior, one of its chief tributaries, to Tuscaloosa. The Tennessee flows through the northern portion of the state, and the Chattahoochee forms part of its eastern boundary. The climate of Alabama is semi-tropical. The temperature ranges from 82° to 18° Fahr. in winter, and in summer from 105° to 60°; the mean temperature for the year being a little over 60°. The average severity of the winter months is considered to have increased—a result due, it is said, mainly to the felling of the forests, which gives more unrestricted scope to the cold north-west winds from the Rocky Mountains. The uplands are healthy, but the inhabitants of the low-lying lands are subject to attacks of intermittent, bilious, and congestive fevers. The stratified rocks of the state belong to the silurian, carboniferous, cretaceous, and tertiary systems. The silurian strata throw up numerous mineral springs along the line of the anticlinal axes, some of which, such as Blount Springs and the St Clair Springs, are much resorted to for their health-giving properties. There are also several noted springs arising from the tertiary beds, such as those of Tallahatta and Bladon. Alabama possesses extensive coal deposits. Mr Tait, the state commissioner for the industrial resources of Alabama, considers that the area of the coal-lands in the state amounts to 5500 square miles, of which 5000 belong to the Warrior, and the remaining 500 to the Cahawba and Coosa fields. Assuming that only one-half of this area can be worked to advantage, Mr Tait further estimates the aggregate possible yield at 52,250,000,000 tons. At present, however, the annual output probably does not exceed 12,000 tons. In regard to iron, the natural wealth of Alabama is also very great. Mr Tait asserts that a ridge of iron, of an average thickness of 15 feet, runs parallel to one of the principal railway lines for a distance of 100 miles; and in other parts of the country there are large deposits of ore, both red hematite and blackband. The ores of Alabama are said to yield from 10 to 20 per cent. more iron than those of Britain. Granite, marble, flagstones, roofing-slate, lime, and porcelain clay, are among the other mineral products. A little gold has also been found in the state.

The soil of Alabama varies greatly in character, but is for the most part productive to a greater or lesser extent, except in the south, where there are considerable tracts of sandy, barren, and almost worthless soil. The forests are mainly in the central and northern parts of the state, and embrace oaks, poplars, cedars, chestnuts, pines, hickories, mulberries, elms, and cypresses. The following table exhibits the chief agricultural statistics of Alabama for 1870, as compared with 1860, the year before the war:—

			1870.	1860.
Land in Farms.	Improved,	acres	5,062,204	6,385,724
	Unimproved,	,,	9,898,974	12,718,821
Live Stock on Farms.	Horses,		80,770	127,063
	Mules and Asses,		76,675	111,687
	Cattle,		487,163	773,396
	Sheep,		241,934	370,156
	Swine,		719,757	1,748,321
Chief Products.	Indian Corn,	bushels	16,977,948	33,226,282
	Wheat,	,,	1,055,068	1,218,444
	Rye,	,,	18,977	72,457
	Oats,	,,	770,866	682,179
	Potatoes,	,,	2,033,872	5,931,563
	Pease and Beans,	,,	156,574	1,482,036
	Butter,	℔	3,213,753	6,028,478
	Cotton,	bales	429,482	989,955
	Wool,	,,	381,253	775,117
	Rice,	℔	222,945	493,465
	Tobacco,	,,	152,742	232,914
	Molasses,	gallons	433,281	140,768

Alabama possesses comparatively few manufactures. It is estimated that in 1870 the capital invested amounted to £1,140,806, and the total products in the same year were valued at £2,608,124. There were in 1870 thirteen establishments for the manufacture of cotton goods, whose products amounted in all to 2,843,000 ℔, including 4,518,403 yards of sheetings and shirtings, and 1,039,321



W.& A.K. Johnston

ENCYCLOPÆDIA BRITANNICA NINTH EDITION

yards of ginghams and checks. In the same year 613 flour mills operated on 3,298,848 bushels of grain. There were 284 lumber mills, producing 1,115,000 laths, 97,192 feet of lumber, and 1,422,000 shingles. In the iron manufactures there has been a marked advance, which is the more noticeable because several other industries have experienced a serious decline. Thus, in 1850 the quantity of ore used for making pig-iron was only 1138 tons, in 1860 it had risen to 3720 tons, and in 1870 to 11,350; the value of the products being respectively £4500, £12,918, and £42,051. Alabama has also manufactories of rolled and cast iron; but the rise in the value of their products is not so marked. There are, besides, tanneries, carriage and waggon works, and machinery factories, in addition to industries of a local nature. Mobile is the chief mercantile city of the state. In the years ending June 30, 1871 and 1872, 688 and 369 vessels (gross burden, 558,525 and 272,853 tons) entered, and 711 and 369 (551,310 and 277,356 tons) cleared the port of Mobile. Cotton was the principal article of export—the amount in 1871 being 287,074 bales, and in 1872, 137,977; of which 240,660 and 123,522 bales went to Great Britain. Mobile is connected with the general network of railways of the United States. A line runs from the city through Montgomery and on to Atlanta in Georgia; another runs from Mobile to Meridian in Mississippi; a line crosses the state from Meridian through Cahawba to Montgomery; a loop-line runs from Montgomery to Troy, and proceeding round by Columbus in Georgia, rejoins the main line at Opelika; from Selma a line proceeds north-easterly, following the valley of the Coosa, and passing through Georgia and Tennessee; and another traverses the valley of the Tennessee, from which a branch strikes off to the north to join the Tennessee group of railways at Nashville. A line also connects Mobile with New Orleans. The part of the line from Mobile to Montgomery between Mobile and Tensas was completed under considerable engineering difficulties. It crosses the Mobile river by a swing drawbridge 1000 feet in length, with a draw of 260 feet; while the Tensas river bridge is built on cylindrical piers, each span measuring 152 feet, and its total length 2084 feet. There are at present 1602 miles of railway and 2135 of telegraph lines in operation in Alabama.

Alabama returns 8 members to Congress. The state government is vested in a governor, Senate, and House of Representatives. The Senate consists of 33 members elected for four years, one half retiring every two years. The House of Representatives consists of not more than 100 members, elected for two years, and apportioned among the counties according to population, each county, however, being entitled to at least one representative. The members of both houses receive 16s. 8d. each per diem, and the governor £520, 16s. 8d. per annum. The taxation in 1870 amounted to $2,982,932, and the public debt to $13,277,154. In 1860 the taxation was only $851,171. The state is divided into 65 counties, and Montgomery is the capital. The other principal towns are Mobile, Tuscaloosa (the former capital), Florence, Huntsville, Selma, and Wetumpka.

Alabama was first penetrated by the Spaniards in quest of gold in 1541, under the celebrated leader De Soto. The natives defended themselves stubbornly, and in their defence inflicted and sustained very severe losses. The present site of Mobile was first occupied by the French in 1711. In 1763 the French possessions east of the Mississippi, including Alabama, were ceded to England. Alabama was originally included in Georgia, but in 1802 became part of the territory of Mississippi. In 1813 the Creek Indians made a desperate effort to check the encroachments of the Anglo-Saxons, but were eventually crushed in the battle of Horse Shoe Bend by General Jackson, who compelled them to surrender three-fourths of their territory. In 1819 Alabama was admitted into the Union as an independent member of the confederation. It seceded in the year 1861, but since the close of the war has been again admitted into the Union.

The census of 1870 showed the following results:—Total population of Alabama, 996,992; coloured, 475,510; with 98 Indians. Of these, 987,030 were native born, and 9962 foreign. In 1860 the population was 964,201, of whom 526,271 were whites and 437,770 (435,080 slaves) were coloured; in 1820 (the year after Alabama had been admitted into the Union) the numbers were—total, 127,901; whites, 85,451; coloured, 42,450 (41,879 slaves). Of the total population in 1870, 488,738 were males (255,023 whites, 233,677 coloured, 38 Indians) and 508,254 females (respectively, 266,361, 241,833, 60). In regard to education, there were in the state between 5 and 18 years of age, 173,273 males (91,989 whites, 81,274 coloured, and 10 Indians) and 169,703 females (89,798, 79,882, and 23); of whom 77,139 have attended school (viz., 31,098 white and 7502 coloured males, and 30,226 white and 8313 coloured females). The returns give 2969 schools, with 2372 male and 992 female teachers. Of persons 10 years and upwards, there were 349,771 returned as unable to read, and 383,012 as unable to write.

ALABASTER (said to be derived from the Arabic *al batstraton*, the whitish stone), a name properly restricted to the fine massive variety of gypsum, or sulphate of lime, which is used in the manufacture of ornamental vases, statuettes, clock-frames, &c. When pure, it is of a brilliant pearly-white lustre, so very soft as to be easily scratched by the nail, and is soluble to a slight extent in water. It occurs in large and very pure masses at several localities in Tuscany, and is turned or chiselled into its various ornamental forms in Florence, which is the centre of the alabaster trade. At a time when the taste for alabaster work was more general than now, it was quarried at Lagny, near Paris. In England considerable deposits are found in various localities, but chiefly in Derbyshire and Staffordshire, where it is worked to form the plaster of Paris moulds used by potters; hence it is termed "potters' stone." Fine blocks found in quarrying the potters' stone are reserved for the alabaster turners. A yellow variety of alabaster, found at Sienna, is termed "alabastra agatato." When it presents a fibrous structure, it is known as "satin spar," which when cut has the opalescent appearance of "cat's eyes." Oriental alabaster is the name applied to the stalagmitic variety of carbonate of lime formed on the floors of limestone caves by the percolation of water, an entirely different material from the above. It is usually clouded or banded in an agate-like manner, and hence is sometimes known as onyx marble. The alabaster yielded by celebrated quarries, known to the ancients and now again worked, in the province of Oran, Algeria, is of this kind. It is this oriental alabaster that is referred to in the Bible, the ἀλαβαστρίτης of the Greeks. The stone was held in very high estimation among the civilised nations of antiquity, being then chiefly procured from quarries in the neighbourhood of Thebes, which to this day remain unexhausted. At the present time it is procured from Oran (Algerian onyx), the Pyrenees, Chili, California, &c. In the Soanean Museum there is an Egyptian sarcophagus in oriental alabaster, covered with hieroglyphics, which was purchased by Sir John Soane for 2000 guineas.

ALABASTER, William, D.D., poet and scholar. If to have been commemorated with golden words by Edmund Spenser in his *Colin Clouts come Home Againe*, ll. 400–415, and by Herrick in his *Hesperides;* and to have been reckoned "foeman worthy of his steel" by Bishop

Bedell; and to have had his portrait painted by Cornelius Jansen, and engraved by Payne; and to have been pronounced by Fuller "a most rare poet as any our age or nation hath produced;" and to have drawn from Samuel Johnson unequivocal eulogium, may be regarded as entitling to a claim on our interest at this later day, Dr William Alabaster unites in himself all these memorable tributes. Alabaster was his own spelling, as it was Bedell's and Fuller's; but it is found contemporaneously "Arblastier." The name is derived from *arcubalista* (in arms of the family, a cross-bow bent in pale), and the same probably as Arblastier. He was born at Hadleigh, Suffolk, about 1567, was educated at Westminster School, and went thence to Trinity College, Cambridge. He was also incorporated at Oxford in 1592. He became fellow of Trinity. Having been appointed chaplain to Robert, Earl of Essex, he attended him in that expedition, designed to aid Henry IV. against the League in 1591, celebrated by Dr Donne in "The Storm" and "The Calm." While in France (in his twenty-fourth year), he was converted to Roman Catholicism, and a quaint English sonnet, "Of his Conversion," survives, wherein he defies the "frowne and scorne and purblind pittie" of the world, as having a vision of perdition if he yielded thereto. He did not long remain a Roman Catholic. In the preface to his work entitled *Ecce Sponsus Venit* (1633), he relates that certain doctrines of his having become obnoxious to the court of Rome, he was enticed to that city and imprisoned there by authority of the Inquisition; and that on his liberation he was confined within the city walls, but escaped at the peril of his life, and returned to England. On his return he became prebendary of St Paul's and rector of Hatfield. Dr Alabaster was famous as a Hebraist; but his studies of Hebrew took a twist in the direction of the cabalistic learning, by which he luxuriated in discussions on the mystical meanings imagined to be hidden in the words of the Old Testament. The investigation and application of this supposed mystical meaning of Scripture was the main object of his *Apparatus in Revelationem Jesu Christi* (Antwerp, 1607); and, indeed, it runs through all his critical writings, as in his singular *Spiraculum Tubarum, sive Fons Spiritualium Expositionem ex equivocis Pentaglotti Significationibus* (n.d., folio), his *Lexicon Pentaglotton* (1637, folio), and the *Commentarius de Bestia Apocalyptica* (1621). It was of these books Herrick wrote as making Alabaster "the one, one onely glory of a million." A MS. of Alabaster's *Elisœis* is among Emanuel College MSS.; a better one, with additional poems, entitled "Inuenta Bellica"—recalling Herbert's "Triumphus Mortis," so headed—and "Inuenta Adespota," is in the Chetham Library, Manchester. The poem is unfinished, but has lines in it which account for Spenser's lofty praise and hopes. It has never been printed. His best known verse is a Latin tragedy called *Roxana*. This is praised by Fuller, stirred Anthony à Wood into enthusiasm, and is regarded by Dr Johnson as the only Latin verse in England worthy to be named previous to Milton. It was prepared for his college (Trinity), and never meant for publication. Having been surreptitiously published in 1632, the author thereupon reprinted it, with this on the title-page, "A plagiariis unguibus vindicata, aucta et agnita." It is a curious composition. The subject is an oriental tale which had previously been dramatised in the *Dalida* of Groto, an Italian. The scenes consist of conversations between real and allegorical personages. The first act is entirely carried on between the ghost of one of the characters and personifications of Death and Suspicion. Hallam charges Alabaster with plagiarism from *Dalida*, but he cannot have really read the two. Alabaster died about 1640. (A. B. G.)

ALACRANES, a group of coral reefs and islands in the Gulf of Mexico, 80 miles off the north coast of Yucatan, and extending 14 miles from north to south, and 11 from east to west. On the 12th February 1847 the mail steamer Tweed was wrecked on the Alacranes; and in January 1849 a similar disaster befell the Forth, belonging to the same company. On the south side, in 22° 23′ 36″ N. lat., and 89° 42′ W. long., there is a secure harbour, well sheltered by dry reefs.

ALAGOAS, a maritime province of Brazil, formerly a district of Pernambuco, is situated between 9° and 10° 30′ S. lat., and extends inland 150 miles. It is bounded on the N. and W. by Pernambuco, and is separated by the river San Francisco from the province of Sergipe on the S. It embraces an area of 12,000 square miles. The country, particularly in the north-west, is very mountainous, but at the same time richly wooded. On the eastern side of the mountains, hilly tracts, well suited for the cultivation of cotton, descend towards the coast, and nearer the sea there is a rich alluvial soil interspersed with swamps (lagoas), whence the province takes its name. The chief articles of produce and export are sugar-cane, rice, cotton, hides, and rosewood. Tropical fruits of all kinds are produced in abundance, and the forests, besides admirable timber, yield various dyes and drugs. The people are chiefly engaged in agriculture, and there are no manufactures of importance. The population of the province is 300,000. The town of ALAGOAS, formerly the capital of the province, is situated on Lake Manguaba. It has declined considerably since the transfer of the local government to Maceio. Population, including district, 12,000.

ALAIN DE LILLE (ALANUS AB INSULIS), theologian and ecclesiastic, born at Lille or Ryssel about the year 1114. The facts of his life are involved in uncertainty, owing to his having been frequently confounded by biographers with others, nearly contemporary, who bore the same name. Some have identified him with Alanus, bishop of Auxerres; others confound him with an elder Alanus, also born at Lille. These, however, were probably three distinct persons. Of the theological writer known as the *doctor universalis*, all that can be said with certainty is that he was a Cistercian monk. It is probable that he passed a great part of his life in England, though he ended his days in the abbey of Citeaux. His works are very numerous, the most important of them being entitled *Anti-Claudianus, sive de Officio Viri Boni et Perfecti*. The title denotes that the work takes for its model Claudian's satire against Rufinus, the minister of Theodosius. It is written in verse, and partakes somewhat of the character of an encyclopædia. Alain's *De Arte Catholicæ Fidei* is remarkable for its endeavour to base dogmatic theology on the exact reasoning of mathematical demonstration, and for its admission that heresy was to be overcome by argument and not by mere authority. His exposition of the prophecies of Merlin, in seven books, is of some importance in its bearing upon English history. A Life of St Bernard and a treatise against heretics, usually included among the works of this author, are, from internal evidence, to be attributed with more probability to the bishop of Auxerres. Alain died about 1202–3.

ALAIS, a flourishing town of France, in the department of the Gard, on the right bank of the Gardon, at the foot of the Cevennes, 25 miles north-north-west of Nîmes, with which it is united by rail. In the 17th century it was a stronghold of the French Protestants, and was besieged and taken by Louis XIII. in 1629. It has a citadel, erected by Louis XIV., a fine Gothic church, and a mining school. The town itself has considerable manufactures of ribands, silk, earthenware, glass, and vitriol; but its prosperity is chiefly derived from the adjacent mineral field,

which was opened up in 1819, and yields great quantities of coal and iron, as well as zinc, lead, and manganese. The numerous mines, blast furnaces, and iron foundries, afford employment to many workmen. There are cold mineral springs in the vicinity, which attract large numbers of visitors during the summer months. Population in 1872, 19,230.

ALAJUELA, a city in the state of Costa Rica, Central America, 23 miles W.N.W. from Cartago, and midway between it and the west coast. It is a place of considerable trade, and is connected by a mule road with the port of Puntas Arenas, the only good harbour possessed by Costa Rica on the Pacific Ocean. Some parts of the town are well built and beautifully situated; and the detached houses in the environs are embowered by trees and flowering shrubs. The sugar-cane is cultivated in the neighbourhood. Population, 12,575.

ALAMANNI, or ALEMANNI, LUIGI, an Italian statesman and poet, was born at Florence in 1495. His father was a devoted adherent of the Medici party, but Luigi, smarting under a supposed injustice, joined with others in an unsuccessful conspiracy against Giulio de' Medici, afterwards Pope Clement VII. He was obliged in consequence to take refuge in Venice, and, on the accession of Clement, to flee to France. When Florence shook off the papal yoke, Alamanni returned, and took a prominent part in the management of the affairs of the republic. On the restoration of the Medici (1530), he had again to take refuge in France, where he composed the greater part of his works. He was a favourite with Francis I., who sent him as ambassador to Charles V. after the peace of Crespi in 1544. As an instance of his tact in this capacity, it is related that, when Charles interrupted a complimentary address by quoting from a satirical poem of Alamanni's the words—

"l'aquila grifagna,
Che per piu devorar, duoi rostri porta,"
(Two crooked bills the ravenous eagle bears,
The better to devour,)

the latter at once replied that he spoke then as a poet, who was permitted to use fictions, but that he spoke now as an ambassador, who was obliged to tell the truth. The ready reply pleased Charles, who added some complimentary words. After the death of Francis, Alamanni enjoyed the confidence of his successor Henry II., and in 1551 was sent by him as his ambassador to Genoa. He died at Amboise in 1556. He wrote a large number of poems, distinguished by the purity and excellence of their style. The best is a didactic poem, *La Coltivazione* (1533), written in imitation of Virgil's *Georgics*. His *Opere Toscane* (1532) consists of satirical pieces written in blank verse. An unfinished poem, *Arvarchide*, in imitation of the *Iliad*, was the work of his old age, and has little merit. It has been said by some that Alamanni was the first to use blank verse in Italian poetry, but the distinction belongs rather to his contemporary Trissino.

ALAMOS, LOS, a town of Mexico, in the state of Sinaloa, situated on a barren plain 140 miles N.N.W. of Sinaloa. The houses of the town are mostly of stone or brick covered with stucco, and several of the streets are well paved; provisions are dear and water scarce. The surrounding district contains many rich silver mines. Of the population, amounting to about 10,000, a large proportion are employed in the mines.

ALAMOS DE BARRIENTOS, DON BALTHAZAR, a Spanish philologist, born at Medina del Campo, in Castile, about 1550. He was on terms of intimate friendship with Antonio Perez, secretary to Philip II.; and when the latter fell into disgrace, Alamos was cast into prison, where he remained nearly twelve years. During this period he prepared the translation of Tacitus, with a commentary, which gave him his reputation as a classical scholar. On the death of Philip II. Alamos recovered his liberty, and afterwards received various important court appointments through the influence of the Duke de Lerma and the Count d'Olivarez. He died at the age of eighty-five.

ALAN, ALLEN, or ALLYN, WILLIAM (1532–94), cardinal, was born at Rossall in Lancashire. He studied at Oriel College, Oxford, and was appointed principal of St Mary's Hall in 1556. Two years later he was made a canon of York; but being opposed to the Reformation, was forced to flee to Louvain on the accession of Elizabeth. He returned to England after a time, and for some years resided chiefly at Oxford; but his proselytising zeal being discovered, necessitated a second flight. At Douay he received a doctor's degree from the recently-founded university, and he himself established a college there for English Catholics. In 1587 he was made cardinal of St Martin de Montibus, and in 1589 archbishop of Mechlin. The great aim of his life seems to have been to restore the papal supremacy in England. For this purpose he founded the college at Douay, and sent over the Jesuit priests trained there to his native land. He was, of course, a bitter enemy of Elizabeth, who expelled his emissaries, and even caused some of them to be put to death. One of his pamphlets, prepared for circulation among the English people, contained charges against the queen so foul and scurrilous that they can scarcely be repeated. It was only natural that he should be one of the chief intriguers in the Spanish plot which led to the fitting out of the Armada, especially as the pope had promised him the archbishopric of Canterbury in the event of the expedition being successful. His letters to Philip were full of encouragement, and the failure of the enterprise must have been a severe blow to him. When the fact became known, he lost favour at the papal court, and was refused permission to return to his diocese.

ALAND ISLANDS, an archipelago at the entrance to the Gulf of Bothnia, about 25 miles from the coast of Sweden, and 15 from that of Finland. The group consists of nearly 300 islands, of which about 80 are inhabited, the remainder being desolate rocks. These islands form a continuation of a dangerous granite reef extending along the south coast of Finland. They formerly belonged to Sweden; and in the neighbourhood the first victory of the Russian fleet over the Swedes was gained by Peter the Great in 1714. They finally passed into the possession of Russia in 1809. The inhabitants, amounting to about 16,000, are mostly of Swedish descent, and are hardy seamen and fishermen. The surface of the islands is generally sandy, the soil is thin, and the climate is keen; yet Scotch fir, spruce, and birch are grown; and rye, barley, flax, and vegetables are produced in sufficient quantity for the wants of the people. Great numbers of cattle are reared; and cheese, butter, and hides, as well as salted meat and fish, are exported. The largest island, which gives its name to the group, is 18 miles long by 14 broad, and contains about two-thirds of the total population. There are several excellent harbours (notably that of Ytternæs), which are of great importance to Russia from the fact that they are frozen up for a much briefer period than those on the coast of Finland. The fortress of Bomarsund, in one of these islands, was attacked and destroyed by an Anglo-French force in 1854.

ALANI, a number of nomadic tribes of eastern origin, who spread themselves over Europe during the decline of the Roman empire. The name was probably at first confined to one tribe of Tatar race, whose original seat was on the northern shores of the Caspian Sea, and was afterwards, as the power of that race extended, applied to other tribes. It is supposed that their first encounter with the Romans was during the Mithridatic war, when Pompey led an expedition into the Caucasus. Isolated statements in

contemporary writers show that the Alani were frequently in conflict with the Roman power. In March 276 A.D. they received a decisive check in an attempt to make their way eastward into Persia, being defeated by the emperor Tacitus, who forced them to recross the Phasis. The most complete account of the Alani is to be found in the pages of Ammianus Marcellinus (lib. xxxi.), who describes their manners and customs at considerable length. From him, too, we learn of the advance of the Huns, who signally defeated the Alani in a battle fought on the banks of the Tanais in 375. The race thereupon divided, some retiring to the east, while the great majority joined their conquerors in an invasion of the kingdom of the Goths. Associated with the Vandals and Suevi, they left the settlements they had in Pannonia and entered Gaul in 406, whence three years later they crossed the Pyrenees into Spain, and founded a settlement in Lusitania and Bætica, where they remained in peace for some years. In 418, however, they were attacked and defeated by Wallia, king of the Visigoths, with whom they had quarrelled. Their king, Ataces, was slain in the battle, and they became subject to Gunderic, king of the Vandals, their national independence being lost. Those of the Alani who had remained in Gaul when the others invaded Spain, settled near Valence and Orleans. Though serving under Theodoric, they sympathised with Attila and the Huns, and by deserting at Chalons (451), all but changed the victory of the Romans into a defeat. Soon afterwards their separate national existence in Gaul was merged in that of the Visigoths. The small portion of the Alani that had remained in their original seat in the Caucasus are frequently noticed in history down to the middle ages. In 572 they were allied with the Armenians under King Saroes. They seem to have afterwards regained their independence. In 1221 they were defeated by Gengis Khan, and in 1237 they were so completely subjugated by Batu-Khan that their very name disappears in subsequent history.

ALARCON, Hernando de, a Spanish navigator of the 16th century, known only in connection with the expedition to the coast of California, of which he was leader. He set sail on the 9th May 1540, with orders from the Spanish court to await at a certain point on the coast the arrival of an expedition by land under the command of Vasquez de Coronado. The junction was not effected, though Alarcon reached the appointed place and left letters, which were afterwards found by Diaz, another explorer. Alarcon was the first to determine with certainty that California was a peninsula and not an island, as had been supposed. He made a careful and exact survey of the coast, sailed a considerable distance up the Rio del Tizon (Colorado), and was thus able, on his return to New Spain in 1541, to construct a map of California, which, according to M. Duflot de Mofras, scarcely differs from one of the present day.

ALARCON Y MENDOZA, Juan Ruiz de, one of the most distinguished Spanish dramatists, born at Tasco in Mexico about the close of the 16th century, was descended from a noble family belonging to Alarcon in Cuença. Nothing is known with certainty of his early life, but it is probable that he was educated at one of the Spanish universities. In 1622 he had taken up his residence at Madrid, and in 1628 he was appointed to the office of *relator* (reporter) of the royal council of the Indies, which afforded him a competency. In the same year he published the first volume of his comedies, dedicating it to "the rabble" in a daringly contemptuous address. A second volume of comedies appeared at Barcelona in 1634, in which he brought charges against several poets of appropriating his productions. About the same time he was successful in an open competition for a dramatic libretto to be played at the fêtes in honour of Philip IV. These two facts, combined with his haughty disdain both of the public and of his literary brethren, made Alarcon very unpopular; and he was scurrilously lampooned by most of the poets and dramatists of the day, Calderon honourably distinguishing himself by his silence. A further injustice was done him in the piracy of his works by other and better known authors than himself. To such an extent was this carried that Alarcon's reputation as a dramatist was almost extinct even before the close of his life, and it is only quite recently that it has been revived. The date of his death is given, on doubtful authority, as 1639. Alarcon holds a foremost place among Spanish dramatists, being surpassed only, if at all, by Lope de Vega and Calderon. He is distinguished by the correctness of his language, the harmony of his verse, and the elevation of his sentiment. His *La Verdad Sospechosa* (Suspicious Truth) supplied Corneille with the materials for his *Menteur*, and called forth the highest praise from the great French dramatist. His *Tejedor de Segovia* (Weaver of Segovia) and *Las Paredes Oyen* (Walls have Ears) are acted at the present day. A complete edition of his comedies was published by Hartzenbusch at Madrid (1848–52).

ALARIC (*Al-ric*, *i.e.*, All rich), a chief, and afterwards king of the Visigoths, was born of the noble family of Balti (*baltha*, bold). He first appears in history (394 A.D.) as a commander in the army of subjugated Goths whom the Emperor Theodosius employed in his war with Eugenius. On the death of Theodosius in 395 the Goths asserted their independence, and under the leadership of Alaric made an incursion from Thrace, where they had been located, into the Morea. Athens yielded to them without resistance, and Alaric enriched himself with the movable treasures of the city, though he did not, as some have asserted, destroy buildings and works of art. Rufinus, the crafty minister of Arcadius, did nothing to check the advance of the barbarians, and it has even been said that he had a secret understanding with Alaric. Opposition came, however, from the Western Empire. Stilicho, the famous general, landed at Corinth, and drove the Goths to Mount Pholoe, on the frontiers of Elis, where he besieged their camp. With proper vigilance, the siege could not have been raised; but the Romans were careless, and Alaric with his army contrived to escape to Epirus. Stilicho was prevented from following him by an order from the Emperor Arcadius, who conferred upon Alaric the prefecture of eastern Illyricum. About the same time the Gothic chief was chosen king by his people. It was natural that Alaric's desire of conquest should increase with the increase of his power, and accordingly about the year 400 A.D. he set out to invade the Empire of the West. His march was exceedingly slow, and it was not until the spring of 403 that he appeared before Milan, from which the Emperor Honorius instantly fled to the fortress of Asta in Liguria. Being besieged there, he was on the point of capitulating when he was relieved by Stilicho, who, in the battle of Pollentia, fought on Easter-day, gained a somewhat doubtful victory over Alaric. Some time after, the contest was renewed at Verona, and Alaric sustained a decisive defeat. He was obliged to accept terms of peace, and to retreat for the time; but his attitude was always threatening, and Honorius found it expedient to buy him off by appointing him prefect of western Illyricum, with a large revenue. In this capacity Stilicho encouraged Alaric to lead his army against Constantinople, probably more with the design of keeping him at a distance from Italy than with any hope of reuniting the divided empire. The final expedition to Constantinople was not undertaken; but for his services during three years in Epirus, Alaric claimed an extravagant reward, and Honorius, on the advice of Stilicho, promised him 4000 pounds of gold. Shortly afterwards the weak-

minded emperor procured the assassination of his minister, the only Roman who had proved himself able to cope with the Gothic forces, and broke all the treaties which Stilicho had made with Alaric. The latter at once marched upon Rome (408) by the Via Flaminia, and laid siege to the city. On coming to treat with him, the Romans found his demands so extravagant that they threatened a desperate resistance, to which Alaric made the well-known reply, "The closer hay is pressed, the easier is it mown." At last the barbarian was induced to retire by the promise of 5000 pounds of gold and 30,000 pounds of silver, besides other treasure. The respite, however, was but for a time. Honorius, who had left Rome for Ravenna, refused to ratify by treaty certain conditions, moderate in themselves, on which Alaric firmly insisted, and the capital was again at the mercy of the enemy. With commendable forbearance, Alaric contented himself at first with taking possession of Ostia, from which he summoned the city to surrender, threatening the immediate destruction of the food stores in case of refusal. The terrified people at once opened their gates, and agreed that the conqueror should appoint another emperor in place of Honorius. Alaric's choice fell upon Attalus, the prefect of the city, who, though well received at first, soon proved himself thoroughly incompetent, and Honorius had to be restored. While the conferences as to the restoration were still being carried on at Ravenna, the treachery of Honorius occasioned yet another and more disastrous siege of Rome by the Goths. Sarus, a barbarian and a hereditary enemy of the house of Balti, was permitted by the emperor to attack the camp of the Goths and return in triumph to Ravenna. Alaric was naturally indignant, laid siege to Rome for the third time, and gained an entrance by the Salarian gate on the night of the 24th August 410. For six days the city was given over to the horrors of a pillage, which the humane orders of Alaric did but little to mitigate. On the 29th August Alaric withdrew his troops from Rome, and led them into southern Italy, which he ravaged for several months. Towards the close of the year, while engaged in the siege of Cosentia (*Cosenza*), he was seized with an illness which proved fatal after a very short duration. He was buried with his treasures in the bed of the river Busentinus, which was diverted from its channel for that purpose, and all the prisoners who were engaged in the work were put to death in order that the place of his sepulture might remain unknown. The character of Alaric has been somewhat variously represented by historians. In forming an estimate of it many have been misled by the use of the term barbarian, which, as applied to him, it should be remembered, indicates a national and not a personal distinction. Many proofs may be found of his humanity and moderation in trying circumstances, while, on the other hand, the charges of cruelty brought against him are not borne out by evidence. His marked respect for Christianity is explained by the fact that, if he was not himself a Christian, he had come early under Christian influence, having had frequent intercourse with Arian teachers.

ALARIC II., eighth king of the Goths in Spain, succeeded his father Euric or Evaric about 484. His dominions not only included the greater part of Spain (Hispania Tarraconensis and Bætica), but extended into Gaul as far as the rivers Rhone and Loire. In religion Alaric was an Arian, but that he was tolerant of the orthodox Catholics is shown by the decrees of the Council of Agde, summoned by him in 506. He displayed similar wisdom and liberality in political affairs by appointing a commission to prepare an abstract of the Roman laws and imperial decrees, which should form the authoritative code for his dominions. This is generally known as the *Breviarium Alaricianum*. It contains six books of the code of Theodosius, and is therefore sometimes called the *Corpus Theodosii*. The full text has been given by Savigny. Alaric was of a peaceful disposition, and endeavoured strictly to maintain the treaty which his father had concluded with the Franks. Clovis, however, desiring to obtain the Gothic province in Gaul, found a pretext for war in the Arianism of Alaric. The intervention of Theodoric, king of the Ostrogoths and father-in-law of Alaric, proved unavailing. The two armies met in 507 at Voglade (*Vouillé*), near Poitiers, where the Goths were defeated, and their king, who took to flight, was overtaken and slain by Clovis himself.

ALASCO, JOHN (in Polish, *Lascki*), a Polish nobleman, born in 1499, who travelled extensively in his youth, and during a residence in Zurich imbibed the doctrines of the Reformation from Zwingli. At Basel in 1525 he had frequent intercourse with Erasmus, who held him in great esteem, and bequeathed his library to him. On his return to his native country he was offered more than once ecclesiastical preferment, which the change in his religious opinions prevented him from accepting. With the view of securing more freedom, he quitted Poland, and after travelling for a time, became pastor of a Protestant congregation at Embden, in East Friesland, in 1542. Foreseeing persecution there, he went to London in 1551, on the invitation of Cranmer, and became superintendent of the congregation of foreign Protestants, most of whom were driven into exile like himself in consequence of the Interim. The revenues of the church of Augustin Friars were assigned to support him and four assistant ministers, who had to be approved by the king. On the accession of Mary in 1553, Alasco and all his congregation were banished. In 1556 he returned to Poland, where he died on the 13th January 1560. Alasco wrote a number of theological treatises, chiefly in defence of the doctrine of the sacraments as held by the Swiss Reformers, and he was one of the eighteen divines who prepared the Polish version of the Bible, which was published in 1563.

ALA-SHEHR, a city of Asiatic Turkey, in the pashalic of Anatolia, 83 miles E. of Smyrna. It is dirty and ill-built; but, standing on elevated ground, and commanding the prospect of the extensive and fertile plain of the Hermus, presents at a distance an imposing appearance. It is the seat of a Greek archbishop, and has five Christian churches and fifteen mosques. The city occupies the site of the ancient *Philadelphia*, one of the "seven churches in Asia" of the Apocalypse. The ancient city, founded two centuries B.C., was subject to frequent earthquakes. In more modern times it was celebrated for its prolonged resistance to the Turks, who took it in 1390, after all the other cities of Asia Minor had surrendered. Ala-Shehr has an active trade, and the population is about 18,000.

ALASKA, or ALIASKA, formerly RUSSIAN AMERICA, but now a territory of the United States, is a vast tract of country forming the north-west portion of North America, bounded on the N. by the Arctic Ocean, on the E. by British America, and on the S. and W. by the Pacific Ocean. The name was formerly confined to a long narrow peninsula stretching into the Pacific, but has been extended to the whole territory. Alaska comprises the whole of North America from 141° W. long. to Behring Strait, and also numerous islands along the coast, notably Prince of Wales Islands, King George III. Archipelago, the Kodiak Islands, and the Aleutian Islands, which stretch seaward from the extremity of the peninsula. From the main portion of the territory a narrow strip, with a breadth of about 50 miles, extends south-east along the Pacific coast, and terminates at the confines of British Columbia, in 54° 40′ N. lat. From north to south the extreme length of

Alaska is about 1100 miles, and the greatest breadth from east to west is 800 miles. The area of the whole territory is estimated at 514,700 square miles.

Coast. The numerous islands, creeks, and inlets of Alaska lengthen out its coast-line to 7860 miles, an extent greater than that of the eastern coast-line of the United States. Beginning at the south-east, the chief creeks and bays are Cook's Inlet, Bristol Bay, Norton Sound, and Kotzebue Sound; while, following the same order, the principal headlands, in addition to the extremity of the peninsula, are Cape Newenham and Cape Romanzoff in the Pacific, Cape Prince of Wales in Behring Strait, and Cape Lisburne, Icy Cape, and Point Barrow in the Arctic Ocean. Point Barrow is in 71° 23′ N. lat., and is the extreme northern point of the country. The exploration of the northern coast was chiefly the work of the British navigators Cook, Beechy, and Franklin, and of the officers of the Hudson's Bay Company. The principal river of Alaska is the Yukon, or Kwichpak, which rises in British America, and, receiving the Porcupine river at Fort Yukon, flows westward across the territory, and falls into the Pacific Ocean to the south of Norton Sound. At a distance of 600 miles from the sea this magnificent river has a width of more than a mile. Its tributaries would in Europe be reckoned large rivers, and its volume is so great that 10 miles out from its principal mouth the water is fresh. Among the other rivers of Alaska are the Copper river, the Suschitna, the Nuschagak, and the Kuskokwim, falling into the Pacific, and the Colville, flowing northward into the Arctic Ocean. A great mountain range extends from British Columbia, in a north-west direction, along the coast of Alaska, the summit being covered with snow and glaciers. Mount St Elias, an active volcano, in 60° 18′ N. lat., and 140° 30′ W. long., rises to the height of 14,970 feet above the sea. The mountain chain runs out along the peninsula which has given its name to the country, and at the western extremity there are several volcanic cones of great elevation; while in the island of Unimak, separated from the mainland by only a narrow strait, there are enormous volcanoes, one rising to more than 8000 feet in height. In the interior and to the north the country is also mountainous, with great intervening plains.

Rivers.

Mountains.

History. The north-west coast of this part of America was discovered and explored by a Russian expedition under Behring in 1741; and at subsequent periods settlements were made by the Russians at various places, chiefly for the prosecution of the fur trade. In 1799 the territory was granted to a Russo-American fur company by the Emperor Paul VIII., and in 1839 the charter of the company was renewed. New Archangel, in the island of Sitka, was the principal settlement, but the company had about forty stations. They exported annually 25,000 skins of the seal, sea-otter, beaver, &c., besides about 20,000 sea-horse teeth. The privileges of the company expired in 1863; and in 1867 the whole Russian possessions in America were ceded to the United States for a money payment of $7,200,000. The treaty was signed on 30th March, and ratified on 20th June 1867; and on 9th October following, the possession of the country was formally made over to a military force of the United States at New Archangel. It still remains in the military keeping of the United States, no steps having been taken to organise a territorial government. It has, however, been constituted a revenue district, with New Archangel, or Sitka, as the port of entry. Since Alaska was ceded to the United States considerable information has been collected as to the resources of the less sterile parts of the country; but the central and northern parts of this region are only known as the inhospitable home of some wandering tribes of Indians and Esquimaux. Portions of Alaska have also been recently explored by the employés of the Russo-American Telegraph Company in surveying a route for a line of telegraph which was designed to cross from America to Asia near Behring Strait—a project which was abandoned, after an expenditure of £600,000, on communication with Europe being secured by the Atlantic cable.

Climate. The climate of the south-western coast of Alaska is tolerably mild, considering its high latitude. The great warm current of the Pacific, sweeping in a north-easterly circuit from the East India Islands, and corresponding very much in character and effects to the Gulf Stream of the Atlantic, washes its shores; and while it modifies the temperature, also causes an excessive rainfall. At Sitka the mean temperature is 42°·9, and the average rainfall about 80 inches. Alaska will never have any great agricultural value. From the great amount of rain and the want of heat, cereals grow, but will not ripen, and vegetables do not thrive. Native grasses and berries grow plentifully, but the chief wealth of the country is in its vast forests, in the furs of its wild animals, and in the fish with which its rivers and seas abound. The forests, rising from the coast and covering the mountains to a height of 2000 feet, consist of a very durable yellow cedar, spruce, larch, and fir of great size, and also cypress and hemlock. The wild animals include the elk, the deer, and various species of bear, and also many fur-bearing animals, such as the wolf and fox, the beaver, ermine, marten, otter, and squirrel. Near the coast and islands there are innumerable fur-bearing seals, which are caught in great numbers by the settlers; but from the rigour of the climate and the arduous nature of the work, the trapping of the animals of the interior is left to the Indians. The salmon abounds in the rivers, and there are great banks along the shores, the favourite haunt of cod and other fish. About eighty whalers prosecute their fishing off the coast of Alaska. Coal and iron are the most important minerals, but the value of the deposits remains to be ascertained.

Produce.

Population. The population is very limited, consisting of 8000 whites and 15,000 Indians, with some Esquimaux on the northern coast. The Indians are rapidly decreasing in number, and are described as treacherous and discontented. New Archangel, now called Sitka, in the island of Sitka, in 57° 3′ N. lat., and 135° 18′ W. long., was the seat of the Russian governor, and is the headquarters of the United States authorities. It contains about 1500 inhabitants, is the residence of a Greek bishop, and has fortifications, magazines, and a magnetic observatory. Of the other settlements, Fort Nicholas on Cook's Inlet, and Fort St Michael on Norton Sound, are the more important. The admirable harbours on the coast and the great navigable river Yukon afford facilities for the formation of new settlements and the increase of trade by the Americans. At the junction of the Porcupine river and the Yukon a fort was established by the Hudson's Bay Company in 1847. (See Whymper, *Travels in Alaska and on the Yukon*, 1868; Dall, *Alaska and its Resources*, 1870.)

ALATRI, the ancient *Alatrium*, a town of Italy, 6 miles N. of Frosinone, in the province of that name, which until 1870 formed part of the papal territory. It is the see of a bishop, and has considerable remains of Pelasgian antiquity. Population of commune, 11,370.

ALAVA, one of the Provincias Vascongadas, or Basque Provinces, in the north of Spain. It is of a triangular shape, and is bounded on the N. by Guipuzcoa and Biscay, on the E. by Navarre, on the S.W. by Logrono, and on the W. by Burgos; with an area of about 1200 square miles. The surface of Alava is very mountainous, especially on the north, where a part of the Pyrenees forms its natural boundary. It is separated from Logrono by the

Ebro, and the other rivers are the Zadorra and the Ayuda. The soil in the valleys is fertile, yielding wheat, barley, maize, flax, hemp, and fruits. Oil, and a poor kind of wine called chacoli, are also produced. Many of the mountains are clothed with forests of oak, chestnuts, beeches, and other trees, and contain iron, copper, lead, and marble. Salt is also found in large quantities in the province. The manufactures of Alava are unimportant; coarse cloth, iron ware, earthenware, hats, and shoes being among the chief. The capital of the province is Vitoria. Population in 1870, 102,494.

ALAVA, Don Miguel Ricardo d', a Spanish general and statesman, born at Vitoria in 1771. He served first in the navy, and had risen to be captain of a frigate when he exchanged into the army, receiving corresponding rank. In politics he followed a very devious course. At the assembly of Bayonne, in 1808, he was one of the most prominent of those who accepted the new constitution from Joseph Bonaparte as king of Spain. In 1811, when Joseph's position was becoming insecure, Alava joined the national independent party, who were fighting in alliance with the English. The Spanish Cortes appointed him commissary at the English headquarters, and Wellington, who seems to have regarded him with great favour, made him one of his aides-de-camp. Before the close of the campaign he had risen to the rank of brigadier-general. On the restoration of Ferdinand, Alava was cast into prison, but the influence of his uncle Ethenard, the inquisitor, and of Wellington, secured his speedy release. He soon contrived to gain the favour of the king, who appointed him in 1815 ambassador to the Hague. Four years later he was recalled, owing, it is said, to the marked kindness he had shown to his banished fellow-countrymen. On the breaking out of the revolution of 1820 he was chosen by the province of Alava to represent it in the Cortes, where he became conspicuous in the party of the *Exaltados*, and in 1822 was made president. In the latter year he fought with the militia under Ballasteros and Murillo to maintain the authority of the Cortes against the rebels. When the French invested Cadiz, Alava was commissioned by the Cortes to treat with the Duc d'Angoulême, and the negotiations resulted in the restoration of Ferdinand, who pledged himself to a liberal policy. No sooner had he regained power, however, than he ceased to hold himself bound by his promises, and Alava found it necessary to retire first to Gibraltar and then to England. On the death of Ferdinand, he returned to Spain, and, espousing the cause of Maria Christina against Don Carlos, was appointed ambassador to London in 1834, and to Paris in 1835. After the insurrection of La Granja, he refused to sign the constitution of 1812, declaring himself tired of taking new oaths, and was consequently obliged to retire to France, where he died at Barèges in 1843.

ALAY (lit. a triumphant procession), a Turkish ceremony observed on the assembling of the forces at the outbreak of war. Its essential feature is the public display of the sacred standard of Mahomet, which may be seen only by Moslems and touched only by the emirs. On one occasion, when, owing to a long interval of peace, this rule had been forgotten, the Christians, who had witnessed the spectacle in large numbers, were cruelly massacred. The procession in which the standard is carried is headed by artisans bearing the implements of their respective trades.

ALB, or Albe, a vestment of white linen, hanging down to the feet, worn by priests at all the more solemn services of the church. It corresponds to the surplice of the English clergy, the difference being that the alb is closer in the sleeves, and bound at the waist by a girdle. In the ancient church it was customary for the neophytes who were baptized on Easter-day to wear an alb for the eight days following, and hence the Sunday after Easter was called *Dominica in Albis*.

ALBA, the ancient *Alba Pompeia*, a town of Italy, in the province of Cuneo, situated on the Tanaro, 30 miles S.E. of Turin. It is the seat of a bishop, and contains a cathedral, founded in 1486, as well as other churches and religious establishments. It has a large trade in cattle, and the surrounding district is very fertile, producing silk, wine, oil, grain, and fruits, and also marble and rock-salt. Population of the commune (1865), 9687.

ALBA LONGA, the most ancient town in Latium, was situated 15 miles S.E. from Rome, on a ridge between the mountain and the lake that were both called from it *Albanus*. It derived its name probably from its elevated or *Alpine* situation, the story of the *white* sow discovered by Æneas on landing (Virgil, *Æneid*, iii. 390–392) being of course mythical. Little beyond the bare fact of its existence for a considerable period as the foremost town in Latium can be accepted as strictly historical. According to the legendary accounts, it was founded by Ascanius, the son of Æneas, 300, or, as a later version has it, 360 years before the foundation of Rome. Fourteen kings, whose names are all preserved, are said to have reigned over it in succession. The names, however, are evidently an invention, having probably this substratum of historic truth, that the ruling family belonged to the Silvian *gens*. The city was destroyed by the Romans under Tullus Hostilius, and its inhabitants removed to Rome. Several of the patrician families, such as the *Julii, Curiatii, Servilii, Tullii, Quintii,* ascribed their origin to these immigrants from Alba.

ALBACETE, one of the new provinces of Spain, was formed in 1833 out of districts taken from Murcia and New Castile. It is bounded on the N. by Cuença, on the E. by Valencia and Alicant, on the S. by Murcia, and on the W. by Ciudad Real and Jaen. The area is 5971 square miles. The province is generally hilly, some of the peaks of the sierras rising to a height of 5000 feet; but it contains rich plains and many fertile valleys. The principal rivers are the Mundo in the southern and the Jucar in the northern part of the province; and there are numerous smaller streams. Some parts of the country have a bare appearance, being destitute of wood, but the neighbourhood of Alcarez is covered with fruit trees, and presents the aspect of a garden. Agriculture is in a tolerably prosperous state, more advanced than in the centre of Castile, but less so than in the rich districts of Murcia and Valencia. Cereals, pulse, and fruits of all kinds are produced, as well as wine of fair quality, and excellent honey. Saffron also is produced in large quantities, and some attention is given to the keeping of silk-worms. Many of the inhabitants devote themselves to the rearing of cattle, sheep, and goats. The bulls of Albacete are in request for bull-fights; there is a good breed of mules, and the horses of the province have long mounted the Spanish cavalry. Manufactures are confined to the spinning of hemp, and the making of coarse cloths, porcelain, earthenware, and cutlery. There are several distilleries, and a considerable trade in wood. The district is rich in minerals, including silver, iron, copper, zinc, sulphur, gypsum, and coal; but, excepting stones and marble for building purposes, they are little wrought. In addition to agricultural produce, small quantities of zinc, iron, and sulphur are exported. There are numerous mineral springs, chiefly sulphureous, and hot as well as cold, at various places in the province. Among the chief towns are Albacete, Chinchilla, Bonillo, and Alcarez. The railway from Madrid to Valencia traverses the province, and at Chinchilla a line branches southward to Murcia.

The state of education throughout the province is very low. In the town of Albacete, where it is best, little more than half the population can read; while at Yeste, where it is worst, the proportion is only 1 in 15. The graver crimes are of infrequent occurrence; but the inhabitants always wear arms, and offences against the person are numerous. Population in 1867, 221,444.

ALBACETE, a town of Spain, capital of the above province, is situated about 140 miles S.E. of Madrid, and is a station on the railway between Madrid and Valencia. It is surrounded by a fertile plain, and has considerable trade in saffron and in the agricultural products of the district. A great market, chiefly for the sale of cattle, is held annually in September, and extends over several days. The town is well built, and has several churches, two hospitals, and a normal school. At one time it had an extensive trade in cutlery, from which it received the name of the Sheffield of Spain. This manufacture has been very much reduced by the importation of cutlery from England and Germany, but Albacete is still famous for its daggers, which are held in high repute and much worn by the Spaniards. They are formidable weapons, of coarse manufacture, but with richly-ornamented handles, and frequently bear proverbial inscriptions suitable to their murderous appearance. Population, 15,150.

ALBAN, ST, usually styled the protomartyr of Britain, was born at Verulamium, and flourished towards the end of the third century. In his youth he took a journey to Rome in company with Amphibalus, a monk of Caerleon, and served seven years as a soldier under the Emperor Diocletian. On his return home he settled at Verulamium, and, influenced by the example and instructions of Amphibalus, renounced the errors of paganism, in which he had been educated, and became a convert to the Christian religion. It is generally agreed that Alban suffered martyrdom during the great persecution in the reign of Diocletian; but authors differ as to the precise date. Bede, who gives a full account of the event, fixes it in 286; some refer it to the year 296; while Usher reckons it amongst the events of 303. Between 400 and 500 years after St Alban's death, Offa, king of the Mercians, built a large and stately monastery near Verulamium to his memory, and around it the present town of St Albans was gradually erected.

ALBANI, or ALBANO, FRANCESCO (1578–1660), a celebrated Italian painter, was born at Bologna. His father was a silk merchant, and intended to bring up his son to the same occupation; but Albani was already, at the age of twelve, filled with so strong an inclination for painting, that on the death of his father he devoted himself entirely to art. His first master was Denis Calvart, with whom Guido Reni was at the same time a pupil. He was soon left by Calvart entirely to the care of Guido, and contracted with him a close friendship. He followed Guido to the school of the Caracci; but after this, owing to mutual rivalry, their friendship began gradually to cool. They kept up for a long time a keen competition, and their mutual emulation called forth some of their best productions. Notwithstanding this rivalry, they still spoke of each other with the highest esteem. Albani, after having greatly improved himself in the school of the Caracci, went to Rome, where he opened an academy and resided for many years. Here he painted, after the designs of Annibal Caracci, the whole of the frescoes in the chapel of St Diego in the church of San Giacomo degli Spagnuoli. His best frescoes are those on mythological subjects, of which there is a large number in the Verospi Palace, now Torlonia. On the death of his wife he returned to Bologna, where he married a second time, and resided till his death in the enjoyment of much domestic happiness and general esteem. His wife and children were very beautiful, and served him for models. But while thus studying from nature, his love of artificial refinement and conventional expression was so great, that even his best works are deficient in breadth and vigour, as well as in unaffected grace and natural feeling. The learning displayed in the composition of his pictures, and their minute elaboration and exquisite finish, gave them great celebrity, and entitle them to a distinctive place among the products of the Bolognese school.

"In point of original invention," says Lanzi, "Albani is superior to Domenichino, perhaps to any other of the school; and in his representation of female forms, according to Mengs, he has no equal. By some he is denominated the Anacreon of painting. Like that poet, with his short odes, so Albani, from his small paintings, acquired great reputation; and as the one sings Venus and the Loves, and maids and boys, so does the artist hold up to the eye the same delicate and graceful subjects. Nature, indeed, formed, the perusal of the poets inclined, and fortune encouraged his genius for this kind of painting; and possessing a consort and twelve children, all of surprising beauty, he was at the same time blest with the finest models for the pursuit of his studies. He had a villa most delightfully situated, which further presented him with a variety of objects enabling him to represent the beautiful rural views so familiar to his eye.

A great number of his works are at Bologna. Among the most celebrated of his pictures are the "Four Seasons;" "Diana and Venus," in the Florentine gallery; the "Toilet of Venus," in the Louvre; "Venus landing at Cythera," in the Ghigi palace at Rome, &c. Among the best of his sacred subjects are a "St Sebastian" and an "Assumption of the Virgin," both in the church of St Sebastian at Rome. He was among the first of the Italian painters to devote himself to the painting of cabinet pictures.

ALBANIA, a country of considerable extent, which though frequently ruled by turbulent and nearly independent chiefs, ranks as one of the provinces of the Turkish empire. The tract of land to which this name is now applied extends from 39° to 43° N. lat., and from 18° 24′ to 21° 48′ E. long.; from the Gulf of Cattaro in the north to the Gulf of Arta in the south, and from the coast of the Adriatic Sea and Ionian Sea on the west to an irregular ill-defined line inland towards the east, roughly indicated in its northern part by the Tchar Dagh, the ancient *Scardus*, a part of the Hæmus or Balkan range, and southwards by the Pindus chain, or rather the portions of it now called the mountains of Sagori, Metzovo, and Suli. Within these limits is included the ancient *Epirus*, corresponding to the southern part of the country now comprehended under the general name of Albania, and divided from Albania, properly so called, by the river Voyutza or Viosa, which enters the Adriatic a few miles north of Avlona. Albania, therefore, is bounded on the N. by Dalmatia, Montenegro (from which it is separated by the river Moroka), and Bosnia; on the E. by Servia and the Turkish province of Rum-ili, in which Macedonia, or the greater part of it, is included; and on the S. by Hellas or Northern Greece, which was the Turkish province of Livadia before Greece regained its independence, and from which it is separated by the river Garla or Suli. The superficial area of Albania is estimated at about 18,944 square miles, and it has a coast-line of about 280 miles from north to south, without reckoning indentations, &c. It nowhere extends more than 100 miles from the sea, and in the southern part not more than 30 miles.

According to the most recent division of the Turkish empire into eyalets, sanjaks, and livas, Albania is comprehended in three eyalets, namely, Uskub or Uskup in the north; Roumelia, which also includes part of Macedonia, in the centre; and Yania, corresponding pretty nearly to the ancient *Epirus*, in the south. The chief towns of these eyalets are respectively Scutari, Monastir,

and Joannina, sometimes written Janina or Yanina; and these divisions are therefore spoken of by some writers as the pashaliks of Scutari, Monastir, and Joannina. The divisions chiefly recognised by the Albanians themselves are those formed by the varieties of the native tribes. Colonel Leake, who is considered one of the best informed authorities on this head, divides them into the Ngege or Ghegides, whose principal towns are Dulcigno, Scutari, and Durazzo; the Toske or Toskides, who occupy Berat and Elbasan; the Liape, a poor and predatory race, who inhabit the mountains between the Toske and Delvino; and the Tsami, who inhabit the most southerly district, and whose principal towns are Suli and Paramithia. The country is mountainous, the interior being traversed by a range which forms a prolongation of the Dinaric Alps, and which is continued southwards in the Pindus range. These mountains, from which numerous spurs are thrown out to the east and west, run in a direction from north to south, parallel to the course of the Tchar Dagh. Along the southern part of the coast-line, and parallel with it, run the Khimara mountains, known to the ancients as the *Acroceraunian* range, terminating northwards in the bold headland of Cape Glossa. There are three lakes of great size in Albania—Scutari in the north, Okhrida in the centre, and Joannina in the south. The rivers for the most part are short, and run, generally speaking, from east to west, or in a north-westerly direction. The Moroka and Zenta enter the lake of Scutari, which is connected with the sea by the Boyana, that flows into the Adriatic near Dulcigno. The White Drin, flowing in a southerly direction, and the Black Drin, running northwards from Lake Okhrida, form the head streams of the Drin. The principal streams in addition to these are the Skombia, Voyutza, Calamas, Arta, and Gurla (the ancient *Acheron*), with its tributary the Vuvó (the ancient *Cocytus*). The climate is generally healthy, though cold and bleak in the highlands; the warmer regions along the coast are also frequently visited by cold northerly winds.

Albania includes not only the ancient *Epirus*, but also part of the ancient *Macedonia*, *Illyria*, and *Chaonia*. This country was in early times, as now, distinguished by the rude valour of its inhabitants. Its remote situation, and the want of union among its tribes, generally prevented it from acting any conspicuous part in Grecian politics. The only remarkable exception occurs in the reign of Pyrrhus, king of Epirus (296–272 B.C.), who was justly ranked among the greatest captains of antiquity. After his death the country was again split into a number of petty states, which were unable to resist the united strength of Macedon; and to that kingdom Epirus continued subject till both were alike subdued by the Roman arms (167 B.C.)

It was during the time of the Greek empire that the name of Albania was first given to this district. During the decline of the empire the Albanians gradually rose to distinction, and at last to independence. Their valour enabled them to maintain their ground against the Bulgarians, who had occupied all the neighbouring districts of Greece. Nor were they less successful against the Turks, a more formidable enemy. Under the command of the celebrated George Castriot, called by the Turks Scanderbeg, they baffled all the efforts of Mahomet II., the conqueror of Constantinople. That powerful monarch entered Albania only to experience a succession of defeats, and was at length compelled to acknowledge its independence by a formal treaty. On the death of Scanderbeg, the Turks redoubled their efforts against Albania, which was at length reduced to a state of nominal subjection. The siege of Scutari, in 1478, formed the termination of this memorable struggle. The subjection, however, was always the imperfect; revolts were frequent, and the inhabitants of mountainous districts still preserved their independence. It was the motives of pay and plunder, rather than compulsion, that brought these hardy soldiers into the Turkish ranks. In proportion as the Ottoman empire declined in vigour, its hold of Albania became less firm; and the vigorous and enterprising genius of Ali Pasha again converted this dependency into what might almost be called a separate kingdom.

In the grand insurrection of Greece (1821–1829), the Albanians, accustomed to view with disdain the Ottoman yoke, showed a considerable disposition to make common cause with the Greeks, and their co-operation would have almost ensured success. But the Greeks, imprudently and unhappily, could not divest themselves of the feelings of enmity cherished during the long series of wars which Ali had waged against them. At the siege of Tripolizza (October 5, 1821) overtures were made to them by a corps of 3000 Albanians, who formed part of the garrison; but the Greeks, having succeeded in entering the place, began a dreadful and indiscriminate massacre, in which the Albanians were not spared. At the siege of Arta, although the capture was much facilitated by the coming over of a corps of Albanians, the Greeks treated them extremely ill. The Albanian nation was thus forcibly thrown into the arms of the Porte, to which it has since continued nominally subject. The allegiance of the Albanians, however, to Turkey rests on a very precarious basis even at the present day, and, it will be remembered, in the Crimean war many Albanian chiefs fought under the Russian flag against the combined forces of England, France, and Turkey.

The inhabitants of Albania are estimated at 1,200,000, of whom a considerable proportion are Turks and Greeks; but the basis of the population consists of the original race, called Arnauts. About half of the entire population are Mahometans; of the other moiety, about 520,000 belong to the Greek Church, and the remainder to the Latin Church. The conversion of those who profess Mahometanism has been, however, very imperfect, and chiefly induced by political motives. In every family the males usually go to the mosque, the females to church; and some members of a family are seen in the most amicable manner eating from the same table, and even from the same plate, meats forbidden to the others. With the Turks, accordingly, infidel and Albanian are terms nearly synonymous. The native Albanian is of middle stature; his face is oval, with high cheek-bones; his neck long; his chest full and broad. His air is erect and majestic to a degree which never fails to strike the traveller. He holds in utter contempt that dissimulation which is characteristic of the Greek, and, unlike the Turk, he is gay, lively, and active. Averse, however, to regular industry, his whole delight is in arms and plunder. He goes constantly armed; and there are few Albanians who have not, in the prime of their life, belonged to some of the numerous bands of robbers who infest the mountains of their native country, of Thessaly, and of Macedonia. This occupation carries with it no disgrace: it is common for the Albanian to mention circumstances which occurred "when he was a robber." In proportion as the trade of robbing becomes overstocked, part of those engaged in it seek employment in the service of the sultan and the different pashas throughout the Turkish empire, by all of whom the Albanians are regarded as the most valuable of their troops.

This fierce and haughty race display a greater degree of contempt for the female sex than is usual even among the most barbarous nations. The females are literally regarded as inferior animals, and treated accordingly; but in the country districts they are not confined or veiled, as is customary in Mahometan countries.

The national costume of the Albanians is handsome in appearance, and bears some resemblance to the Highland dress. It consists of a cotton shirt; a white woollen *fustanella* or kilt, which reaches to the knees; a jacket; a sash round the waist, in which pistols and a yataghan are commonly carried; coloured leggings; sandals; and a red cap, round which some twist a shawl or scarf. The chiefs and wealthy Albanians generally wear a jacket and vest of velvet, richly embroidered with gold, and metal greaves over their leggings, which are usually made of fine scarlet cloth. The poorer classes, though picturesque in appearance, are extremely dirty in their habits, and seldom change their clothes. As a protection from the weather, every Albanian has a *capote*, or rough shaggy mantle with a hood attached, and usually made of horse-hair stuff or coarse woollen cloth. The dress of the females is more various, and often fantastical. A singular custom prevails among the girls of stringing together the pieces of money which they have collected for their portion, and wearing them upon their heads. Some of them have their hair hanging down in braids to a great length, loaded with this species of ornament.

Scutari, on the lake of that name, is now considered the chief town of Albania. It is the centre of a large inland trade, and contains about 40,000 inhabitants. Prisrend, in the north-east, is noted for its manufactures of fire-arms and cutlery, and has a population of 25,000. Monastir, or Bitolia, although the capital of the eyalet of Roumelia, is not, strictly speaking, within the confines of Albania. It has a large transit trade between eastern and western Turkey. Joannina, with 36,000 inhabitants, situated on the south-west shore of a lake of the same name, was the capital of Albania in the time of Ali Pasha, and was his stronghold as well as the seat of his government. The other important towns of the interior are Jacova, Tirana, Okhrida, Elbasan, Delvino, and Metzovo. The principal seaports and river-ports are Dulcigno, Durazzo, Parga, Prevesa, and Arta.

The commerce of Albania is chiefly carried on through Arta and Prevesa, on the north side of the entrance to the Gulf of Arta. The principal merchants, however, are Greeks residing at Joannina, among whom a very active commercial spirit appears to prevail. The exports consist almost entirely of unmanufactured produce, live stock, and provisions, and comprise valonia (the cup of the acorn of the Valonia oak, used in tanning), raw silk, cheese, raw hides, drugs, dye-woods, sheep, horses, and salted meats. Notwithstanding its mountainous character, the fertility of its plains affords a surplus of grain, of which a considerable quantity is sent to Italy, the Ionian Isles, Malta, and other places. The vine, olive, pomegranate, orange, lemon, mulberry, and fig are also cultivated. Wool is exported, chiefly unmanufactured, but partly also wrought into coarse cloth. Other important articles of export are oil, tobacco of good quality, cotton, and cotton yarn. Some cargoes of wood for building and firewood are annually sent to Malta. The chief imports consist of woollen cloths, used for winter coverings. For this purpose the preference is given to a coarser and cheaper kind than any that is usually manufactured in Great Britain. This is supplied from Germany. Fire-arms, cutlery, gunpowder, hardware, coffee, and sugar are also imported. The manufactures of Albania are few and unimportant, being almost entirely confined to *capotes*, embroidery on cloth and velvet, fire-arms and cutlery to a limited extent, and gun and pistol stocks—all for home consumption.

See the *Journey through Albania and Turkey* of Mr J. Cam Hobhouse (Lord Broughton); *Travels in the Ionian Isles, Albania, &c.*, by Sir Henry Holland, who resided for some time in the capacity of physician at the court of Ali Pasha; Rev. T. S. Hughes's *Travels in Sicily, Greece, and Albania*; Leake's *Travels in Northern Greece*; Mrs Mary A. Walker's *Through Macedonia to the Albanian Lakes*.

ALBANIA, in *Ancient Geography*, a country of Asia, bounded, according to Strabo, on the W. by Iberia, on the E. by the Caspian Sea, on the N. by Sarmatia, on the S. by Armenia and the river Cyrus (*Kour*). The country formerly called Albania corresponds with the modern *Daghistan, Schirvan,* and *Leghistan*, and is extremely fertile, owing to the alluvial deposits made by the river Cyrus. The ancient historians describe the Albanians as tall, strong-bodied, and, generally speaking, of a very graceful appearance. The Albanians were originally a nomad race, and never devoted themselves to agriculture or commerce. They became known to the Romans during Pompey's expedition in pursuit of Mithridates (65 B.C.), against which they opposed a force of 60,000 infantry and 22,000 cavalry. Though Pompey exacted from them a nominal submission, they continued practically independent.

ALBANO, a town and lake in the Campagna di Roma, Italy, about 14 miles S.E. of Rome. The town is much admired for the picturesque scenery around it. It is well built, and the Roman aqueduct and other monuments of antiquity are in tolerable preservation. It contains a cathedral, and there are many handsome villas of the Roman nobles in the vicinity. Population, 6400. The lake of Albano, lying to the N.E. of the town, occupies the crater of an extinct volcano, and is of a beautiful oval form, surrounded with high wooded banks, and about 7 miles in circumference. It has long been an object of attraction to the painter and the traveller. In the fourth century of ancient Rome, during the siege of Veii, there was an extraordinary rise of the waters of this lake, and the oracle declared that there was no hope of success against Veii while the Alban lake was allowed thus to swell. This prompted the Romans to drain it by a tunnel cut through the rock, a mile and a half in length, 4 feet wide, and 6 high, which is still perfect. This outlet keeps the surface of the lake at the height of 920 feet above the level of the sea. Monte Cavo, the ancient *Albanus*, rises on the eastern side of the lake to a height of 3000 feet, and commands a magnificent prospect. On its summit stood the famous temple of Jupiter Latialis.

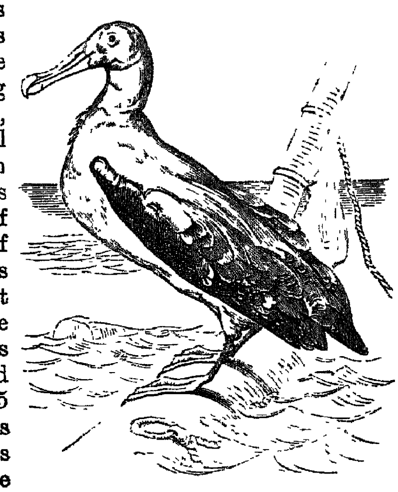
ALBANY, a city of the United States, capital of the state of New York and of the county of Albany, picturesquely situated in a beautiful and fertile country on the western bank of the Hudson, 145 miles from New York. It is, for an American city, irregularly laid out, and much of its architecture is poor, although it contains several very fine buildings, and many of its more recently made streets are broad and handsome. The Capitol, a brown stone edifice, 115 feet by 90, built in 1807, faces a square called Capitol Park; and opposite it, on the eastern side of the square, are the State Hall and City Hall, both constructed of white marble. There are several beautiful churches, including a large Roman Catholic cathedral. Among the literary and scientific institutions of Albany may be mentioned the university, incorporated in 1852, giving instruction in most branches of education, especially practical science and law; a medical college; an academy, and other schools of various grades; a large observatory; the state library, with about 90,000 volumes; and the Albany Institute for the collection and diffusion of scientific information. Albany is an important centre of trade, being situated at the point where the united Erie and Champlain canals join the Hudson, and possessing good railway communication with most cities of the United States. The chief articles of commerce are timber, wheat, barley, wool, and tobacco, enormous quantities of which,

especially of the first-mentioned, pass through the city annually. Besides its transit trade, its numerous foundries, its breweries, carriage and hat manufactories, and tanneries are of importance. In 1873, 536 vessels (83 sailing and 352 unrigged vessels and 101 steamers), of 68,682 tons, belonged to the port. Albany was founded by the Dutch in 1623, and is thus one of the oldest European settlements in the United States, dating sixteen years after that of Jamestown in Virginia. It was captured by the British in 1664, who changed its name from Beaverwyck or Williamstadt in honour of the Duke of York and Albany. It received its charter in 1686, and became the capital of the state of New York in 1797. It is governed by a mayor and twenty aldermen, and is divided into ten wards. Population in 1870, 69,422; number of families, 14,105; and of dwellings, 8748.

ALBANY, Louisa Maria Caroline, Countess of, daughter of Prince Gustavus Adolphus of Stolberg-Gedern, was born at Mons on the 27th Sept. 1753, and assumed the title of Albany in 1772, when she married the Pretender, Charles Edward, grandson of James II. of England. Her husband was much older than herself, and their union proved very unhappy. There were no children, and the Pretender, who was a confirmed drunkard, treated his wife with such brutality that her health and even her life were endangered. In 1780 she obtained a legal separation, and entrusted herself to the care of her husband's brother, the Cardinal of York, who placed her in a convent, and afterwards removed her to his own house at Rome. Here she was frequently visited by the poet Alfieri, who made her the object of what seems to have been the only pure attachment of his life, and who, according to his own avowal, was indebted to her influence for all that was best in his works. (See Alfieri.) In 1788 she was freed from her bonds by the death of the Pretender, and in the same year she is said to have been secretly married to Alfieri. For the remainder of her life she resided at Florence, where she continued to be known as Countess of Albany, and distinguished herself as a patroness of literary men and artists. Alfieri died at her house in 1803, and in 1810 she caused a monument to his memory, by Canova, to be erected in the church of San Croce. With the death of the Cardinal of York in 1807 the Stuart line became extinct, and the countess, who died on the 29th January 1824, was the last who was known by the name of Albany. She was buried beside Alfieri in the church of San Croce.

ALBATEGNI, an Arabian astronomer, whose proper name is *Mohammed Ibn Jábir Ibn Senán Abú Abdillah*, derived this appellation from Batan in Mesopotamia, his native town, of which he is said to have been chief. His astronomical observations extended from 877 A.D. to his death in 929, and were principally conducted at Rakkah or Aracta, on the Euphrates, and at Antioch in Syria. His principal work, *Zidje Sabi*, the original MS. of which is in the Vatican, was published in a Latin translation by Plato Tiburtinus at Nuremberg in 1537, under the title *De Scientia Stellarum*, and reprinted at Bologna in 1645. Among the unpublished works of Albategni are commentaries on the *Almagest* and *Makalat* of Ptolemy, and a *Treatise on Astronomy and Geography*. Instead of the tables of Ptolemy, which were imperfect, he computed new ones; these were adapted to the meridian of Rakkah, and were long used as the best among the Arabs. Albategni gives the motion of the sun's apogee since Ptolemy's time, as well as the motion of the stars, which he estimated at 1° in 70 years. He makes the obliquity of the ecliptic 23° 35′. His determination of the length of the tropical year is more exact than that of Ptolemy, being only 2m. 26s. short. Upon his observations were founded the Alphonsine tables of the moon's motion. He first substituted sines for chords, and also introduced into trigonometry the use of tangents and versed sines. On account of his discoveries, the chief of which is the motion of the sun's apogee, he has been called the Arabian Ptolemy, and has been placed by some at the head of Arabian astronomers.

ALBATROSS, a genus of aquatic birds (*Diomedea*), closely allied to the Petrels and Gulls, belonging to the family of *Longipennatæ*, or long-winged birds, in the order *Natatores*. In the name *Diomedea*, assigned to them by Linnæus, there is a reference to the mythical metamorphosis of the companions of the Greek warrior Diomedes into birds. They have the beak large, strong, and sharp-edged, the upper mandible terminating in a large hook; the wings are narrow and very long; the feet have no hind toe, and the three anterior toes are completely webbed. Of the three species that the genus includes the best known is the Common or Wandering Albatross (*D. exulans*), which occurs in all parts of the Southern Ocean, and in the seas that wash the coast of Asia to the south of Behring Strait. It is the largest and strongest of all sea-birds. The length of the body is stated at 4 feet, and the weight at from 15 to 25 lb. It sometimes measures as much as 17 feet between the tips of the extended wings, averaging probably from 10 to 12 feet. Its strength of wing is very great. It often accompanies a ship for days—not merely following it, but wheeling in wide circles round it—without ever being observed to alight on the water, and continues its flight, apparently untired, in tempestuous as well as in moderate weather. It has even been said to sleep on the wing, and Moore alludes to this fanciful "cloud-rocked slumbering" in his *Fire Worshippers*. It feeds on small fish and on the animal refuse that floats on the sea, eating to such excess at times that it is unable to fly, and rests helplessly on the water. The colour of the bird is a dusky white, the back being streaked transversely with black or brown bands, and the wings darker than the rest of the body. The flesh, though hard, dry, and unsavoury, is eaten by the inhabitants of Kamtchatka, who also capture the bird for its entrails, which they inflate for net-floats, and its long wing-bones, which they manufacture into various articles, particularly tobacco-pipes. The albatross lays one egg; it is white, with a few spots, and is about 4 inches long. In breeding-time the bird resorts to solitary island groups, like the Crozet Islands and the elevated Tristan da Cunha, where it has its nest—a natural hollow or a circle of earth roughly scraped together—on the open ground. The early explorers of the great Southern Sea cheered themselves with the companionship of the albatross in its dreary solitudes; and the evil hap of him who shot with his cross-bow the bird of good omen is familiar to readers of Coleridge's *Rime of the Ancient Mariner*.



ALBAY, a town of Luzon, the chief of the Philippine Islands, in 13° 22′ N. lat. and 123° 52′ E. long. It is the capital of the fertile province of the same name, and the residence of the governor, and has an active trade. Close to the town is an active volcano by which it has been frequently devastated. Population, 13,115.

ALBERONI, Giulio, cardinal and statesman, was born near Piacenza, probably at the village of Fiorenzuola, on the 31st May 1664. His father was a gardener, and he himself became first connected with the church in the humble position of verger in the cathedral of Piacenza. Having gained the favour of Bishop Barni, he took priest's orders, and afterwards accompanied the son of his patron to Rome. During the war of the Spanish succession Alberoni laid the foundation of his political success by the services he rendered to the duke of Vendôme, commander of the French forces in Italy; and when these forces were recalled in 1706, he accompanied the duke to Paris, where he was favourably received by Louis XIV. In 1711 he followed Vendôme into Spain as his secretary. Two years later, the duke having died in the interval, Alberoni was appointed consular agent for Parma at the court of Philip V. of Spain, being raised at the same time to the dignity of count. On his arrival at Madrid he found the Princess des Ursins all but omnipotent with the king, and for a time he judged it expedient to use her influence in carrying out his plans. In concert with her he arranged the king's marriage with Elizabeth Farnese of Parma, whom he represented to be of such a facile disposition that the princess's power over Philip would be in no degree impaired by the union. Alberoni was already in Parma to conclude the negotiation ere the Princess des Ursins discovered that he had entirely deceived her as to the character of Elizabeth. A messenger was at once despatched to prevent, if possible, the ratification of the engagement; but he arrived too late. On reaching Spain Elizabeth's first act, prompted doubtless by Alberoni, was to demand the instant dismissal of the outwitted favourite, who was compelled to leave the Spanish dominions. The influence of the new queen being actively exerted on Alberoni's behalf, he speedily rose to high position. He was made a member of the king's council, bishop of Malaga, and in 1715 prime minister, and was raised to the dignity of cardinal in 1717. His internal policy was exceedingly vigorous, and, though carried out altogether regardless of popular rights and liberties, might have restored the lost greatness of Spain had it not been for his unscrupulous and audacious conduct of foreign affairs. The key to his daring and crafty schemes is probably to be found in the desire of Elizabeth to secure a throne for her son Don Carlos, born in 1716. Seizing the flimsiest pretext for making war upon Austria, he invaded the island of Sardinia, then Austrian territory, and took possession of Sicily. In France he pressed the claims of Philip V. to the regency in opposition to the Duke of Orleans; he sought to keep England employed at home by encouraging the Pretender, and he pursued a similar policy towards Austria in connection with Ragotski of Transylvania and the Sultan. An alliance which he formed with Russia and Sweden led to no practical results, and his other schemes similarly failed. England, France, Austria, and Holland united themselves in what is known as the Quadruple Alliance against the aggressions of Spain; and though their first proposals were rejected fearlessly by Alberoni, they were strong enough to succeed when, in a second negotiation, they required of Philip the dismissal of his minister as an indispensable condition of peace. On the 5th December 1719 he was ordered to leave Spain, Elizabeth herself having taken an active part in procuring the decree of banishment. He went to Italy, and there had to take refuge among the Apennines, Pope Clement, who was his bitter enemy, having given strict orders for his arrest. On the death of Clement, Alberoni boldly appeared at the Conclave, and took part in the election of Innocent XIII. (1721), after which he was for a short time imprisoned by the pontiff on the demand of Spain. At the next election he was himself proposed for the papal chair, and secured ten votes at the Conclave which elected Benedict XIII. Benedict's successor, Clement XII., named him legate of Ravenna, in which capacity he incurred the pope's displeasure by the strong and unwarrantable measures he adopted to reduce the little republic of San Marino to subjection to Rome. He was consequently replaced by another legate in 1740, and soon after he retired to Piacenza, where he founded a college which still bears his name. He died on the 16th June 1752, leaving a sum of 600,000 ducats to endow the seminary he had founded, and the residue of the immense wealth he had acquired in Spain to his nephew. Alberoni left a large quantity of manuscripts; but the genuineness of the *Political Testament*, published in his name at Lausanne in 1753, has been questioned.

ALBERT (Albrecht) I., Duke of Austria, and afterwards King of Germany, born in 1248, was the son of Rudolph of Habsburg, the founder of the imperial Austrian dynasty. Rudolph having acquired the duchy of Austria by conquest, vested it in his son, with consent of the electors, in 1282, and thus founded the dynasty which still reigns. He also endeavoured to secure for Albert the succession to the throne of Germany, but was unsuccessful. On the death of his father in 1291, Albert seized the insignia of sovereignty, and with characteristic presumption declared himself king of Germany, without regard to the decision of the electors. Their choice fell (1292) upon Adolphus of Nassau, and Albert, who was called to suppress a revolt among his subjects in Switzerland, found it necessary to acknowledge the superior claims of his rival. The government of Adolphus having become displeasing to the electors, they formally deposed him in 1298, and named Albert his successor. As, however, the former refused to recognise their verdict, the matter had to be referred to the arbitrament of the sword. The forces of the rival kings met at Gölheim, near Worms, where the army of Adolphus was defeated, and he himself slain by Albert's own hand. Upon this, Albert, wishing probably to show his moderation, resigned his claim to the throne, but he was re-elected, and crowned at Aix-la-Chapelle on the 24th August 1298. Pope Boniface VIII., however, denied the right of the electors, and refused to confirm their choice, alleging that the empire belonged to him alone to hold or bestow at his pleasure. In league with Philip the Fair of France, Albert at first openly resisted the pope; but soon finding it advisable to change his policy, he deserted his ally, admitted the papal jurisdiction, and was rewarded with the kingdom of the deposed Philip. It should be noted, however, that he never received from the pope the crown of the Roman empire, though his name is generally included in the list of emperors. His reign as king of Germany was one of continual warfare. With a rapacity which seems to have known no bounds, he endeavoured to subdue Holland, Zealand, Friesland, Hungary, and Bohemia; but was in each case unsuccessful. The attempt to bind his yoke more firmly upon the Swiss cantons caused the revolt of Unterwalden, Schwyz, and Uri, in January 1308, and thus laid the foundation of the Swiss Confederation. It was while endeavouring to check this revolt that Albert met his death at the hand of his nephew, John of Habsburg, whose claim to his father's dominion of Swabia had been refused in the most insulting terms by the king. Incensed at the denial of his rights, John formed a conspiracy with three noblemen of the king's suite. On the 1st May 1308 the four crossed the river Reuss at Windisch with Albert, who was slain immediately on landing, and before the eyes of the other members of the suite, who had been left on the opposite side. He died in the arms of a beggar woman, who happened to be passing.

Albert was married to Elizabeth, daughter of the count of Tyrol, who bore him eleven children.

Four other reigning dukes of Austria bore the name of ALBERT. Of these, Albert II., surnamed the Wise, reigned from 1330 to 1358; Albert III. from 1365 to 1390; and Albert IV., surnamed the Pious, from 1390 to 1402. Albert V., surnamed "The Magnanimous," born in 1397, was elected king of Germany in April 1438, and is therefore sometimes styled Albert II., the higher dignity having been previously borne only by the first of the name. Through his marriage in 1422 with Elizabeth, daughter of Sigismund, king of Bohemia and Hungary, he ultimately added the sovereignty of these dominions to his own, being elected king of Hungary on the death of Sigismund in 1437, and king of Bohemia in May 1438. He died at Langendorf on the 27th October 1439, while engaged in an expedition against the Turks.

ALBERT I., margrave of Brandenburg, surnamed "The Bear," from the heraldic emblem he assumed, born in 1106, was the son of Otto the Rich, count of Ballenstädt, by his marriage with Eilica, eldest daughter of the duke of Saxony. In 1121 he received from the Emperor Lothario the marquisate of Lusatia, to be held in fief, and he served the empire faithfully in the war with Bohemia in 1126. In the following year, from some unknown motive, the emperor conferred the duchy of Saxony, to which Albert, as son of the eldest daughter of Magnus, had the best claim, upon Henry of Bavaria, son of a younger daughter; and in 1131 Albert was deprived of Lusatia. He still remained, however, loyal to the empire, and received as a reward the margravate of Brandenburg in 1134. In 1136–7 he made incursions into the territory of the Wends, his troublesome neighbours on the north, and succeeded in strengthening his position. In 1138 the Emperor Conrad III. conferred upon him the duchy of Saxony; but finding himself unable to maintain his rights against Henry the Lion, he betook himself in 1142 to the emperor, who restored Saxony to his rival, and allotted Swabia to him in compensation. A few years later Albert again attacked the Wends, and secured by conquest large accessions of territory, which he held as a fief of the empire. On the extinction of the house of Staden in 1150, Albert was raised to the dignity of an elector. A third expedition against the Wends, undertaken in 1157, ended in their almost total extinction, and Albert caused the depopulated territory to be colonised by industrious agriculturists from the Rhine and the Netherlands, who greatly improved the face of the country. In 1158 Albert went on a crusade to the Holy Land, in company with his wife, returning the following year. The close of his reign was signalised by another war with Henry of Saxony (1164–8), in which Albert was unsuccessful. Immediately on peace being concluded, he abdicated in favour of his eldest son; and after two years spent in retirement, he died at Ballenstädt on the 18th November 1170.

ALBERT, Margrave of Brandenburg and first Duke of Prussia, third son of the Margrave Friedrich of Anspach, was born on the 17th May 1490. Being intended for the church, he was educated by Archbishop Hermann of Cologne, and became a canon of Cologne cathedral. He seems, however, to have himself preferred a military life, as he accompanied his father in the train of the emperor on an expedition to Venice, and was present at the siege of Pavia. On the 13th Feb. 1511 he joined the Teutonic order; and a few days after, though scarcely twenty-one years old, was chosen grand master, it being expected that, as nephew of Sigismund of Poland, he would be able to secure the privileges and immunities which the order were at the time claiming from that monarch. The refusal of Albert to swear allegiance to Sigismund led, after protracted negotiations, which proved fruitless, to a war with Poland in 1520. A four years' truce being concluded at Thorn in 1521, Albert repaired to the diet at Nuremberg to invoke the aid of his brother German princes on behalf of his order. The diet found itself unable to render him any assistance, and at the same time he received advice from Luther which altogether changed his purpose. Embracing the doctrines of the Reformation, he was declared Duke of Prussia, consented to hold the duchy as a fief from Poland, and took the oath of allegiance at Cracow on the 9th April 1525. At the same time he resigned the grand mastership of the order. In 1527 he married Anne Dorothea, daughter of the king of Denmark. His subsequent reign was marked by zealous efforts, amid many difficulties, to promote the welfare of his duchy. He interested himself especially in the advancement of learning, inviting men of letters to his court, and promoting the publication of their writings. In 1544 he founded the university of Königsberg, in spite of great opposition, chiefly from the pope. Keen theological disputes between the professors of this university were among the many troubles of his later years. He died of the plague on the 20th of March 1568. His second wife, the Princess Anna Maria of Brunswick, who had been attacked by the same disease, survived him only a single day.

ALBERT, Cardinal Archbishop of Magdeburg and Elector of Mentz, born 1489, was the youngest son of John, Elector of Brandenburg. In 1513 he was consecrated archbishop of Magdeburg, and about the same time he was chosen administrator of the diocese of Halberstadt. Next year he was raised to the still higher dignity of archbishop and elector of Mentz, and he continued to hold all three offices simultaneously. For the *pallium* in connection with the latter appointment the pope demanded the exorbitant sum of 30,000 ducats, but enabled the archbishop to recoup himself by granting him the privilege of selling indulgences throughout his diocese. It was his employment of the Dominican Tetzel in this service which, by calling forth Luther's famous ninety-five theses, had so important an influence on the course of the Reformation. In 1518 he was created a cardinal as a reward for his services to the Romish church. His opposition to the doctrines of Luther did not prevent many within his own diocese from accepting the Reformation; and he found it necessary to grant religious liberty to his subjects in 1541, availing himself of the opportunity to extort from them in return for the boon the payment of his debts, which amounted to 500,000 florins. Albert was a patron of learning, and counted Erasmus among his friends. He died at Mentz on the 24th September 1545.

ALBERT (PRINCE), FRANCIS CHARLES AUGUSTUS ALBERT EMMANUEL, Prince Consort of England, born at Rosenau on the 26th Aug. 1819, was the second son of the hereditary Duke of Saxe-Coburg-Gotha, by his first wife the Princess Louise of Saxe-Gotha-Altenburg. He thus belonged to the Ernestine or elder branch of the royal family of Saxony, which, on account of its adherence to the doctrines of the Reformation, had to surrender the kingdom to the Albertine or younger branch, which is still in possession of it. The marriage of his parents proving an unhappy one, they separated in 1824, and the young prince never again saw his mother, who died in 1831. He was educated, along with his elder brother Ernest, under the care of *Consistorial-Rath* Florschütz, who, in a memorandum drawn up after the prince's death, speaks in the highest terms of his pupil's benevolent disposition and studious habits. At the proper age the brothers proceeded to the university of Bonn, where Herr Florschütz still continued to exercise a general superintendence of their studies. Prince Albert devoted himself especially to the

natural sciences, political economy, and philosophy, having for teachers men of such world-wide fame as Fichte, Schlegel, and Perthes. He also diligently cultivated at this period the sister arts of music and painting, and thus qualified himself for some of the most valuable services he was afterwards to render to the land of his adoption. His feeling for art in all its forms was very sensitive, and his executive skill, both as a musician and painter, very considerable. In gymnastic exercises he greatly excelled, carrying off the first prize for fencing in a competition with a large number of students.

In 1836 the prince visited England in company with his father, and met his future consort for the first time. The idea of a matrimonial alliance between the cousins had occurred to various members of the family, and had been cherished especially by their grandmother the dowager-duchess of Coburg, and their uncle Leopold, the king of the Belgians. From the time of the queen's accession there seems to have been a family understanding on the subject, though, owing to the youth of the prince and his cousin, no formal engagement was entered into till two years later. In the winter of 1838–9 the prince travelled in Italy, accompanied by Mr Seymour, a young English gentleman, who was selected doubtless out of regard to the probable future of his charge. A year later the hopes of many were realised when, on the 23d Nov. 1839, the queen announced to the Privy Council her intended marriage with her cousin. The circumstances of the engagement have been fully made known since the prince's death, and they show that the union was founded upon mutual choice, springing from mutual affection. On the 10th February 1840 the marriage was celebrated at the chapel-royal, St James's, amid universal rejoicings. A few days before the event two bills had been passed in parliament, one naturalising the prince as a British subject, and the other providing an annuity of £30,000 a year for the maintenance of his establishment. The ministry had proposed that the sum should be £50,000, following the precedent established in the case of Prince Leopold; but the reduction was made on the motion of Colonel Sibthorpe, who received the support of the radicals and the entire opposition. The result of the vote caused the prince considerable vexation and disappointment, which were enhanced when difficulties were raised in parliament as to the precedence to be accorded to him. The latter question was only settled by an exercise of the queen's prerogative. Letters patent were issued on the 5th March, giving the prince precedence next to the queen.

The position in which the prince was placed by his marriage, while it was one of distinguished honour, was also one of peculiar difficulty, and it was only the possession of a rare discretion that enabled him to fill it so irreproachably as he did. Published letters and memoranda show how thoroughly he appreciated the delicate nature of his duties, and how clearly he perceived the limits within which his influence must be confined if it was to be legitimately and usefully exerted. A letter to the Duke of Wellington, declining, after mature consideration, to be designated to the office of commander-in-chief of the army, is especially noteworthy as containing an admirable description of the proper functions of a prince-consort. Generally, his idea was that it was his duty to merge his personality as completely as possible in that of the sovereign, while giving her in all things real but unobtrusive advice and support; and that he acted during his whole life in conformity with this idea those who had the best means of knowing were the readiest to testify. Once, indeed, at the commencement of the Crimean war, it was generally believed that he had overstepped the limits of his position by interfering unwarrantably with the foreign policy of the country and the patronage of the army. The charges were so definite and so widely circulated that it was deemed necessary to take notice of them in parliament. They were met by a complete and emphatic denial on the part of the ministry, and no one now believes that they had any real foundation. It was, of course, both natural and proper that the prince should interest himself deeply in the affairs of the country over which, by an Act passed on the 4th Aug. 1840, he had been named regent in the event of the death of the queen before the heir to the crown had attained the age of eighteen years. He had also a right to interest himself in the administration of the army, as being himself a field-marshal and a colonel of hussars.

It was fortunate for the prince, shut out as he was by the circumstances of his station from any share in party politics, that he found other and more congenial work sufficient to engage all his energies. He was qualified, as few of his rank are, to deal with those social and scientific problems in the solution of which men of all parties are equally interested. He engaged himself especially in endeavours to secure the more perfect application of science and art to manufacturing industry. The Great Exhibition of 1851 originated in a suggestion he threw out at a meeting of the Society of Arts, and owed the greater part of its success to his intelligent and unwearied efforts. Similar institutions, on a smaller scale but with a kindred aim, always found in him warm advocacy and substantial support. It was chiefly at meetings in connection with these that he found occasion for the delivery of addresses characterised by profound thought and comprehensiveness of view, a collection of which was published in 1857. One of the most favourable specimens of his powers as a speaker is the inaugural address which he delivered as President of the British Association for the Advancement of Science when it met at Aberdeen in 1859, printed in an edition of his speeches which appeared in 1862. The education of his family and the management of his domestic affairs furnished the prince with another very important sphere of action, in which he employed himself with conscientious devotedness. The training of the Prince of Wales was carried on under his own superintendence, in accordance with a plan he himself had drawn up; and it may be questioned whether so much wisdom and care was ever bestowed on the upbringing of an heir to the British throne. The estates of the Duchy of Cornwall, the hereditary appanage of the Prince of Wales, were so greatly improved under his father's management that the rent-roll rose from £11,000 to £50,000 a year. Prince Albert, indeed, had a peculiar talent for the management of landed estates. His model farm at Windsor was in every way worthy of the name; and the grounds at Balmoral and Osborne, so universally admired, were laid out entirely in conformity with his designs.

A character so pure, and a life so useful and well-directed in all its aims, could scarcely fail to secure universal respect. As the prince became better known, the mistrust, of which the adverse votes in parliament were undoubtedly to some extent an expression, gave way, and the people vied with their queen in showering deserved honours upon him. After a keen contest with Earl Powis, he was elected chancellor of the university of Cambridge in 1847; and he was afterwards appointed master of the Trinity House. In 1857 the formal title of "Prince-Consort" was conferred upon him by letters patent, in order to settle certain difficulties as to precedence that had been raised at foreign courts. As he had previously possessed no distinctive title, the precedence he had received was only by courtesy.

It was in the prime of manhood and the full career of his usefulness that the prince-consort was removed by death. He had been greatly occupied during the autumn

of 1861 with the arrangements for the projected international exhibition, and it was just after returning from one of the meetings in connection with it that he was seized with his last illness. He died of typhoid fever on the 14th of Dec. 1861. Few have ever been more sincerely or more universally mourned. The grief of the queen was deep and lasting, and the whole nation sympathised in the truest sense with her in her sorrow. Perhaps never before, except on the occasion of the death of the Princess Charlotte, had all classes of the people been so closely knit together in the feeling of a common bereavement and a common sorrow. A national memorial, to be erected partly by parliamentary vote and partly by public subscription, was at once resolved upon, and nearly every town of importance throughout the kingdom embodied in a statue or some other form its tribute to the memory of "The Good Prince." The magnificent mausoleum at Frogmore, in which his remains were finally deposited, was erected at the expense of the Queen and the royal family. (See *Early Years of H.R.H. the Prince Consort*, 1867; *Principal Speeches and Addresses of Prince Albert*, with an Introduction, 1862).

ALBERT NYANZA, a large lake in East Central Africa, extending from 2° 45′ N. lat. at least as far as 2° S. Its surface is 2720 feet above the level of the sea: on its western coast are the Blue Mountains, rising 7000 feet higher; and on the east a ridge of steep cliffs, with elevations varying from 1500 to 5000 feet. The White Nile, flowing in a north-westerly direction from Lake Victoria Nyanza, enters Lake Albert Nyanza about 2° 15′ N. lat., and issues from it near its northern extremity. Messrs Speke and Grant were informed of the existence of this lake by the natives, but Sir Samuel (then Mr) Baker and his wife were the first Europeans who explored it in 1864. (See AFRICA and NILE, and also Sir S. W. Baker's *The Albert Nyanza, the Great Basin of the Nile, and Explorations of the Nile Sources*, 2 vols., London, 1866).

ALBERTI, LEON BATTISTA, distinguished as a painter, poet, philosopher, musician, and especially as an architect, was descended from the noble family of the Alberti of Florence. The place and date of his birth are variously given, but it is most probable that he was born at Venice about the year 1404. He was so skilled in Latin verse that a comedy he wrote in his twentieth year, entitled *Philodoxius*, deceived the younger Aldus, who edited and published it as the genuine work of Lepidus. In music he was reputed one of the first organists of the age. He held the appointment of canon in the metropolitan church of Florence, and thus had leisure to devote himself to his favourite art. He is generally regarded as one of the restorers of the ancient style of architecture, and has been called by some writers the Florentine Vitruvius. At Rome he was employed by Pope Nicholas V. in the restoration of the papal palace and of the fountain of Acqua Vergine, and in the ornamentation of the fountain of the Piazza de Trevi. At Rimini he designed the celebrated church of San Francesco, which is generally esteemed his finest work. On a commission from Rucellai, he designed the principal façade of the church of Santa Maria Novella in Florence, as well as the family palace in the Via della Scala, now known as the Palazzo Strozzi. In Mantua he was employed by the Marchese Ludovico Gonzaga to design several buildings, the most important being the church of Sant' Andrea. Alberti wrote works on sculpture, *Della Statua*, and on painting, *De Pictura*, which are highly esteemed; but his most celebrated treatise is that on architecture, *De Re Ædificatoria*, which has been translated into Italian, French, Spanish, and English. A splendid edition of this work in English and Italian, by Leoni, was published at London in 1726, in 3 vols. folio. Alberti, being of an amiable and generous disposition, was highly esteemed by his contemporaries. He died at Rome in 1472, or, according to others, in 1484.

ALBERTRANDY, JAN CHRZCICIEL, or JOHN CHRISTIAN, historian, was born at Warsaw in 1731, his father being an Italian. Educated in the public school of the Jesuits, he joined their order in his fifteenth year, and gave such proof of his ability that, at the early age of nineteen, he was appointed professor at the college of Pultusk. After having successively filled similar positions in Plock, Nieswiez, and Wilna, he became, in 1766, librarian to Bishop Zaluski, who designed to make his extensive collection of books available to the public. A detailed catalogue of the 200,000 volumes which it contained was accordingly prepared by Albertrandy. In 1764 he was chosen by the primate Lubienski tutor to his grandson, Count Felix Lubienski, afterwards minister of justice. In this capacity he visited Italy in 1770 with his pupil, residing first at Siena and then at Rome. The preference Lubienski showed for numismatics induced Albertrandy to devote himself while in Italy to the special study of that science, and he was soon recognised as an authority on the subject. When he returned to his native country, King Stanislaus Augustus appointed him, at the request of Lubienski, keeper of his medals, and afterwards his reader and librarian. The representations he made to the king as to the extent and value of the materials for Polish history that were scattered throughout the libraries of Rome, induced Stanislaus to send him on a second visit to Italy, in order that he might collect these materials. He arrived at Rome in 1782, and devoted three years to the task. The *Excerpta*, all written with his own hand, filled 110 volumes of manuscript. To complete the collection, he subsequently visited Sweden, where the difficulty of the work was greatly increased by his being forbidden to copy any portions of the books or manuscripts he consulted. An excellent memory, however, enabled him in great measure to overcome the difficulty; and from the libraries of Stockholm and Upsala he made extracts which increased the entire collection to 200 volumes. In recognition of his merit the king bestowed on him the bishopric of Zenopolis. He was the first president of the Royal Society of the Friends of Science in Warsaw, and took a large share in its proceedings up to the time of his death, which occurred on the 10th August 1808.

ALBERTUS MAGNUS, a celebrated scholastic philosopher, was born of the noble family Von Bollstädt at Lauingen in Suabia. The date of his birth is most probably 1193. He was educated principally at Padua, where he received particular instruction in Aristotle's writings. In 1223 he became a member of the Dominican order, and studied theology under its rules at Bologna and elsewhere. Selected to fill the position of lecturer at Cologne, where the order had a house, he taught for several years there, at Regensburg, Freiburg, Strasburg, and Hildesheim. In 1245 he repaired to Paris and received his doctorate, teaching for some time, in accordance with the regulations, and with great success. In 1254 he was made provincial of his order, and fulfilled the arduous duties of the office with great care and effectiveness. During the time he held this office he publicly defended the Dominicans against the university of Paris, commented on St John, and answered the errors of the Arabian philosopher, Averroes. In 1259 the pope made him bishop of Regensburg, which office he resigned after three years. The remainder of his life he spent partly in preaching throughout Bavaria and the adjoining districts, partly in retirement in the various houses of his order; almost the last of his labours was the defence of the orthodoxy of his former pupil, Thomas Aquinas. He died in 1280, aged 87. Albert's works, published in twenty-one folios by the Dominican Peter

Jammy in 1651, sufficiently attest his great activity. He was the most widely read and most learned man of his time. The whole of Aristotle's works, presented in the Latin translations and notes of the Arabian commentators, were by him digested, interpreted, and systematised in accordance with church doctrine. Albert's activity, however, is rather philosophical than theological, for while pressing philosophy in general, and Aristotle in particular, into the service of theology, he excludes from what belongs to the natural reason all that is specially biblical, as, *e.g.*, miracles, the atonement, and the Trinity; though he does not refuse to see with Augustin exemplifications, shadowings, of the latter doctrine even in nature. The philosophical works occupying the first six and the last of the twenty-one volumes are generally divided according to the Aristotelian scheme of the sciences, and consist of interpretations and condensations of Aristotle's relative works, with supplementary discussions depending on the questions then agitated, and occasionally divergences from the opinions of the master. In logic, he attempts to unite the three rival theories of universals, holding that universals exist in three ways—(1.) *Ante res*, as ideas in the mind of God, from which the class is modelled, and which therefore exist before individual things; (2.) *In rebus*, as the common basis in a class of individual objects; (3.) *Post res*, as the mental notion of the class. In the metaphysical and physical treatises he mainly repeats Aristotle, differing from him as regards the eternity of the world and the definition of the soul. His principal theological works are a commentary in three volumes on the *Books of the Sentences* of Peter Lombard (*Magister Sententiarum*), and the *Summa Theologiæ*, in two volumes. This last is in substance a repetition of the first in a more didactic form. Albert's knowledge of physical science was considerable, and for the age accurate. His industry in every department was great, and though we find in his system many of those inner gaps from which no scholastic philosophy was ever free, yet the protracted study of Aristotle gave him a great power of systematic thought and exposition, and the results of that study, as left to us, by no means warrant the contemptuous title sometimes given him—the "Ape of Aristotle." They rather lead us to appreciate the motives which caused his contemporaries to bestow on him the honourable surname "The Great," and the no less honourable title, "Doctor Universalis." For Albert's life the best authorities are Sighart, *Albertus Magnus, sein Leben und seine Wissenschaft*, 1857; and D'Assailly, *Albert le Grand*, 1870. The most comprehensive surveys of his philosophy are those of Stöckl, *Geschichte d. Scholastischen Philosophie*, and, in smaller compass, Erdmann, *Grundriss d. Ges. d. Phil.*, vol. i. Hauréau, Ritter, and Prantl may also be referred to.

ALBI, a city of France, capital of the department of the Tarn, is situated on the river Tarn, 41 miles N.E. of Toulouse. It is a place of great antiquity, and was a stronghold of the early French Protestants, giving its name to the Albigenses. It is the seat of an archbishop, and has a chamber of commerce and a public library of 12,000 volumes. The cathedral, dedicated to St Cecilia, is a magnificent Gothic edifice, in the style of the 13th century, and has one of the finest choirs in France. Here there is a very valuable silver shrine, of exquisite mosaic work, containing the relics of St Clair, the first bishop of the see. The environs are charming, and the promenade of *La Lice*, without the city, is a beautiful terrace bordered with two rows of very fine trees. At one end is the convent of the Dominicans. Albi has woollen and linen manufactures; coal, iron, and copper are wrought in the vicinity; and the surrounding district is very fertile, producing much grain and fruit. Population (1872), 17,469.

ALBIGENSES, a sect opposed to the Church of Rome, which derives its name from Albiga (the modern *Albi*, noticed above), either because its doctrines were expressly condemned at a council held there, or, more probably, because its adherents were to be found in great numbers in that town and its neighbourhood. The Albigenses were kindred in origin and more or less similar in doctrine to the sects known in Italy as Paterins, in Germany as Catharists, and in France as Bulgarians, but they are not to be entirely identified with any of these. Still less ought they to be confounded, as has frequently been the case, with the Waldenses, who first appear at a later period in history, and are materially different in their doctrinal views. The descent of the Albigenses may be traced with tolerable distinctness from the Paulicians, a sect that sprang into existence in the Eastern Church during the 6th century. (See PAULICIANS.) The Paulicians were Gnostics, and were accused by their enemies and persecutors of holding Manichæan doctrines, which, it is said, they vehemently disowned. Their creed, whatever it was precisely, spread gradually westward through Europe. In the 9th century it found many adherents in Bulgaria, and 300 years later it was maintained and defended, though not without important modifications, by the Albigenses in the south of France. The attempt to discover the precise doctrinal opinions held by the Albigenses is attended with a double difficulty. No formal creed or definite doctrinal statement framed by themselves exists, and in default of this it is impossible to depend on the representations of their views given by their opponents in the Church of Rome, who did not scruple to exaggerate and distort the opinions held by those whom they had branded as heretics. It is probably impossible now to determine accurately what is true and what is false in these representations. It seems almost certain, however, that the bond which united the Albigenses was not so much a positive fully-developed religious faith as a determined opposition to the Church of Rome. They inherited indeed, as has been already said, certain doctrines of eastern origin, such as the Manichæan dualism, docetism in relation to the person of Christ, and a theory of metempsychosis. They seem, like the Manichees, to have disowned the authority of the Old Testament; and the division of their adherents into *perfecti* and *credentes* is similar to the Manichæan distinction between *electi* and *auditores*. The statement that they rejected marriage, often made by Roman Catholics, has probably no other foundation in fact than that they denied that marriage was a sacrament; and many other statements as to their doctrine and practice must be received at least with suspicion as coming from prejudiced and implacable opponents. The history of the Albigenses may be said to be written in blood. At first the church was content to condemn their errors at various councils (1165, 1176, 1178, 1179), but as their practical opposition to Rome became stronger, more decided measures were taken. Innocent III. had scarcely ascended the papal throne when he sent legates to Toulouse (1198) to endeavour to suppress the sect. Two Cistercians, Guy and Regnier, were first commissioned, and in 1199 they were joined by Peter of Castelnau and others, who were known throughout the district as inquisitors. Raymond VI., count of Toulouse, took the part of his Albigensian subjects, though not himself belonging to the sect, and for this he was excommunicated in 1207. A year later the pope found a pretext for resorting to the most extreme measures in the assassination of his legate Peter of Castelnau, Jan. 15, 1208. A crusade against the Albigenses was at once ordered, and Raymond, who had meanwhile submitted and done penance, was forced to take the field against his own subjects. The bloody war of extermination which followed has scarcely a parallel in history. As

town after town was taken, the inhabitants were put to the sword without distinction of age or sex, and the numerous ecclesiastics who were in the army especially distinguished themselves by a bloodthirsty ferocity. At the taking of Beziers (July 22, 1209), the Abbot Arnold, being asked how the heretics were to be distinguished from the faithful, made the infamous reply, "Slay all; God will know his own." The war was carried on under the command of Simon de Montfort with undiminished cruelty for a number of years. Raymond's nephew, Viscount Raymond Roger, who had espoused the cause of the Albigenses, was taken prisoner at Carcassone, and the sect became fewer in numbers year by year. The establishment of an Inquisition at Languedoc in 1229 accelerated the exterminating process, and a few years later the sect was all but extinct.

ALBINO. The name *Albinism*, or *Leucopathia*, is applied to a remarkable peculiarity in the physical constitution of certain individuals, which consists in the skin and hair being perfectly white. The earliest accounts we have of it refer to its being observed among the negroes of West Africa by the Portuguese, who called the persons so affected *Albinoes*. They have also been called *Leucœthiopes*, *i.e.*, white negroes. Albinism is most common and most marked in the negro and Indian races, but it occurs in all parts of the world and among all the varieties of the human race. The appearance arises from the absence of the minute particles of colouring matter which ordinarily occur in the lowest and last-deposited layers of the epidermis or outer skin, and to the presence of which the skin owes its colour. With very rare exceptions, it affects the entire body, and continues through life. The skin of the albino is of a dull milky or pearly colour, unrelieved by the slightest tint of red or brown, and is generally of rough texture. All the hair on the body is of the same dull hue, and is commonly soft and silky. Another peculiarity that invariably accompanies this whiteness of skin and hair is an affection of the eyes: the pupil is a bright red, and the iris (or *white* of the eye) that surrounds it is of a pale rose colour. This redness is attributable to the absence of a colouring matter, the *pigmentum nigrum* of the membrane of the eye, which serves to protect the retina. In consequence of this defect, the eye of an albino cannot bear a strong light. Albinism is hereditary in the same limited degree as blindness, deafness, &c. See on this Darwin's *Variation of Animals and Plants under Domestication* (chap. xii.), where mention is made that "two brothers married two sisters, their first cousins, none of the four nor any relation being an albino; but the seven children produced from this double marriage were all perfect albinoes." Apart from the peculiarities mentioned above, there is no distinction between albinoes and other men. Albinism is not to be regarded as a diseased condition of body; and the idea, once entertained, that it is accompanied with a want of physical and mental vigour is now completely exploded. Probably this notion arose from some of the albinoes whose condition was first described being unhealthy or imbecile; and even still more (as the interesting account of Saussure, *Voyages dans les Alpes*, 1787, suggests) from the temptation to which, as natural curiosities, they were exposed to live in indolence without exerting their natural powers. In many species of animals albinism occurs, *i.e.*, an abnormal whiteness of the skin, hair, feathers, &c., due to similar causes as in the human albino, but not so uniformly permanent. Of this, white hares, mice, blackbirds, &c., are instances. White elephants are regarded with particular veneration by some eastern nations.

ALBINUS (originally Weiss), Bernard Siegfried, a celebrated anatomist, born in 1697 at Frankfort-on-the-Oder, where his father was professor of the practice of medicine. In 1702 the latter was transferred to a professorship at Leyden, and it was there that Bernard Siegfried commenced his studies, having for his teachers such men as Boërhaave, Bidloo, and Rau. His great ability, especially in surgery and anatomy, was early recognised, and Rau, so justly celebrated as a lithotomist, is said to have seldom performed an important operation without inviting him to be present. Having finished his studies at Leyden, he went to Paris, where, under the instruction of Vaillant, Winslow, and others, he devoted himself especially to anatomy and botany. After a year's absence, he was, on the recommendation of Boërhaave, recalled in 1719 to Leyden to be a lecturer on anatomy and surgery. Two years later he succeeded his father in the professorship of these subjects, and delivered an address at his installation which was received with universal approbation. Albinus speedily became one of the most famous teachers of anatomy in Europe, his classroom being resorted to not only by students, but by many practising physicians. With little original genius, and no special talent for exposition, he possessed those habits of accurate observation and patient research which are the best qualification for his department of study. The engravings of bones and muscles executed by Wandelaar for the treatise of Albinus on these organs were far superior in clearness and exactness to anything that had previously been produced. In 1745 Albinus was appointed professor of the practice of medicine, being succeeded in the anatomical chair by his brother Frederick Bernard, who, as well as another brother, Christian Bernard, attained considerable distinction. Bernard Siegfried was twice rector of his university, and was an associate of the learned societies of London, St Petersburg, and Haarlem. He died on the 9th September 1770.

ALBINUS, Flaccus. See Alcuin.

ALBOIN, a king of the Lombards, who invaded Italy, 568 A.D. He was murdered at Verona on the 8th June 573. See Italy and Lombards.

ALBORNOZ, Gil Alvarez Carillo de, a cardinal of Spain, was born at Cuença early in the 14th century, and was related to the royal families of Leon and Arragon. While still young he was appointed archbishop of Toledo by Alfonso XI. of Castile. Uniting, as many in that age did, the exercise of the military with that of the clerical profession, he was able to show his gratitude to his patron by saving the king's life at the battle of Tarifa in 1340. He conducted the siege of Algeciras in 1343, when the king dubbed him a knight. Falling into disfavour with Pedro the Cruel, whose licentious life he had rebuked, he fled to Avignon, then the papal seat, and was soon afterwards made a cardinal by Pope Clement VI. In 1353 Innocent VI. sent him as a legate into Italy, with a view to the restoration of the papal authority in the States of the Church. He was recalled in 1357, but was sent again to Italy after a brief interval; and in 1362 had paved the way for the return of Urban V. to Rome. As a mark of gratitude, the pope appointed him legate at Bologna in 1367, but he died at Viterbo the same year. According to his own desire, his remains were carried to Toledo, where Henry of Castile caused them to be entombed with almost royal honours. A work by Albornoz on the constitution of the Church of Rome, first printed at Jesi in 1473, is now very rare. The college of St Clement at Bologna was founded by Albornoz.

ALBRECHTSBERGER, Johann Georg, a celebrated musician, born at Kloster-Neuburg, near Vienna, on the 3d February 1736. He studied musical composition under the court organist, Mann, and became one of the most learned and skilful contrapuntists of his age. After being employed as organist at Raab and Maria-Taferl, he was

appointed in 1772 organist to the court of Vienna, and in 1792 kapellmeister of St Stephen's cathedral. His fame as a theorist attracted to him in the Austrian capital a large number of pupils, some of whom afterwards became eminent musicians. Among these were Beethoven, Hummel, Moscheles, Seyfried, and Weigl. Albrechtsberger died in 1809. His published compositions consist of preludes, fugues, and sonatas for the piano and organ, string quartettes, &c.; but the greater proportion of his works, vocal and instrumental, exist only in manuscript, and are in the possession of Prince Esterhazy. Probably the most valuable service he rendered to music was in his theoretical works, which to a great extent superseded earlier treatises, and are still standard authorities. In 1790 he published at Leipsic a treatise on composition, of which a third edition appeared in 1821. A collection of his writings on harmony, in three volumes, was published under the care of his pupil Seyfried in 1826. The English translation of the latter is from a French version, and not from the original.

ALBUERA, a small village of Spain, in the province of Badajoz, 13 miles S.E. of the town of that name. It is celebrated on account of the victory gained there on the 16th of May 1811 by the English, Portuguese, and Spaniards, under Marshal Beresford, over the French army commanded by Marshal Soult.

ALBUFERA DE VALENCIA, a lagoon, 7 miles south of Valencia in Spain, about 12 miles in length and 4 in breadth, 12 feet being its greatest depth. It communicates with the sea by a narrow outlet, which can be opened or closed at pleasure. The lake is crown property, and is of great value from the fish and wild fowl with which it abounds. In 1812 Marshal Suchet was created duke of Albufera by Napoleon for his conquest of Valencia, and invested with the domain; but the battle of Vitoria soon deprived him of his possession, though he still retained the title. Subsequently the revenues of Albufera were conferred upon the Duke of Wellington, in token of the gratitude of the Spanish nation.

ALBUM (*albus*, white), originally denoted a tablet on which decrees, edicts, and other public notices were inscribed in ancient Rome. It was so called probably because the tablet was made of white or whitened material, though some authorities say that the inscription was in white characters. The Pontifex Maximus wrote his annals (*Annales Maximi*) upon an album. In course of time the term came to be restricted almost exclusively to lists of official names. Such were the *Album Judicum*, *Album Senatorum*, *Album Decurionum*, *Album Centuriæ*. In modern times album denotes a book in which verses, autographs, sketches, photographs, &c., are collected. It is also applied to the official list of matriculated students in a university, and to the roll in which a bishop inscribes the names of his clergy.

ALBUMAZAR (ABU-MAASCHAR), a celebrated Arabian astronomer, born at Balkh, in Turkestan, in 805 A.D., died at Wasid in 885. He had reached the age of forty-seven before he entered on the studies to which he owes his fame. His principal works are *An Introduction to Astronomy* and the *Book of Conjunction*, both published in a Latin translation at Augsburg in 1489, and again at Venice in 1515. A work *On the Revolution of the Years* is also attributed to him, in which it is maintained that the world was created when the seven planets were in conjunction in the first degree of Aries, and that it will come to an end at a like conjunction in the last degree of Pisces.

ALBUMEN, an organic substance of a very complicated structure. It is typical of a group of bodies that have the same chemical composition but very different properties. The principal varieties are named albumen, fibrin, and casein. They are sometimes called the histogenetic bodies, because they are essential to the building up of the animal organism. The vegetable kingdom is the original source of the albumenoid group of substances. In plants the albumen is found in greatest quantity in the seed. The mean average percentage composition of the albumenoids is as follows—

Carbon,	53·8
Hydrogen,	7·0
Nitrogen,	15·7
Sulphur,	1·2
Oxygen,	22·3
	100·0

The true chemical formula of these bodies is unknown, but if we regard the sulphur as replacing oxygen, then the *simplest empirical* formula is $C_{24}H_{38}N_6O_8$.

All the albumenoid bodies are capable of existing in two forms—(*a*) soluble, (*b*) insoluble. They belong to the class of bodies called *colloids*, and easily pass from the one condition into the other. Whether in the soluble or insoluble condition, they are easily dissolved by caustic potash, and may be precipitated by the addition of acetic acid. The soluble varieties are coagulated by alcohol, and precipitated by salts of copper, lead, and mercury. Strong sulphuric acid dissolves them, with the production of leucine, tyrosine, and ammoniacal salts. Strong nitric acid produces in their solutions a coagulum of a bright orange colour, and then gradually dissolves it with effervescence. A solution of nitrate of mercury, when heated with the members of the group, produces a deep red colour, and this is one of the most delicate tests. Some varieties of albumen coagulate when heated. All the albumenoid bodies are amorphous, and may be kept when dry for any length of time, but when moist they rapidly putrefy, and produce a sickening odour. Among the products of putrefaction are found leucine and tyrosine, and carbonate, butyrate, valerate, and sulphide of ammonium. The readiness with which these bodies change in the moist condition produces the digestive and other ferments in the body, and the synaptase, diastase, and emulsin which we find in plants. The special properties of albumen, fibrin, and casein will be described in the article CHEMISTRY. From its property of coagulating when heated, albumen is employed in the arts to remove colouring matters from liquids.

ALBUQUERQUE, a town of Spain, in the province of Badajoz, 9 miles from the frontiers of Portugal. Situated on an eminence, it is defended by an almost impregnable fortress built on a high mountain. It was taken by the allies of Charles, at that time a competitor for the Spanish throne, in 1705, but was restored to the Spanish crown in 1715. It has woollen and linen manufactures, and exports cattle and fruits. Population, 7000.

ALBUQUERQUE, ALPHONSO D' (in Portuguese *Affonso d'Alboquerque*), surnamed "The Great," and "The Portuguese Mars," was born in 1453 at Alexandria, near Lisbon. Through his father, Gonzalvo, who held an important position at court, he was connected by illegitimate descent with the royal family of Portugal, and through his mother, Dona Leonora de Menezes, he could claim kindred with Zarco and other illustrious navigators. He was educated at the court of Alphonso V., and after the death of that monarch seems to have served for some time in Africa. On his return he was appointed *estribeiro-mor* (chief equerry) to João II. In 1503 he set out on his first expedition to the East, which was to be the scene of his future triumphs. In company with his kinsman Francisco he sailed round the Cape of Good Hope to India, and succeeded in establishing the king of Cochin securely on his throne, obtaining in return for this service permission to build a Portuguese fort at Cochin, and thus

laying the foundation of his country's empire in the East. He returned home in July 1504, and was well received by King Emmanuel, who entrusted him with the command of a squadron of five vessels in the fleet of sixteen which sailed for India in 1506 under Tristan da Cunha. After a series of successful attacks on the Moorish cities on the east coast of Africa, Albuquerque separated from Da Cunha, and sailed with his squadron against the island of Ormuz, in the Persian Gulf, which was then one of the chief centres of commerce in the East. He arrived on the 25th September 1507, and soon obtained possession of the island, though he was unable long to maintain his position. With his squadron increased by three vessels, he reached the Malabar coast at the close of the year 1508, and immediately made known the commission he had received from the king empowering him to supersede the governor Almeida. The latter, however, refused to recognise Albuquerque's credentials, and cast him into prison, from which he was only released, after three months' confinement, on the arrival of the grand marshal of Portugal with a large fleet. Almeida having returned home, Albuquerque speedily showed the energy and determination of his character. An unsuccessful attack upon Calicut in January 1510, in which the commander-in-chief received a severe wound, was immediately followed by the investment and capture of Goa. Albuquerque, finding himself unable to hold the town on his first occupation, abandoned it in August, to return with reinforcements in November, when he obtained undisputed possession. He next directed his forces against Malacca, which he subdued after a severe struggle. He remained in the town nearly a year in order to strengthen the position of the Portuguese power. In 1512 he sailed for the coast of Malabar. On the voyage a violent storm arose, Albuquerque's vessel, the "Flor de la Mar," which carried the treasure he had amassed in his conquests, was wrecked, and he himself barely escaped with his life. In September of the same year he arrived at Goa, where he quickly suppressed a serious revolt headed by Idalcan, and took such measures for the security and peace of the town that it became the most flourishing of the Portuguese settlements in India. Albuquerque had been for some time under orders from the home government to undertake an expedition to the Red Sea, in order to secure that channel of communication exclusively to Portugal. He accordingly laid siege to Aden in 1513, but was repulsed; and a voyage into the Red Sea, the first ever made by a European fleet, led to no substantial results. In order to destroy the power of Egypt, he is said to have entertained the idea of diverting the course of the Nile, and so rendering the whole country barren. His last warlike undertaking was a second attack upon Ormuz in 1515. The island yielded to him without resistance, and it remained in the possession of the Portuguese until 1622. Albuquerque's great career had a painful and ignominious close. He had several enemies at the Portuguese court who lost no opportunity of stirring up the jealousy of the king against him, and his own injudicious and arbitrary conduct on several occasions served their end only too well. On his return from Ormuz, at the entrance of the harbour of Goa, he met a vessel from Europe bearing despatches announcing that he was superseded by his personal enemy Soarez. The blow was too much for him, and he died at sea on the 16th December 1515. Before his death he wrote a letter to the king in dignified and affecting terms, vindicating his conduct and claiming for his son the honours and rewards that were justly due to himself. His body was buried at Goa in the Church of Our Lady, and it is perhaps the most convincing proof possible of the justice of his administration, that, many years after, Moors and Hindoos used to go to his tomb to invoke protection against the injustice of his successors. The king of Portugal was convinced too late of his fidelity, and endeavoured to atone for the ingratitude with which he had treated him by heaping honours upon his natural son Affonso. The latter published a selection from his father's papers, under the title *Commentarios do Grande Affonso d'Alboquerque.*

ALCÆUS, one of the great lyric poets of Greece, was a native of Mitylene in Lesbos, and flourished about the year 600 B.C. From the fragments of his poems which have come down to us we learn that his life was greatly mixed up with the political disputes and internal feuds of his native city. He sided with the nobles, and took an active part against the tyrants, who at that time set themselves up in Mitylene. He was obliged, in consequence, to quit his native country, and spend the rest of his life in exile. The date of his death is unknown. His poems, which were composed in the Æolian dialect, were collected afterwards, and apparently divided into ten books. The subjects, as we can still see from the fragments, were of the most varied kind: some of his poems were hymns to the gods; others were of a martial or political character; others again breathed an ardent love of liberty and hatred of the tyrants; and lastly, some were of an erotic kind, and appear to have been particularly remarkable for the fervour of the passion they described. Horace looks upon Alcæus as his great model, and has, in one passage (*Od.* ii. 13. 26, *et sqq.*) given a fine picture of the poetical powers of the Æolian bard. The care which Alcæus bestowed upon the construction of his verses was probably the reason why one kind of metre, the Alcaic, was named after him. Not one of his compositions has come down to us entire, but a complete collection of all the extant fragments may be found in Bergk's *Poetæ Lyrici Græci*, Lipsiæ, 1852, 8vo.

ALCAICS, in *Ancient Poetry*, a name given to several kinds of verse, from Alcæus, their reputed inventor. The first kind consists of five feet, viz., a spondee or iambic, an iambic, a long syllable, and two dactyles; the second of two dactyles and two trochees. Besides these, which are called *dactylic Alcaïcs*, there is another, simply styled *Alcaïc*, consisting of an epitrite, two choriambi, and a bacchius; thus—

Cur timet fla|vum Tiberim | tangere, cur | olivum?

The Alcaïc ode is composed of several strophes, each consisting of four verses; the first two of which are always alcaïcs of the first kind; the third verse is an iambic diameter hypercatalectic, consisting of four feet and a long syllable; and the fourth verse is an alcaïc of the second kind. The following strophe is of this species, which Horace calls "*Alcæi minaces camenæ*"—

Non possidentem multa vocaveris
Recte beatum; rectius occupat
Nomen beati, qui deorum
Muneribus sapienter uti.

ALCAIDE, or ALCAYDE, a word of Moorish origin, being derived from the Arabic *káda*, to head, which was applied by the Spanish, the Portuguese, and the Moors to the military officer appointed to take charge of a fortress or prison. See ALCALDE.

ALCALA DE GUADAIRA, a town of Spain, in the province of Seville, Andalusia, situated on the Guadaira, 7 miles E. of Seville. It contains an old castle and other Moorish remains; but it is now chiefly remarkable for the excellent quality of its bread, whence the epithet *de los Panaderos*, sometimes applied to it. Nearly the whole of the bread required by the town of Seville is made here. Population, 7000.

ALCALA DE HENARES, an ancient Spanish city on the river Henares, 17 miles E.N.E. of Madrid. It has been identified with the Roman *Complutum*, which was destroyed about the year 1000, and was rebuilt by the Moors in 1083. In later times it was renowned for its richly-endowed university, founded by Cardinal Ximenes in 1510, which, at the height of its prosperity, numbered more than 10,000 students, and was second only to that of Salamanca. Here the famous edition of the Holy Bible known as the *Complutensian Polyglot* was prepared. The college of St Ildefonso contains a magnificent chapel, in which Ximenes is buried, and is distinguished by its splendid architecture, partly Moorish and partly Gothic. Alcala is further celebrated as the birthplace of the German emperor Ferdinand I., the poet Figueroa, the naturalist Bustamente de la Camera, the historian Solis, and last and greatest of all, Cervantes, who was born here in 1547. Since the removal of the university to Madrid in 1836 the town has rapidly declined. It contains a military academy and various public institutions, but is of little commercial importance. Population, 8745.

ALCALA LA REAL, a town of the province of Jaen in Spain, 18 miles S.W. of the town of that name. It stands on a declivity between two mountain ridges, at an elevation of about 3000 feet above the sea. It possesses a fine abbey. Its distinctive name *la Real*, the Royal, is derived from its capture in 1340 by Alphonso XI. of Leon, in person. In 1810 the Spaniards were defeated here by the French under Sebastiani. Some trade is carried on at the place in wine and wool. Population, 11,521.

ALCALDE (from the Arabic *al-cadi*, the judge), an official title given in Spain to various classes of functionaries entrusted with judicial duties. Criminal judges, members of courts of appeal, magistrates, and even parish officers are all known by the name alcalde—secondary descriptive titles distinguishing their different positions and functions. It is to be observed that the word is entirely distinct from Alcaide, the latter being always employed to designate a military officer.

ALCAMENES (Ἀλκαμένης), a famous Athenian sculptor, a pupil of Phidias, who is celebrated for his skill in art by Cicero, Pliny, Pausanias, Lucan, &c. He flourished from about 448 to 400 B.C., and appears as one of the great triumvirate of Greek sculptors, Phidias, Alcamenes, and Polycletus. He is said to have once competed with his master, the subject being a statue of Minerva. In this attempt the style of Alcamenes was exquisite in finish, but he had overlooked the consideration that the statue was to be placed on a high column, and there his work would not bear comparison with that of his great master. His statue of Venus Urania, in the temple of that deity at Athens, was reckoned his masterpiece.

ALCAMO, a city of Sicily, in the Italian province of Trapani, is situated 22 miles E. of Trapani, near the Gulf of Castellamare. It lies in a district of peculiar fertility, which produces some of the best wines in the island. The town is pleasantly situated on elevated ground, but its internal appearance is mean and dirty. It contains a very strong castle, and many churches and monasteries. Near it are the ruins of the ancient *Segesta*, including a Doric temple and a theatre in good preservation; and there are also on the neighbouring hill Moorish towers and other remains, standing as memorials of the Saracen occupation of Sicily. Population (1865), 19,518.

ALCANTARA, the ancient *Norba Cæsarea*, a town of Spain, in the province of Caceres, on a rocky height on the left bank of the Tagus. Alcantara (in Arabic, *the bridge*) derived its name from the magnificent Roman bridge which spanned the Tagus at this point, and which was erected, according to the inscription, A.D. 104, in honour of the emperor Trajan, who was a native of Spain. This remarkable structure is built entirely of blocks of granite without cement, and consisted, until its partial destruction, of six arches of various span, with a total length of 670 feet and a height of 210 feet. The second arch on the right bank was blown up by the English in 1809, and, although temporarily reconstructed, was again destroyed in 1836 to prevent the passage of the Carlist troops. The bridge has never since been repaired; and it is a striking illustration of the want of public spirit in Spain that the river is crossed by means of a ferry-boat in the neighbourhood of this grand engineering work, which it is a national duty to preserve. The population of the town is 4200.

ALCANTARA, a seaport of Brazil, in the province of Maranhão, on the bay of San Marcos. It has a tolerable harbour; and excellent cotton is grown in the vicinity, forming the chief article of commerce. Rice and salt, obtained from the neighbouring lagoons, are also exported. Population, 10,000.

ALCANTARA, KNIGHTS OF (*la Caballeria de Alcantara*), an order of knights of Spain, instituted about 1156 A.D. by the brothers Don Suarez and Don Gomez de Barrientos for protection against the Moors. In 1177 they were confirmed as a religious order of knighthood under Benedictine rule by Pope Alexander III. Until about 1213 they were known as the Knights of San Julian del Pereyro; but when the defence of Alcantara, newly wrested from the Moors by Alphonso IX. of Castile, was entrusted to them, they took their name from that city. For a considerable time they were in some degree subject to the grand master of the kindred order of Calatrava. Ultimately, however, they asserted their independence by electing a grand master of their own, the first holder of the office being Don Diego Sanche. During the rule of thirty-seven successive grand masters, similarly chosen, the influence and wealth of the order gradually increased until the Knights of Alcantara were almost as powerful as the sovereign. In 1494–5 Juan de Zuñiga was prevailed upon to resign the grand mastership to Ferdinand, who thereupon vested it, as he had already done that of two other orders, in his own person as king; and this arrangement was ratified by a bull of Pope Alexander VI., and was declared permanent by Pope Adrian VI. in 1523. The yearly income of Zuñiga at the time of his resignation amounted to 150,000 ducats. In 1540 Pope Paul III. released the knights from the strictness of Benedictine rule by giving them permission to marry, though second marriage was forbidden. The three vows were henceforth *obedientia, castitas conjugalis*, and *conversio morum*. In modern times the history of the order has been somewhat chequered. When Joseph Bonaparte became king of Spain in 1808, he deprived the knights of their revenues, which were only partially recovered on the restoration of Ferdinand VII. in 1814. The order ceased to exist as a spiritual body in 1835, though it is still recognised in its civil capacity.

ALCARAZ, a small town in Spain, in the province of Albacete, 34 miles W.S.W. of the town of that name. It stands on very hilly ground near the river Guadarmena, and has the remains of a once strong castle and of a magnificent Roman aqueduct. Weaving, iron-founding, and agriculture are the chief branches of industry. Copper and zinc are found in the vicinity. Population, 7325.

ALCAVALA, a duty formerly charged in Spain and its colonies on all transfers of property, whether public or private. It was originally imposed by Alphonso XI. to secure freedom from the Moors in 1341, as an *ad valorem* tax of 10, increased afterwards to 14 per cent., on the selling price of all commodities, whether raw or manufactured, which was chargeable as often as they were sold or ex-

changed. It subjected every farmer, every manufacturer, every merchant and shopkeeper, to the continual visits and examination of the tax-gatherers, whose number was necessarily very great. This monstrous impost was permitted to ruin the industry and commerce of the greater part of the kingdom down to the invasion of Napoleon. Catalonia and Aragon purchased from Philip V. an exemption from the alcavala, and, though still burdened with other heavy taxes, were in a comparatively flourishing state, in consequence of their exemption from this oppressive duty. (See M'Culloch *On Taxation.*)

ALCAZAR DE SAN JUAN, a Spanish town, in the province of Ciudad Real, 45 miles N.E. of Ciudad Real, and on the railway between Alicante and Madrid. It is a well-built town, and has manufactures of soap, saltpetre, and gunpowder. This is the *Alce* of the Romans, taken by T. Sempronius Gracchus 180 B.C. Population, 7800.

ALCAZAR KEBIR, a city of Marocco in Africa, 80 miles N.W. of Fez. It was formerly of great note as the magazine and place of rendezvous for the Moorish invasions of Spain. It is now greatly decayed, probably on account of its low and unhealthy situation. Not far from the city is the river Elmahassen, famous for the battle fought in 1578 between Sebastian, king of Portugal, and the Moors, in which the Portuguese were defeated and their king slain. Population, 6000.

ALCESTER, pronounced *Auster*, a market town in the county of Warwick, situated at the junction of the Arrow and Alne, 14 miles W.S.W. of Warwick. Its position on the Roman way known as the Icknild Street, and the discovery of numerous remains of ancient art, as well as urns and coins, make it sufficiently evident that this was a Roman encampment. A monastery was founded here in 1140; but the building has totally disappeared, though sufficient vestiges remain to indicate its site. The church is a fine building, and contains several interesting monuments, one of which, to the marquis of Hertford, is by Chantrey, and is in the best style of that sculptor. The town possesses a free grammar school and an elegant market-hall. Employment is afforded to about 1200 of the inhabitants in the manufacture of needles, which is the chief branch of industry. Fish-hooks are also manufactured. Population of parish, 2363.

ALCESTIS, or ALCESTE, the daughter of Pelias and Anaxibia, and wife of Admetus, king of Pheræ in Thessaly. She consented to die in place of her husband, and was afterwards restored to life by Hercules. This beautiful instance of conjugal devotion forms the subject of one of the best plays of Euripides, the *Alcestis*, which furnishes the basis for Robert Browning's *Balaustion's Adventure.*

ALCHEMY, CHEMY, or HERMETICS. Considering the present state of the science and the advance of public opinion, the old definition of alchemy as the pretended art of making gold is no longer correct or adequate.

Modern science dates from three discoveries—that of Copernicus, the effect of which (to borrow St Simon's words) was to expel the astrologers from the society of astronomers; that of Torricelli and Pascal, of the weight of the atmosphere, a discovery which was the foundation of physics; lastly, that of Lavoisier, who, by discovering oxygen, destroyed the theory of Stahl, the last alchemist who can be excused for not being a chemist.

Before these three grand stages in the progress of science, the reign of astrology, magic, and alchemy was universal and almost uncontested. Even a genius like Kepler, who by his three great laws laid the foundations for the Copernican system, was guided in his investigations by astrological and cabalistic considerations. Hence it follows that a philosophical history of modern science is certain to fall into the opposite superstition of idolising abstract reason, if it does not do full justice to this long and energetic intellectual struggle which began in India, Greece, and Egypt, and, continuing through the dark ages down to the very dawn of modern enlightenment, preceded and paved the way for the three above-mentioned discoveries, which inaugurated a new era.

It was the alchemists who first stated, however confusedly, the problems which science is still engaged in solving; and to them, in conclusion, we owe the enormous service of removing the endless obstructions which a purely rationalistic method, born before its time and soon degenerating into verbal quibbles and scholastic jargon, had placed in the path of human progress.

Alchemy was, we may say, the sickly but imaginative infancy through which modern chemistry had to pass before it attained its majority, or, in other words, became a positive science. The search for gold was only one crisis in this infancy. This crisis is over, and alchemy is now a thing of the past. There is no longer any need to exhort adventurous spirits, who hope to find Golconda at the bottom of their crucibles, to leave such visions and turn to the safer paths of science or industry. The battle has been fought and won, the problem of the unity of chemical elements or simple bodies belongs rather to the province of metaphysics than to that of experimental science. If here and there an honest student of the black art still survives, he is regarded as a mad but harmless enthusiast; and as for the pretended searchers for the philosopher's stone, they are, if possible, less interesting objects than the dupes they still continue to cheat. Thus the full time is come for applying to the occult sciences the same searching analysis to which the other myths of prehistoric times have been so rigorously subjected. To trace its earliest beginnings, to investigate its development by the aid of modern criticism, is the province of physical science, no less than of the sister science of morals. Nay, more, we shall find that both had a common origin. Those ancient cosmogonies, those poetical systems which the genius of each nation and race has struck out to solve the problem of the universe and of the destiny of mankind, were the germs of science no less than of literature, of philosophy as well as of religion. And as in the infancy of science its various branches were confused and confounded, so in a like stage of society we often find the same person uniting the parts of philosopher, *savant*, and priest. Besides this, it is evident that in the absence of all scientific apparatus or instruments, the ancients, if they had limited themselves to the exercise of their reason, must have remained observers and nothing more. It is true they did observe, and that widely and well; but observation alone, even when aided by the strongest and subtlest reason, can lead to nothing but contradictory theories, irreconcilable, because they cannot be verified. And it is not in human nature to remain a simple spectator. Curiosity was first excited by fancy (and the fancy of primitive man, we must remember, was far more active and vigorous than ours), and when it found itself baffled by a natural reaction, it had recourse to divination.

In a word, the ambition of these earliest philosophers was more intense, because its sphere was narrower. In the first stages of civilisation the magician was the man of science. The mysteries of this magic art being inseparable from those of religion and philosophy, were preserved, as it were, hermetically sealed in the adyta of the temple. Its philosophy was the cabala. We must consequently look on the various cabalas or oral traditions, transmitted from age to age as the oracles of various faiths and creeds, as constituting the elements of that theory which the Jewish cabala promulgated some centuries later in a condensed and mutilated form. Astrology and magic were the efforts

made in various ways to verify and apply this theory; magic, indeed, or rather magical power, was at starting purely cosmogonic, *i.e.*, regarded as an attribute of God or nature, before it was counterfeited by the magicians of various countries. But, as St Simon has well observed, chemical phenomena are much more complicated than astronomical—the latter requiring only observation, the former experiment—and hence astrology preceded alchemy. But there was then no hard and fast line between the several branches of science, and hence the most opposite were united, not, as now, by a common philosophical or philanthropical object, but by reason of their common theological origin. Thus alchemy was the daughter of astrology, and it was not till the end of the 16th century A.D. that she passed from a state of tutelage. Just in the same way medicine as a magical or sacred art was prior to alchemy; for, as was natural, before thinking of forming new substances, men employed already existing herbs, stones, drugs, perfumes, and vapours. The medical art was indissolubly bound up with astrology, but, judging from the natural inventiveness of the ancients, we should have expected beforehand that chemical preparations would have played a more important part among the instruments of priestly thaumaturgy.

As in the middle ages invention busied itself with instruments of torture, and as in our days it is taken up almost as much with the destructive engines of war as with the productive arts of peace, so in those early ages it applied itself to the fabrication of idols, to the mechanism and theatrical contrivances for mysteries and religious ceremonies. There was then no desire to communicate discoveries; science was a sort of freemasonry, and silence was effectually secured by priestly anathemas; men of science were as jealous of one another as they were of all other classes of society. If we wish to form a clear picture of this earliest stage of civilisation, an age which represents at once the *naïveté* of childhood and the suspicious reticence of senility, we must turn our eyes to the priest, on the one hand, claiming as his own all art and science, and commanding respect by his contemptuous silence; and, on the other hand, to the mechanic plying the loom, extracting the Tyrian dye, practising chemistry, though ignorant of its very name, despised and oppressed, and only tolerated when he furnished Religion with her trappings or War with arms. Thus the growth of chemistry was slow, and by reason of its backwardness it was longer than any other art in ridding itself of the leading-strings of magic and astrology. Practical discoveries must have been made many times without science acquiring thereby any new fact. For to prevent a new discovery from being lost there must be such a combination of favourable circumstances as was rare in that age and for many succeeding ages. There must be publicity, and publicity is of quite recent growth; the application of the discovery must be not only possible but obvious, as satisfying some want. But wants are only felt as civilisation progresses. Nor is this all; for a practical discovery to become a scientific fact, it must serve to demonstrate the error of one hypothesis, and to suggest a new one, better fitted for the synthesis of existing facts. But old beliefs are proverbially obstinate and virulent in their opposition to newer and truer theories which are destined to eject and replace them. To sum up, even in our own day chemistry rests on a less sound basis than either physics, which had the advantage of originating as late as the 17th century, or astronomy, which dates from the time when the Chaldean shepherd had sufficiently provided for his daily wants to find leisure for gazing into the starry heavens.

After this general introduction we may now proceed to consider the subject in detail under the following heads:—First, we will cast a rapid glance at certain cosmologies and philosophical systems, in order to bring prominently before the reader those points which throw light on chemical theories. Secondly, we will consider alchemy at the moment when it ceased to be purely religious and began an independent existence; that is to say, during the 3d and 4th centuries A.D., and in that city which was the battlefield on which the various philosophical and religious creeds of the East met. In the fierce struggles which ensued, in the strange alliances which they there made, we shall find them, by their mutual recriminations, involuntarily revealing to us their hidden secrets. As the darkness of the middle ages approaches, we shall follow our science in its journey to Arabia; from Arabia we shall trace it back to Europe, and hear it taught with stammering lips and feeble tongue by subtile or solemn doctors. We shall attempt to analyse its ambitious aspirations and its barren performances. During the Renaissance we shall see it at its zenith, inspired by a mad enthusiasm which was near akin to genius, an enthusiasm which gave birth to medicine and modern chemistry. Lastly, in the 17th and 18th centuries we shall see it degenerate into pure charlatanism. In conclusion, we shall attempt to recover the few grains of pure ore which may be extracted from its broken alembics.

I. Cosmogonies and Philosophies.

In India, as is well known, the contempt in which the caste of artizans was held was still farther increased by the tendency of religion to consider birth and life, and the actions and desires which are part and parcel of man's life, as an unmixed evil. Consequently, outside the workshop, practical chemistry can have made but little progress. Nevertheless, among the priests of India, as in later times in Europe, we find the ordeal of fire and of serpents commonly practised. It follows that the Brahmins must have possessed some chemical secrets to enable them to kill or save those they thought guilty or innocent. These secrets, too, must from time to time have been divulged by indiscretion or perfidy, and spread beyond the temple; for we read of accused persons escaping unharmed from the ordeal, even when their accuser was a Brahmin. But the Mussulman traveller of the 9th century, who has preserved this curious detail, allows that the trial was in his day becoming more elaborate and complicated, and that it was next to impossible for an accused person to escape. However this may be, it is certain that the meditative genius which distinguishes the race had, even before they conquered the yellow and black races, led these first speculators to certain conceptions which have an important bearing on the present subject. Some had conceived ether as composed of distinct atoms, others imagined an ether decomposing itself into atoms by the free play of its own forces. These two theories, the one dualistic, the other unitarian, strangely foreshadow the discoveries of modern dynamics. We find the speculators of another race indulging the singular fancy that they could observe in atoms what we may call osculations of the play of forces. This, at any rate, is the most natural explanation of the term *nodes* by which the Phœnicians designated atoms. The Persians, who considered the first tree and the first bull as the two ancestors of man, discovered in physics generally two antagonistic principles, one male and one female, primordial fire and primordial water, corresponding to the good and bad principles of their religion. Over all creatures and all things there were presiding genii, *Tzeds* or *Feroners*. They had already formulated the parallelism between the *Sephiroth*, the empyrean, the *primum mobile*, the firmament, Saturn, Jupiter, Mars, Sun, Mercury, Moon, and the parts of the body, the brain, lungs, heart, &c. In this correspondence between the heavenly bodies and the human frame which the ancient Persians laid down, and the Hindu belief in the peregrination of sinful souls through the animal, vegetable, and even the mineral world, till, by these pilgrimages, they at last won absorption into the Deity, or *Moncti*, we have, in their original form, the two fundamental beliefs of alchemy.

The Greeks, unrivalled as they were in poetry, art, and ethics, made little way in occult philosophy. The Greek intellect, precise and anthropomorphic, with no leaning to transcendentalism, was a protest against the boldness of oriental metaphysics. Thus they contented themselves with inventing a strange gamut of deities corresponding to different types of men. This gamut—Jupiter, Saturn,

Apollo, Mercury, Mars, and Venus—was afterwards completed in the cabala by the addition of the moon, typifying the phlegmatic character of northern races, and forms a connecting link between astrology and alchemy, by establishing a double correspondence between planets of the same name and metals. The whole was systematised in the works of Paracelsus and Böhme, and called the theory of *signatures*. Whether the Greek philosophers taught that the principle of all things was water, like Thales, or air, like Anaximander, or air and water, as Xenophanes, or the four elements, earth, air, fire, and water, as the school of Hippocrates, the tendency of Greek speculation was to establish those profound distinctions which resulted later in the theory of the four elements, the four humours, &c., which the disciples of Aristotle held. Hippocrates, for example, thought that if man was composed of a single element, he would never be ill; but as he is composed of many elements, complex remedies are required. Thus Hippocrates may be called an anti-alchemist; and though the theory of the four elements reigned supreme throughout the middle ages, it easily lent itself to the search for the philosopher's stone and the universal panacea, because the oriental idea of the transmutation of elements, from the time when the various systems of the East were syncretised at Alexandria and received their final development in Arabia in the writings of Geber Rhasis and Ibn Sina (Avicenna), was a universal article of belief. But even in the palmiest days of Greek anthropomorphism there was a gradual infiltration of Asiatic ideas, partly through the mysteries of Eleusis, partly through the doctrines of certain philosophers, who were by nature susceptive of barbaric influences. For, besides Greece proper, there was a second Greece in Asia Minor and a third in Italy, not to mention the Pelasgic tribes who adhered tenaciously to the primitive ideas of the race.

Among the Greek philosophers, then, who appreciably influenced physics, chemistry, and physiology (the three sciences were then one), we may notice in particular—1. Heraclitus of Ephesus, surnamed the "Obscure." Maintaining that fire alone was the principle of all things, he regarded generation as an ascending road, *i.e.*, a volatilisation; and decomposition as a descending road, *i.e.*, a fixation. Here we have the first idea of Jacob's ladder or "Homer's Chain" of the alchemists. 2. Empedocles, who is indeed the first who mentions the four elements; but he subordinates them as complex products to his primordial indestructible atoms, which were animated by love and hatred. 3. Democritus, who, investing these atoms with a movement of their own, proceeds to construct the universe by shocks and harmonies of shocks or vortices. 4. Anaxagoras, who saw "the all-in-all" (Aristotle, *Met.* 4, 5), the infinitely great universe in the infinitely small atom, and ingeniously applied the principle of analogy to unravel the tangled skein of ancient science. 5. Aristotle, who added to the four elements a fifth, ether, eternal and unchangeable, itself the *primum mobile* (Arist., *De Cœlo*, 1, 2). In the 4th century A.D., Nemesius, bishop of Emesa (the modern *Homs*, on the east bank of the Orontes), is one of the most distinguished representatives of Alexandrian syncretism. A single quotation will suffice to show that the idea of the transmutation of metals, from the time when Platonism, magic, and neo-Christianity were combined in a species of eclectic mysticism, was regarded as an article of orthodox belief:—"To prevent the destruction of elements, or things which are compounded of elements, the Creator has wisely ordained that elements should be capable of transmutation one into the other, or into their component parts, or that their component parts should be resolved again into their original elements. Thus the perpetuity of things is secured by the continual succession of these reciprocal generations." This statement of the pious bishop is all the more weighty, inasmuch as the author of *The Nature of Man* was only treating of psychology and physiology. The study of gnosticism would carry us too far; and one more quotation from this work, which has long fallen into unmerited oblivion, will prove to what an extent the most scientific theories of this day were tinged and vitiated by mysticism:—"Porphyry, in his treatise on sensation, tells us that vision is produced neither by a cone nor an image, nor any other object, but that the mind, being placed *en rapport* with visible objects, only sees itself in these objects, which are nothing else than itself, seeing that the mind embraces everything, and that all that exists is nothing but the mind, which contains bodies of all kinds." Another step, and we are landed in realism. It is not surprising, then, to find that the alchemists, while working in the laboratory, aspired at the same time to find the moral quintessence and verify the doctrines of revealed religion. For mysticism in theory is nothing but a reaction against the positivism of reason and science: the mystic, dissatisfied with these, seeks in nature a reflection of his inner feelings. And in practice mysticism rests on confusions or exaggerations, like those of Porphyry, or some such dictum as the one which Nemesius quotes with the following uncritical comment:—"Now since Porphyry asserts that there is but one reasoning soul for all things, he is right in saying that the soul sees itself in everything."

Such visionaries, though they may to a certain extent have observed, were not likely to experiment. Thus, at Babylon, where similar theories prevailed, the college of philosophers was divided into three classes, the "Hhartumim," or soothsayers; the "Asaphim," who were more agriculturists than zoologists, more zoologists than physicists, more physicists than chemists; the "Mechasphim," or doctors, who were consulted by the great, as often to rid them of their enemies as to cure their families and dependants; lastly, the "Chasedim" or Chaldeans, properly so called; *i.e.*, the astronomers or astrologers. In this classification of sciences as pursued at Babylon by a peculiar caste, chemistry was little regarded. Science was the monopoly of a privileged class before it became the common property of the human race. A class is sure to cling to a monopoly; an individual is obliged by his feebleness to impart his knowledge to others.

In Egypt the doctrine of the Palingenesis was symbolised by the Scarabæus, which suggested to St Augustine the following strange comparison:—"Jesus Christus bonus ille scarabæus meus, non ea tantum de causa quod unigenitus, quod ipsemet sui auctor mortalium speciem induxerit, sed quod in hac fæce nostra sese volutarit et ex ipsa nasci homo voluerit."

These ideas, which St Augustine borrowed from the religious beliefs of Egypt, were adopted by certain alchemists; and Egypt, which saw in the Scarabæus "the Father, Man, a world of trial, a ladder whereby fallen souls may rise," justly claimed to be the birthplace of ancient chemistry, to which it assigned a peculiar rank, calling it the "sacred art." But although certain Egyptian priests may have spread the report that they owed their enormous fortunes to their knowledge of chemical secrets, this veneration produced but few practical results. It was, however, this report which made the emperors Severus and Diocletian issue an edict that all their magical books should be burned.

II. The Sacred Art.

Paganism, at the time when it was engaged in its last struggle with Christianity, had long ceased to be exclusively Greek or Roman. It had assimilated Mithratic, Chaldean, and Egyptian mysteries, and even allied itself to a certain extent with the Helleno-Hebraism of the Cabala. It was not likely, then, to reject what purer times would have regarded as an utter profanation. The narrow ground on which the battle was fought, the intellectual affinities between such men as St Basil and the emperor Julian rendered the struggle as desperate and sanguinary as any struggle can be when the combatants are only rival creeds. The sacred and divine art (τέχνη θεία καὶ ἱερά), the sacred science (ἐπιστήμη ἱερά), was one of the mysteries which paganism derived from the dim religious light of the temple. But we may presume that the sacred art of the Alexandrians was no longer the same as that of the ancient Egyptians, that their Hermes was not the Hermes of Egypt, that the pseudo-Democritus is not the true Democritus, that Pythagoras, as retouched by Iamblicus, is not the original Pythagoras. No epoch was so full of forgeries as the 3d and 4th centuries A.D.; and these forgeries were in one sense fabricated in good faith. An age of eclecticism is as eager for original documents as a *parvenu* is for a coat of arms or a genealogical tree. These forgeries were no obstacle to human progress; but in an age when the learning of Egypt was the fashion, it was natural that Persian, Jewish, and Platonic doctrines should be tricked out in an Egyptian dress. One of the masters of the sacred art, Alexander of Aphrodisias, invented the term *chyics* (χυικόν, from χέω, to pour, χευέω, to fuse or melt), to describe the operations of the laboratory. Hence the word *chemics*, a word unknown in the 4th century, and only popular some centuries later. The reason is, that the

true etymology of the word *chemic* is logical, and had therefore no charms for the psychological spirit of the age. Later on, when men began to reflect that the ancient name for Egypt was *Cham* or *Chemia*, because, according to Plutarch, its soil was black like the pupil of the eye (χημεία τοῦ ὀφθάλμου), it flattered the chemists to call chemistry "the art of the ancient Chemi." Hence from a false derivation the art received a fresh impulse.

The discovery of the principal manuscripts of the sacred art we owe to the labour of M. Ferdinand Hoefer. We can take no safer guide than the judicious and profound author of the *History of Chemistry* in investigating the delusions into which a master of the sacred art was most likely to fall.

"Let us forget for an instant the advances which this science has made since the 5th century. Let us fancy ourselves for a moment transported to the laboratory of one of the great masters of the sacred art, and watch as neophytes some of his operations. *1st Experiment.*—Some common water is heated in an open vessel. The water boils and changes to an aeriform body (steam), leaving at the bottom of the vessel a white earth in the form of powder. Conclusion—water changes into air and earth. What objection could we make to this inference, if we were wholly ignorant of the substances which water holds in solution, and which are, after evaporation, deposited at the bottom of the vessel? *2d Experiment.*—A piece of red-hot iron is put under a bell which rests in a basin full of water. The water diminishes in volume, and a candle being introduced into the bell sets fire at once to the gas inside. Conclusion—water changes into fire. Is not this the natural conclusion which would present itself to any one who was ignorant that water is a composite body, consisting of two gases, one of which, oxygen, is absorbed by the iron, while the other, hydrogen, is ignited by contact with the flame? *3d Experiment.*—A piece of lead, or any other metal except gold or silver, is burned (calcined) in contact with the air. It immediately loses its primitive properties, and is transformed into a powder or species of ashes or lime. The ashes, which are the product of the death of the metal, are again taken and heated in a crucible together with some grains of wheat, and the metal is seen rising from its ashes and reassuming its original form and properties. Conclusion—metals are destroyed by fire and revivified by wheat and heat. No objection could be raised against this inference, for the reduction of oxides by means of carbon, such as wheat, was as little known as the phenomenon of the oxidation of metals. It was from this power of resuscitating and reviving dead, *i.e.*, calcined metals, that grains of wheat were made the symbol of the resurrection and life eternal. *4th Experiment.*—Argentiferous lead is burned in cupels composed of ashes or pulverised bones, the lead disappears, and at the end of the operation there remains in the cupel a nugget of pure silver. Nothing was more natural than to conclude that the lead was transformed into silver; and to build on this and analogous facts, the theory of the transmutation of metals, a theory which, later on, led to the search for the philosopher's stone. *5th Experiment.*—A strong acid is poured on copper, the metal is acted upon, and in process of time disappears, or rather is transformed into a green transparent liquid. Then a thin plate of iron is plunged into this liquid, and the copper is seen to reappear in its ordinary aspect, while the iron in its turn is dissolved. What more natural than to conclude that iron is transformed into copper? If instead of the solution of copper, a solution of lead, silver, or gold had been employed, they would have held that iron was transformed into lead, silver, or gold. *6th Experiment.*—Mercury is poured in a gentle shower on melted sulphur, and a substance is produced as black as a raven's wing. This substance, when warmed in a closed vessel, is volatilised without changing, and assumes a brilliant red colour. Must not this curious phenomenon, which even science in the present day is unable to explain, have struck with amazement the worshippers of the sacred art, the more as in their eyes black and red were nothing less than the symbols of light and darkness, the good and evil principles, and that the union of these two principles represented in the moral order of things their God-universe. *7th and last Experiment.*—Organic substances are heated in a still, and from the liquids which are removed by distillation and the essences which escape, there remains a solid residuum. Was it not likely that results such as these would go far to establish the theory which made earth, air, fire, and water the four elements of the world?"

But neither M. F. Hoefer's explanation of the appearances which the first master of the sacred art mistook for fact, nor the metaphysical theory of Nemesius, will enable us to understand how Zosimus the Theban, in the very infancy of the art, succeeded in discovering in sulphuric acid a solvent of metals; in assigning to mercury (which he called "holy water") its proper function, a function which succeeding generations of alchemists so monstrously exaggerated; and finally in disengaging from the red oxide of mercury oxygen gas, that Proteus which so often eluded the grasp of the alchemists, till at last it was held fast by the subtle analysis of Lavoisier. For we must remember that solid metals were considered as living bodies, and gases as souls which they allowed to escape. Of all the ingenious inventions of the Jewess Maria for regulating fusions and distillations, the only one that has survived is the *Balneum Mariæ.* The principle it depends on, viz., that the calcination of violent heat is less powerful as a solvent or component than the liquefaction produced by gentle heat, was afterwards reasserted by the Arabian Geber, and advocated by Francis Bacon. M. Hoefer imagines that Maria the Jewess discovered hydrochloric acid, the formidable rival of sulphuric acid. Succeeding writers on the history of chemistry have remarked that the bandages of Egyptian mummies were not more numerous than the mysteries of the sacred art, and the injunctions not to divulge its secrets, "under pain of the peach tree," or, to translate into modern English the language of an ancient papyrus, under pain of being poisoned by prussic acid. We should be wrong in thinking that all these allegories had no meaning for the initiated, and that this mystical tendency of the sacred art arrested its growth at starting. Rather the truth is, that these myths, which at a later stage prevented the free development of alchemy, at first served to stimulate its nascent powers.

Modern critics have pronounced some traditional sayings of Hermes Trismegistus to be apocryphal, but they have not given sufficient weight to the remarkable circumstance that it is precisely because these sayings are a medley of the cabalistic, gnostic, and Greek ideas with which Alexandria was then seething, that the seven golden chapters, the Emerald Table, and the Pimander obtained their authority—an authority they would never have possessed had they been only a translation of some obscure Egyptian treatise. No Egyptian priest could have written a sentence like that we find so often quoted as an axiom by subsequent alchemists:—"Natura naturam superat; deinde verò natura naturæ congaudet; tandem natura naturam continet." Plato adds (not the disciple of Socrates, but a pseudo-Plato in the famous collection called *Turba Philosophorum*)—"continens autem omnia terra est." For, translated into modern language, this means that there may indeed be in this universe things which pass our intellectual ken; but that all that exists, all that is produced by the strife and changes of the elements, all, in a word, that appears to us supernatural, is really natural. That this is his meaning we may gather from the singularly bold comment which Plato himself adds, and which we may thus translate—"Everything, even heaven and hell, are of this earth." It is true that the alchemists failed to draw any very definite conclusions from this fundamental axiom. But if we consider it carefully, we shall see that this earliest doctrine of the sacred art, which was now rapidly passing into alchemy, by thus excluding the supernatural, was making a great advance in the direction of positive science. This early advance was, however, counterbalanced by an early error (which itself arose from a noble ambition), viz., that art is as powerful as nature. The Emerald Table begins with a sentence no less celebrated than that quoted above:—"This is true, and far distant from a lie; whatsoever is below is like that which is above, and that which is above is like that which is below. By this are acquired and perfected the miracles of the one thing." To understand the importance of this emphatic and categorical exordium, we must forget the sharp distinction we now draw between

art, science, and literature; we must think of that foolishness of which St Paul speaks, by which he sought to save those that believe, because of the insufficiency of human reason. The seekers for the philosopher's stone were in the same case. In the absence of clear facts and just notions, reason for them was not sufficient. Thus it was that they and the masters of the sacred art, and after them the Arabs, and in later times the alchemists, one and all listened eagerly to the "foolishness" of Trismegistus's doctrine, which, in a modern form, would run thus: "We go further than the *Zohar*—the sacred book of the cabala—which says that as soon as man appeared, the world above and the world beneath were consummated, seeing that man is the crown of creation and unites all forms. We go further than the *Zohar*, which says in another place that the lower world was created after the similitude of the upper world. We perfect the doctrine of a microcosm and a macrocosm, and declare that there is no such thing as high or low—as heaven or earth, for the earth is a planet, and the planets are earths; we affirm that the chemical processes of our alembics are similar to those of the sidereal laboratories. All is in all. Everywhere analogy infers the same laws." From analogy to identity was an easy step for the theorists; and in the full light of the 19th century we find Hegel a devoted admirer of the mystic Böhme falling into this pitfall. If the *spectrum analysis* had been known, the Alexandrians, the Arabs, and the alchemists would have been able to verify and limit the sweeping generalisation by which they established a vast system of correspondencies between the three worlds, the physical or material, the rational or intermediary, and the psychical or spiritual. Between the heavens and earth and man's nature they were ever seeking to discover affinities, and ignoring differences which would have been fatal to their system. Thus, according to them, even heaven—the abode of spirits—was partly physical; and even in the mineral world there was a spiritual element—viz., colour, brightness, or, in their language, tincture. Neither Linnæus, Berzelius, nor Cuvier had yet classified living beings and things. The distinction between the animal, the vegetable, and the inorganic world was unknown, and indeed it was impossible that it should be known. The alchemists sought for physical conditions in the invisible and spiritual world, and for a spirit even in stocks and stones. This explains the magic which they found in nature, and which they tried to imitate by their art. But to establish this harmony between heaven, man, and nature, they required some fixed standard or scale, for in their eclectic system they were bound to find room for Pythagoras. Where was this scale to be found? In the heavens; for there must be the sphere of true music. Hence arose chemical, medical, and physionomical astrology. (See ASTROLOGY.) Hence the sun, which vivifies all nature, the most active heavenly energy, or rather being—for with them everything had life—in the *συνγαμία*, or marriage between heaven and earth, represented the male principle, *ita ut cœlum agat et terra patiatur;* and appearing in all terrestrial objects, since everything is penetrated by heat, fire, or sulphur, presided principally over the generation of gold—his image or antitype—in the bowels of the earth. Hence, too, the moon represented silver, Venus copper, Mercury (the planet and the god) the metal of the same name, Mars iron, Jupiter tin; while to Saturn, the most distant and coldest of the planets, lead, the most unsightly of metals, was dedicated. It was an old belief that there was a time when gods and men dwelt together on earth, a belief, moreover, for which they could quote chapter and verse. Was it not written *πᾶσιν οὐρανίοις κοινὴν γαῖαν*? Further, seeing that there were three worlds, it followed that there were three heavens, three suns, and three golds. For spirits still engrossed with matter the philosopher's stone meant the search for riches—the gold of the third world. For other spirits which belonged to the first world it signified the healing art—the preservation of humanity by means of the universal panacea and a universal theory of morals. Hence two rival systems, the first of which culminated in the great doctor Paracelsus, the second in the great Illuminato Postel. Did not Dante, the bitter foe, not of the science of alchemy, but of that miserable search for gold—for the riches of this world—which, with keen irony, he calls *Peltro* (tin whitened by mercury)—did not Dante himself write his great poem in order to bring back humanity to the right road from which it had strayed (*svia*), misled by those who should have been its true guides, the pope and the emperor? For the symbolism of those ancient masters included an alchemy of morals as well as an alchemy of medicine and metallurgy, though the first was even less known and less appreciated.

Recurring to our former illustration, it was this "foolishness" of St Paul—this divine madness—which inspired the Alexandrians, the Arabs, Roger Bacon, Albertus Magnus, and the host of anonymous alchemists of the middle ages: such was the madness which cast a ray of genius over the daring spirit of even a second-rate author like Raymond Lully, which sustained Robert Fludd, Paracelsus, and Postel, who tried to find the universal panacea in universal peace. The fundamental axiom, the stronghold from which these terribly logical madmen were never wholly dislodged, may perhaps be summarised in a single sentence. The saying of Galen, *in natura nihil planè sincerum*, was adopted by his implacable adversaries:—Nature, they said, is in appearance an illegible scrawl, but when deciphered there will be found a single element, a single force, to separate and reunite, to produce decay and growth—*knowledge is power*. To know the process of generation in this triple universe, wherein one world resembles another; to know by its *signatures* this universe, which is a living organism in the eyes of all alchemists (save indeed Jacob Böhme, who, anticipating Hegel, regarded it as a mighty tree); this is the first step towards counterfeiting nature. Monstrosities are the production of diseased metals (really alloys), which, if properly treated, may be cured, and will turn to gold, or at least silver. The second stage in this imitation of nature is to obtain by tincture or projection solid or liquid gold—the cure of all evils. Finally, to surpass material and rational nature, this is the crowning end. For God delegates his power to the sage.

Alchemy in Arabia.—How the sacred art passed into Moslem lands it is hard, from dearth of evidence, to say. Modern criticism now does more justice to the part which Arabia took in the accumulation of scientific facts, and in the scientific theories which we find in the books of Rhazès and Geber. It is certain that in their treaties with the European Greeks of Constantinople the Arabs always stipulated for the delivery of a fixed number of manuscripts. Their enthusiasm for Aristotle is equally notorious; but it would be unjust to imagine that, in adopting the Aristotelian method, together with the astrology and alchemy of Persia, and of the Jews of Mesopotamia and Arabia, they were wholly devoid of originality. On the other hand, we must not understand Arabia in the ethnological sense of the word, but as signifying an agglomeration of various races united by a common religion. Thus Djafar (who lived in the middle of the 8th century), better known to us as Geber, was a Sabæan. Avicenna, born in 978, was a native of Shiraz. The remarkable geographer and geologist Kazwyny (geology was then a part of alchemy), derived his name from his birthplace, Casbin, in

Persia. Mohammed-ben-Zakaria, so celebrated in mediæval Europe under the name of Rhazès, was also a Persian. In Spain the Jews of the famous school of Saadia and Juda Halevy exercised considerable influence over the academy of Cordova. Lastly, European historians have systematically exaggerated the ignorance of the Arabs before the time of Mahomet and their intolerance after the establishment of Moslemism, either from the zeal which prompted them to carry on a sort of literary crusade in honour of Christianity, or because in the 18th century they directed against Mahomet attacks which were intended for Christianity itself.

Alchemy received from the Arabians many significant titles. It was the *science of the key*, because it opened all the mysteries of creation, physiology, and medicine; it was the science of the letter M (*misam* is the Arabic for balance), because by means of the balance the gain or loss of all bodies could be determined, even while undergoing chemical combinations. Later on, as is well known, it was by a rigorous and obstinate use of the balance in the hands of Priestley, Cavendish, and Lavoisier, that positive chemistry was founded. Lastly, Rhazès gave to the science of the philosopher's stone a name which plunges us again into the mythological ages of chemistry. He called it the *astrology of the lower world.*

The discoveries of Geber as a chemist do not form part of our subject; but we may mention, in passing, the infernal stone, the corrosive sublimate, the exact process of the cupellation of gold and silver, and three sorts of distillation by evaporation, condensation, and simple filtration. In another direction Geber, by re-inventing *aqua fortis*, and by discovering ammoniacal salts for his *aqua regalis*, laid the foundation both of alchemy and chemistry. The salt of ammonia, so easy to volatilise, was the source of many baseless dreams, as is proved by its various names—*anima sensibilis, aqua duorum fratrum ex sorore, cancer, lapis angeli conjungentis,* &c. Geber believed in the parallelism between metals and planets; he thought that metals were all equally composed of mercury, arsenic, and sulphur, and that in the descending scale from gold to lead, mercury, arsenic, and sulphur were each present in a greater or less degree of purity in proportion to the colour and quality of each metal. Later on, the addition of the four elements—heat, cold, dryness, and moisture—complicated still more the reasonings by which the alchemists sought to prove that the transmutation of metals was in the power of any man who imitated nature—*i.e.*, perfected the imperfect metal by correcting its excess of heat or moisture. Geber did not think that an operation of the laboratory could counterfeit the natural work of purification, which demanded a thousand years. But with him moisture played the same part as phlogiston in Stahl's system. In other words, the philosopher to whom all succeeding searchers for the philosopher's stone swore allegiance was contented to formulate his theory without considering the possibility of putting it in practice. He was an alchemist indeed, but no gold-seeker. This forerunner of positive science foresaw the part which the gases would be found to play in the composition of bodies; he called them spirits—a figure which took strong hold on the imagination of Geber, as well as of the masters of the sacred art, and which was formalised by the alchemists of the middle ages. Rhazès, who re-invented sulphuric acid and *aqua vitæ*, was *par excellence* a doctor. The same remark applies to Avicenna, whose works are a methodical, but not very profound, systematisation of the current ideas and science of his day. Artephius was a cabalist, as his theory of the apparent and latent parts of man's nature shows. The author of *The Key of Wisdom* and *A Secret Book on the Philosopher's Stone* was the reputed possessor of an *elixir vitæ*. We do not know whether this was potable gold or a quintessence of all the active elements of the three kingdoms. However this may be, this mysterious alchemist, who lived about 1130, was the inventor of soap, and, what is of more importance for our subject the promoter of a new interpretation of Jacob's ladder or Homer's chain. Minerals, he said, come from the primitive elements, plants from minerals, animals from plants, and as each body is resolved into another body of the order immediately below it, animals become vegetables and vegetables minerals. We see that in this view of the interdependence of the three kingdoms there is as much truth as error. With Calid, the author of the *Book of the Three Words* and of the *Book of the Secrets of Alchemy*, the parallelism between the metals and planets takes a retrograde step towards astrology. This Calid, a *soi-disant* king of Egypt, held that before engaging in any operation of alchemy the stars ought to be consulted. This recommendation was literally followed by the thaumaturgists of the middle ages and the Renaissance. The effect was fatal, if, when Calid or one of his school saw the metals obstinately refuse to be purified in his crucible, he did not wait for a happy conjunction of constellations above in order to try his chance again with the operations of inferior astrology.

The East, when it accepted from Aristotle the theory of form and matter, invested it with a signification of its own never dreamed of by the Stagyrite, and invented, as it were, an Arabian Aristotle—that is, the Aristotle of the middle ages. Not only at Alexandria had the students of the sacred art evolved the theory of the transmutation of the four elements (Cicero assigns the doctrine to the Stoics), but in the East the translators of Aristotle added to the theory a corollary more important than the proposition itself, viz., that every body by its form and natural motions indicates its soul, its natural properties, &c.; that the resemblance between the external appearance of things and beings indicates their natural likenesses, &c. The idea of destiny, which all nations who accepted the doctrine of the Logos expressed by some term or other analogous to the Latin *fatum* (what is spoken), Mahomet translated by his famous phrase *nectoub* (it was written). We find a Turkish writer, the declared enemy of astrology and elixirs, Nabi Effendi, in his remarkable book, *Counsels to my Son, Aboul Khair*, saying that heaven is covered with a writing that only God can read, and seeking what letter the eyes, the eyebrows, the mouth, &c., form to find therein the secret of their better use. Like one of the Talmudists, the obscure Kallir for instance, he decomposes the name Mahomet in order the better to offer the prophet, as it were, the quintessence of praise, more worthy of God, who in that sacred name, as in all terrestrial things, has written at least one letter of the Word which will serve as a key to open all their hidden virtues. By pursuing an analogous direction, mediævalism, and more especially the Renaissance, introduced new subtleties into the astrological branch of alchemy—tetragrams, pentacles, and other mysterious characters and figures.

It is not surprising, then, to find that Nabi Effendi, who lived in the second half of the 17th century, can produce no other reasons for dissuading his son from joining the alchemists than the fact that some were poor, others quacks, and, as the most important ground of all, that God had declared his wrath against those who dare to imitate his works. Indeed, the peculiar symbolism of the various nations of the East had been broken up by revolutions and conquests, and the *disjecta membra* again reunited, so as to form a wonderful phantasmagoria of ideas and images—a sort of scientific Arabian Nights.

III. Alchemy of the Middle Ages.

The care we have taken to note down at the moment of its birth each of the ideas which influenced alchemy, allows us to sketch more rapidly the history of its decline and fall. Albert Groot, commonly known as Albertus Magnus (1193–1280), revived the theory of Geber; and, in spite of the tendencies of the time, entertained the same doubts as his illustrious master on the possibility of transmutation. He is the first to speak of the affinity of bodies, a term he uses in reference to the action of sulphur on metals. He gives the *savans* of the day the sage advice not to take service with princes, who are sure to treat as thieves those who do not succeed. And, indirectly, he warns princes that philosopher's gold is only tinsel. Beginning with nitric acid, which he calls *prime water*, and so on, through a regular series of secondary, tertiary waters, &c., he proposed a method for dissolving all metals. Roger Bacon, while opposing magic, calls oxygen *aer cibus ignis*, and regards the elixir as a substitute for time, that agent of which nature takes no account. Gold is perfect, because nature has consummated her work. But Roger Bacon seems to have turned his genius principally to physics and mechanism. St Thomas Aquinas, in his theological writings, forbids the sale of alchemist's gold, and in his special treatise on the subject unmasks an imposture of the charlatans of the day, who pretended to make silver by projecting a sublimate of white arsenic on copper. Further, Aquinas, by reducing the primitive elements of metals to two, revives and corroborates the theory of Galen and Albertus Magnus. About the same time we find a pope, John XXII., and a king, Alphonso X. of Leon and Castile, occupying themselves with alchemy. But the pope in a well-known bull denounced all those searchers for gold "who promised more than they could perform;" another proof that alchemy and the search for gold, though distinguished by

the true alchemist, were confounded by many adepts. It is evident that the science, as far as the seeker for gold was concerned, was approaching the times of king John and Philip the Fair, who found in unscrupulous charlatans abettors in their debasement of the currency, and that for disinterested alchemists those evil days were at hand when, disgusted at attaining no practical result, the most serious of them sought in the physiological mysteries of generation, in the Adam and Eve, the red man and the white woman, of the first chapters of Genesis, what they failed to find in Rhazès, in Geber, and the Arabian Aristotle. The science was still called chemy. It was as a compliment to the Arabian masters, who were still quoted side by side with Genesis, that they added to the word the Arabic article *al*. The popular etymology of the day was likewise Arabic, or, more correctly speaking, Semitic; the Hebrew *chom* or the Arabic *cham* signified heat. Hence their furnaces for heating, the alembics for modifying heat, and the Bains-Marie for imitating the temperature of warm blood; for they could only proceed by analogy. Nevertheless, the great men of the day were the alchemists. The boldness of their actions, the eccentricity of their genius, prove it.

Few novels are as interesting as the story of Raymond Lully (1235-1315). He began life as the passionate lover of the Lady Eleanor of Castello. He was cured of his passion by the lady herself, who discovered to him the ulcer which was eating away her breast. At her desire he consecrated himself to God, to the service of humanity in general, and especially to the conversion of Mussulmans. Christianity, in the mouths of the European disciples of Geber and Rhazès, was better adapted than it now is for converting infidels, whose knowledge it respected while deploring all the more their errors. In his eightieth year Raymond Lully died in sight of the island of Minorca, from the consequences of a stoning he had received at Tunis a few days before while preaching the gospel. This was on his third mission, and he did not hide from his friends that he sought the crown of martyrdom. He had invited the support of all the princes of Europe, and in particular of the kings of France, England, and Castile. Alchemy, indeed, with him seems to have been mainly a means of recommending himself to these kings, and at the same time a search for the panacea. But his trust was placed much more in his rhetoric, which he borrowed from the cabala, in his oriental eloquence, and his Christian faith. By the number of conversions he made at Algiers, at Tunis, and at Bugia, where during his second voyage he was snatched from imminent martyrdom by his friends among the converted Mussulmans—that is to say, in the very strongholds of Islamism—he succeeded in demonstrating that his idea of uniting all worshippers of the true God in a common faith was not chimerical. Lully's principal success was with the disciples of Averroes; and no one who reflects will be surprised at this. As the moral difficulties of missions were less than they are now, so the practical dangers were greater. This too needs no explanation.

Raymond Lully's works on alchemy are hopelessly obscure, notwithstanding elucidations, compendiums, vade-mecums, and a certain *dialogus demogorgon*, which, if the title is to be believed, *Lullianis scriptis multam præclarè lucem adfert*. Nor need we wonder at this. Eirenæus Philalethes, the pseudonym under which some English adept, whose real name has not been discovered, wrote, states positively that he has learned nothing from Raymond Lully, adding at the same time a curious reason—"Some who are no adepts give more instruction to a beginner than one whom perfect knowledge makes cautious." Eirenæus is fond of quoting Bernard of Trevisa, who, he tells us, has given him, more especially in his letter to Thomas of Bologna, "the main light in the hidden secret." But of all writers he gives the palm to Sir George Ripley. Bernard of Trevisa, whom he mentions, spent a long life and a considerable fortune in romantic travels, in the purchase of books, and in the pursuit of chemical experiments. When depressed and weary with chasing shadows which were ever eluding his grasp, he used, as a pastime and relaxation, to read the *Turba Philosophorum*, or the *Great Rosary*, just as Don Quixote would read the romances of chivalry. At last, when seventy-five years old, the good Bernard, for so the adepts called him, thought he had discovered the secret, —at least the joy of what he considered a real success served for a while to lull his restless energies. His letter to Thomas of Bologna shows no ordinary man. "Dissolutions of this sort," he writes, "by acids or aquafortis, are not the true foundations of the art of transmuting metals; but rather the impostures of sophistical alchemists, who think that in them resides the secret of that sacred art. They affirm that they produce dissolutions (*solutiones*), but what they can never do is to produce the various kinds of metals in their perfection; because metals when dissolved by corrosives do not remain in the same proportion and original form as they do when dissolved by mercury, which may be truly called the water of metals. Bodies dissolved by mercury are not decomposed (*separabuntur*); their nature remains hidden in mercury till they fill up its intervals (*usque ad sui reinspissationem*). Mercury contains interstices (*latentia*), and therefore metals can lie hidden in mercury." He then goes on to compare the part that mercury plays in amalgams to that of water (*simplex aqua*) in vegetable and animal structures. He is well acquainted with what the French now call *l'eau de composition;* but, as usual, he pushes his analogies too far. We may remark in passing that it was his opponents the alchemists who, by the discovery of their *aquæ fortes*, provided modern chemistry with one of its most powerful agents.

In speaking of Bernard, we incidentally hit upon a word which exactly characterises mediæval works on alchemy—they are romances, romances full of interminable allegories; they sometimes begin and always end with an invocation to Christ and the Trinity. From time to time, amid the old abortive attempts to read the riddle of the universe, we find some new idea cropping up. The generation of plants and animals had failed to explain the generation of metals; so they turned to digestion and fermentation for analogies, and though they never reached their goal, they picked up much that was valuable on the way. The road itself was barred, and therefore to profit by their works we must follow them into bypaths and digressions. Thus, for instance, we may study with advantage their dialectics. Whilst refuting their adversaries, they were gradually laying the foundations of the logic of science. True alchemists were generally haughty and contemptuous; the mechanic often grew rich on the scraps which the alchemist was too proud to touch. We cannot always make sure of understanding them, yet from the medley of their writings more fragments of real chemistry may be gathered than is generally supposed. There is rhythm and harmony, a ring of true genius about the best of their works, which charms us if it does not send us to sleep with its sweet but monotonous music. In reading Laurent Ventura's book, *De Ratione Conficiendi Lapidis Philosophici*, we are tempted for a moment to endorse the strange fancy of the Dutch Rabbins, "that even if a man do not understand the language of the *Zohar*, he ought no less to read it; for this language, as the cabalists have written it, is a medicine for the soul."

Often what appeared a work of pure fiction (as the *Roman de la Rose*) concealed a treatise on alchemy; often, on the other hand, what purported to be a work of pure alchemy was a medium for heretical theology, sometimes for the ideas of Spinosa and Goethe. The times, moreover, were sad, and all could appreciate the advantage of a romance. It was not given to every one to follow the terrible logic of Danstin, the contemporary of Raymond Lully, the author of a Rosarius, which has never been published, from which M. F. Höfer gives the following extract:—"All bodies may be divided into three classes—1. Sensible and intellectual beings (animals and men); 2. Vegetables; 3. Minerals. Like always tends to unite with like. Intellectual elements are homogeneous with the Supreme Intelligence; that is why the soul yearns to be absorbed into the Deity. The elements of the body are of the same nature as the surrounding physical world; hence their tendency to unite the one with the other. Death is then for all a moment to be desired." *Dico Amen tibi, reverende mi Doctor*, to borrow Bernard's favourite expression.

After so much mist and fog we need a breath of fresh air. Let us pass at once, then, to the Luther of science, who reproached so bitterly the Luther of theology with only going half-way—to an epoch which witnessed the new birth of intellectual life, and to a man who was carried by the new movement into every sort of extravagance, though his errors were those of a generous and unselfish nature. Let us treat of the Renaissance and Paracelsus.

IV. Paracelsus and his Influence.

Tempting as the subject is, we must not linger either on the philosophical doctrine or the medical system of this extraordinary man, for fear of encroaching on the article Medicine or the article Paracelsus. We only wish to show that he is the pioneer of modern chemists, and the prophet of a revolution in general science. Those who only know Bacon in manuals of philosophy are never tired of repeating that the great English philosopher is the father of experimental science. This is true, indeed, in the sense that Bacon insisted with inexhaustible eloquence on the necessity of experimental science, but it is false if it means that Bacon inaugurated modern science by personal experiments. It was this popular conception of Bacon which Liebig attacked, and he thus found no difficulty in drawing up a long and crushing indictment. Bacon was

the prophet of experimentation, and this title is sufficient to secure his fame against the abuse of modern dogmatists, who think that science increases little by little, with here a fact and there an idea, without a single pause, a single relapse or revolution. Few take the trouble to consider how far Bacon's philosophy belongs to the past; most are satisfied with cut and dried phrases about the part he played in modern science. Just in the same way, Paracelsus, the great innovator, who thought himself even more enfranchised from the bondage of Aristotle and Galen than he really was, is dispatched with ready-made phrases, but, unlike Bacon, he gets nothing but ridicule and abuse. Madman, charlatan, impostor—no name is too bad for him with the historians; and yet they are forced to confess that this impudent adventurer brought about a necessary revolution. Thomas Thomson is very severe; he goes so far as to reproach Paracelsus with declining the word *tonitru*. He would have wished, forsooth, the revolutionist of Basle to have delivered before his young and enthusiastic audience "the sober lectures of a professor in a university." Dryasdusts are fond of falling into such anachronisms; a far truer estimate of Paracelsus has been given us by Mr Browning in the drama which bears his name. There are self-deceived visionaries who are always thinking that the problem is solved, who compose elaborate romances with which enthusiasts are enchanted. Raymond Lully was one of this class. There are spirits of light who point out and trace the road along which humanity travels slowly in their wake. Bacon belongs to the first category, but has played the part of a genius of the second order. Thirdly, there are souls of fire always enveloped in clouds, from which ever and anon the lightnings of genius flash forth, who bear humanity towards a goal foreseen rather than seen by themselves, by a rough and rugged road with endless turns and windings. Such a nature was Paracelsus. His pride was more towering than the mountains of his native Switzerland. He believed that through him a new race, the Germans, were destined to succeed to science. The Greeks, the Arabians, and the Italians, their immediate disciples, had had their day with him, and through him the German era was to begin. He studied under Trithema, the abbot of Spanheim, and under his father, a distinguished alchemist: Agrippa was his fellow-student. Afterwards he resorted to strange masters—old wives and workmen, his beloved miners, who confided to him their secrets. He was the greatest traveller in that age of scientific travellers. Lastly, he practised medicine as the doctor of the poor, and inaugurated lectures in the vulgar tongue. Van Helmont, his real successor, who inherited his goodness of nature, established clinical medicine, *i.e.*, lessons at the bedside of the patient. Stahl, who inherited his arrogance and his love of symbolism, developed from one of the ideas of his master the phlogistic theory, the elaboration of which theory was for chemistry a prosperous period of incubation, while from the refutation of this theory the science may be truly said to date its birth. Paracelsus's work, like his genius, oscillates perpetually between magic and science, but what has not been sufficiently observed is, that science invariably ends by carrying the day. If, for instance, he is giving us "the green lion," a recipe for making gold, he ends by breaking a lance with the seekers for gold:—"Away with these false disciples who hold that this divine science, which they dishonour and prostitute, has no other end but that of making gold and silver. True alchemy has but one aim and object, to extract the quintessence of things, and to prepare arcana, tinctures, and elixirs, which may restore to man the health and soundness he has lost." He beards the "white-gloved" disciples of Galen, and, in spite of their juleps and draughts, asserts that alchemy is indispensable, and that without it there is no such thing as medical knowledge. He rejects the easy explanation of the universe by means of an entity, stigmatising it as *paganity*, meaning thereby a necessary consequence of paganism, which as a theosophist he holds in abhorrence. He rejects the favourite instrument of the schoolmen, the syllogism. Nature, as he views it, is not a clear and intelligible system of which the form declares the essence; no, it is mysterious. There is a spirit at work beneath the outside shell. What is written on this shell no one can read but the initiated who have learned to separate the real and the apparent. "At the same time, everything is not active. To separate the active portion (the spirit) of this outside shell from the passive, is the proper province of alchemy." Thus we see that with Paracelsus alchemy ceased to be the search for the first principles of bodies, and made one step in advance towards chemistry. His innate genius for medicine, as he boasted, but more truly his noble heart, urged him to learn a study which better satisfied his pride, but which had not the practical usefulness of medical chemistry to recommend it. The name *iatrochemics* marks this transition from alchemy to chemistry. A remarkable saying of Paracelsus shows us the close connection between his alchemy and his medicine: "*Vita ignis, corpus lignum.*" This notion of the importance of combustion was taken up again by Becker and his disciple Stahl, the inventors of the term phlogiston, which they thought was of an earthy nature, because resin, phosphorus, sulphur, and other combustible bodies are insoluble in water. Paracelsus was too well initiated in the cabalistic theory of astral light, which symbolised the universal agent of light and heat, to have accepted such a gross materialistic theory. A distinguished Frenchman of the present century, who prided himself on being a follower of the cabalists, has in one of his novels, called *La Peau de Chagrin*, reproduced the theory of Paracelsus, *vita ignis, corpus lignum*. Each act, each wish of the possessor of the talisman, causes the skin to shrink; and Mr Huxley, in his remarkable lecture on *The Physical Basis of Life*, has not been ashamed to borrow this illustration from Balzac. What renders Paracelsus's saying so valuable is, that it is neither materialistic nor spiritualistic, but merely dynamical.

Another instance of Paracelsus's oscillating between the modern and the ancient world is seen in the hesitation he shows when discussing the influence of the planets over the internal organs of the body. Sometimes he seems to take the symbol for the thing itself, but he ends by admitting only the parallelism of the macrocosm and the microcosm. When he assigns the brain to the moon and the heart to the sun, he seems to say: "I do not think with Plato that the brain is all; it is but the reflector and guide—the heart is the regulator of the organism. I place my archeus a little above the heart, as a connecting-link between the nervous and sanguine circulation, as Hippocrates has his *enormon*." If he had lived in calmer times, and known the true Aristotle, Paracelsus would have allowed that μορφή does not represent the ἐντελεχεία of the Stagyrite, that ἐνεργέια is the true meaning. But in those times of false Aristotelianism the *Spagirism* of Paracelsus was pitted against the *Stagyrism* of Aristotle. By making the viscera the seat of diseases, Paracelsus claims to be the founder of the organicists; by his chemistry of the blood—mercury which evaporates, sulphur which burns, salt which is constant—he is answerable for the blunderings of Maitre Purgon; by his *archeus*, the grand motor and regulator of the astrology of the body, he is the ancestor in a direct line of animism, and collaterally of modern Hippocratism or vitalism of the Montpellier school. In short, it is hard to name anything that cannot be found in the works of this mad genius, who, in spite of the jars and jolts of his wild

career, still manages to keep the road without upsetting either at Paris or Montpellier. What, we may ask, would modern therapeutics be without the opium and mercury of Paracelsus—without the laudanum of his disciple Quercetan, physician to Henry IV., &c.? When this charlatan had substituted for astrological influence a simple parallelism, it was easy for Van Helmont to rid modern science of this simple parallelism. Besides all this, Paracelsus was a real doctor. The death of Erasmus's friend, whom he was attending, did him less harm than the cure of another patient, who was dining with him ninety-nine days after he had been pronounced *in extremis;* more fatal still was the case of Cornelius de Liechtenfels, who, when cured by him of the gout, refused to pay his benefactor the stipulated price. Paracelsus would not hold his tongue or submit to the magistrates, and in consequence had to resign his professorship at Basle. A double interest attaches to this story; it hastened Paracelsus's death, and it proves that he would never have accepted the *vis medicatrix naturæ* of Stahl. We have seen that those strange bodies which escaped from the retorts of the masters of the sacred art were called by them souls; their successors, on a closer acquaintance with them, called them spirits. Basil Valentin and Paracelsus, recognising their importance in the transmutation of bodies, gave to them the name of mercury. Van Helmont studied them more minutely, and invented the name gas. He was acquainted with carbonic acid under the name of woody gas. But his ignorance of the action of the oxygen of the atmosphere prevented him from making the fundamental distinctions between experiments performed in a closed vessel and in one open to the air. Priestley, Lavoisier, and Scheele, by the use of the test-tube and the balance (both Van Helmont and Stahl had also turned the balance to good account), weighed and tested the results of ancient alchemy. Hence modern chemistry was born. But we must in justice add that the work had already been begun by men of genius, such as Bernard Palissy, Boyle the eminent critic and experimentalist, Homberg, the two Geoffroys, Margraff, Bergmann, Rouelle the master of Lavoisier, who may be called the Diderot of chemistry. Moreover, the most important discoveries in chemistry have been made by men who combined with chemical experiments a marked taste for alchemic theories. We may instance Glauber, ablest of mystics; Kunkel, who thought he had found in the "shining pills" of his *phosphorus mirabilis* as efficacious a remedy as the potable gold in which he also believed; Glaser the alchemist, master of Lemery, who has been called the father of chemistry; Robert Fludd, &c.

It is curious to observe that soon after chemistry was established as a science there was a regular deluge of searchers for the philosopher's stone. The limits of this article prevent us from giving a full list of their names. Suffice it to mention, among Frenchmen, De Lisle, who died in the Bastile of the wounds his guardians inflicted on him to extort his secret; among Englishmen, Dr Price, who committed suicide to escape from a public trial of his pretended discovery. As to the theoretical possibility of making gold, the great French chemist Dumas considered that a solution might be found in the doctrine of isomerism; and the great English chemist Sir Humphrey Davy refused to pronounce that the alchemists must be wrong. Before concluding this short sketch of a vast subject, we must give a brief list of titles of the most important authorities on the subject, and enumerate the principal words which alchemy has bequeathed to scientific terminology, or which have passed into the language of common life:—

Authorities.—Roger Bacon, Thesaurus Chimicus, 8vo, Francof., 1603; Francis Bacon Lord Verulam, History of Metals, fol., London, 1670; J. J. Becher, Opera Omnia, Francof., 1680; Chymia Philosophica, 8vo, Nuremberg, 1639; John Espagnet, Enchiridion Philosophiæ Hermeticæ, Paris, 1638; Robert Fludd, Clavis Alchimiæ, 2 vols., Francof.; T. R. Glauber, Works, Chimistry, fol., London, 1689; Hermis Trismegisti, Traduction par J. Mesnard, 8vo, Paris (edited by Didier); J. Kunkel, Experiments, 8vo, London, 1705; Paracelsi Opera Omnia (with a remarkable preface by Fred. Bitiski), 2 vols. fol.; J. B. Porta, De Æris Transmutationibus, 4to, Romæ, 1610; Quercetan, Hermetical Physic, 4to, London, 1605; Georgii Ripley, Opera Omnia, 8vo, Cassel, 1649; J. Trithemius, De Lapide Philosophico, 8vo, Par. 1611; Basil Valentin, Last Will, &c., 8vo, London, 1671. Of compilations we may mention—Artis Auriferæ quam Chemiam vocant Duo Volumina (this work includes the Turba Philosophorum), Basileæ, 1610; J. J. Manget, Bibliotheca Chemica Curiosa, 2 vols. fol., 1702; Theatrum Chimicum, 6 vols. 8vo, Argent., 1662; The Lives of the Adepts in Alchemystical Philosophy, with a critical catalogue of the books in this science, and a selection of the most celebrated treatises, &c., 8vo, London, 1814; Essai sur la Conservation de la Vie par le Vcte. Le Lapasse, 8vo, Paris. Among the best historical and critical works with which we are acquainted we will mention—Petr. Gregor. Tholozanus Syntaxeōn Artis Mirabilis, 2 vols., Lugduni, 1576; O. Borrichius de Ortu et Progressu Chemiæ, 4to, 1668; The History of Chemistry, by Thomas Thomson, 2 vols. 8vo, London, 1830; Eusebe Salverte, Les Sciences Occultes, 8vo, Paris, 1829; Ferd. Hoefer, Histoire de la Chimie, 2 vols. 8vo, Paris, and an abridgment by the same author; Histoire de la Physique et de la Chimie, 8vo, Paris, 1872; Louis Cruveilhier, Philosophie des Sciences Médicales, Œuvres Choisies, 8vo, Paris, 1862; Fred. Morin, Genèse de la Science (an important work, which we only know from quotations in French reviews and encyclopædias); Dumas, Philosophie Chimique. Lastly, if we wish to trace the transition of alchemy to chemistry we shall find valuable information in Le Dictionnaire de Physique, dedicated to Mons. le Duc de Berry, 3 vols. 4to, Avignon, 1761, under the words Alkali, Alum, Chimie, Pierre Philosophale, Homberg. The reader will observe that in this encyclopædia, written with the express purpose of propagating the Newtonian theory in France, the classical science could bring no real arguments against alchemy. He may also consult the remarkable work of La Metherie, which has been undeservedly forgotten—Essai Analytique sur l'Air pur et les Differentes Espèces d'Air, 3 vols. Paris, 1785; and The Birth of Chemistry, by G. F. Rodwell, London, 1874.

Etymology.—The idea that nature must be tortured to make her reveal her secrets is preserved in the word *crucible:* Fr. *creuset*, Ital. *cruciolo*, Span. *crisol*—all from the Latin *crux*, a cross. The word *matrass*, Fr. *matras*, is probably from the Celtic *matara*, an arrow, through the old French verb *matrasser*, to harass. *Bain-Marie* and *amalgam* (μάλαγμα) are a legacy of the sacred art. We can trace the two principles, male and female, of the alchemists in the word *arsenic* (ἀρσενικόν, male). From the Arabs we get *alcohol* (*al kohl*), properly anything burnt, then a powder of antimony to darken the eyelids, and lastly, spirits of wine; *alkali*, ashes; *borax*, the white substance; *lacker*, from *lac*, resin; *elixir*, from *el kesir*, essence; *alembic*, Arab. *alanbiq*. *Potash* is obviously the ash of the pot, Germ. *potasch; laudanum* is a corruption of *laudandum*. The derivation of *tartar*, Fr. *tartre*, is strange. Paracelsus considered tartar to be the cause of the gout, and borrowed the name from the infernal regions (Tartarus). The Spaniards have borrowed from the Arabs, *azogue*, mercury; *azogar*, to overlay with quicksilver; *azoguero*, a worker in mercury; *azogamiento*, agitation; *azogadamente*, with agitation. The same Celtic root which gave to Latin the word *vertragus*, used by Martial for greyhound, and to Greek οὐέρτραγος, found in Ælian, from which Dante took the word *veltro*, has also created a large family of words—the Ital. *peltro*, tin and mercury; Span. *peltre*, lead and tin; old Fr. *peautre = peltro;* Eng. *pewter*, *pewterer*, &c. The Place *Maubert* at Paris derives its name from the fact that Magister Albertus lived there (Maubert = Ma' Albert). From the alchemists we get both the ideas and the words *affinity* (Albertus Magnus), *precipitate* (B. Valentin), *reduce* (Paracelsus), *saturation* (Van Helmont), *distillation, calcination, quintessence, aqua vitæ* (brandy was originally only employed as a medicine), *aqua regalis, aqua secunda, gas, cobalt*, from Kobolds, the genii of mines, &c. (J. A.)

ALCIATI, Andrea, an eminent Italian jurist, born at Alzano, near Milan, on the 12th January 1492, died 1550. He displayed great literary skill in his exposition of the laws, for which De Thou highly praises him. He published many legal works, and some annotations on Tacitus. His *Emblems*, a collection of moral sayings in Latin verse, has been greatly admired, and translated into French, Italian, and Spanish. Alciati's history of Milan, under the title *Rerum Patriæ, seu Historiæ Mediolanensis, libri IV.*, was published posthumously at Milan in 1625.

ALCIBIADES was born at Athens about 450 B.C. Through his father, Cleinias, he traced his descent from Eurysaces, the son of Ajax, and through his mother, Deinomache, from Megacles, the head of the Alcmæonidæ. He was thus related to Pericles, who, after the death of Cleinias at the battle of Coronea (447 B.C.), became his guardian. A youth early deprived of his father's control, possessed of great personal beauty, and the heir to great wealth—a youth consequently universally honoured, courted, and caressed—was not in a position to acquire a knowledge of the virtue of self-restraint in any shape or form. Spoilt accordingly by flatteries and blandishments, the boy showed himself self-willed, capricious, and passionate, and indulged in the wildest freaks and most insolent, tyrannical behaviour. Nor did the instructors of his early manhood supply the corrective which his boyhood lacked. The collection of moral, political, and religious beliefs which the earlier Greeks, from custom, convenience, or the promptings of common sense, had accepted as a standard by which to regulate their own conduct and judge that of others, had been exposed by the sophists to the keenest scrutiny and the widest scepticism. Negative criticism, accompanied with showy novel paradoxes, are always attractive to a young man of intellectual vigour; and thus Alcibiades learnt from Protagoras, Prodicus, and others, to laugh at the common opinions about justice, temperance, holiness, patriotism, &c. The long, patient, laborious thought, the self-sufficing and comparatively ascetic life of his master Socrates, he was able to admire, but not to imitate or practise. On the contrary, his ostentatious vanity, his amours, his debaucheries, and his impious revels, became notorious throughout Athens. But great as were Alcibiades's moral vices, his intellectual abilities were still more conspicuous. He proved his courage at the battle of Potidea (432 B.C.), where, wounded, he was rescued by Socrates; at the battle of Delium (424 B.C.), where he protected his former deliverer; and on many subsequent occasions. Though he was not a very fluent speaker, he always kept to the point. His energy was immense, his ambition unbounded but selfish, and provided he could gratify this passion, he never scrupled at the means or the price. He could read the character of others, and adapt himself to it with a versatility, adroitness, and flexibility which if any even of his shifty fellow-countrymen equalled they never surpassed. Nor were his personal qualities his only recommendation to popular favour. His ancestors and relatives had been for generations the recognised leaders of the people; he had many admirers and followers among the clubs of young nobles; he had numerous dependants who partook of his wealth; and he gratified the populace by the lavish expenditure with which he performed his various liturgical duties. On his first entering prominently into public life, he succeeded by a clever but unscrupulous trick in duping the Spartan ambassadors, and persuading the Athenians to conclude an alliance with Argos, Elis, and Mantinea (420 B.C.) Next year he was appointed general, and for three years busily traversed the Peloponnesus, endeavouring to advance the objects of the alliance. But to be the first man in Athens was far too limited an object to satisfy the ambition of Alcibiades: all Greece must be dazzled by his greatness. As the first step towards the accomplishment of this scheme he fixed upon the conquest of Sicily, which would necessarily be followed by that of the Peloponnesus and probably by that of Carthage. With this view, he warmly advocated the adoption of measures for the relief of Segesta. The Sicilian expedition being resolved on with great enthusiasm, he, Nicias, and Lamachus, were appointed generals. But shortly before the day appointed for the armaments setting sail there took place a mysterious crime, which was destined to alter the whole complexion of Alcibiades's future, and with it that of the Athenian state. In the course of one night (May, 415 B.C.) all the busts of Hermes in Athens were sacrilegiously mutilated. The enemies of Alcibiades (many of them probably the actual perpetrators) endeavoured to connect him with the sacrilege; and his well-known impieties gave plausibility to a charge which could never have had any real foundation. Recalled to stand his trial almost as soon as he reached Sicily, he escaped, and made his way to Sparta, where he revealed all the plans of the Athenians, and induced the Spartans to send Gylippus to Sicily and an army to fortify Decelea. He then passed over to Asia Minor, and prevailed upon many of the Ionic allies of Athens to revolt. But in a few months he had lost the confidence of the Spartans; and at the instigation of Agis II., whose personal hostility he had excited, an order was sent from Lacedæmon for his execution. Receiving timely information of this order, he crossed over to Tissaphernes (412 B.C.), and quickly worming himself into the satrap's confidence, he persuaded him to cease giving active assistance to Sparta, so that the two Grecian parties, after wearing themselves out by their mutual struggles, might both be easily expelled from Asia. But Alcibiades was now bent on returning to Athens, and he used his supposed influence with Tissaphernes to effect his purpose. In his negotiation with Peisander, though he failed in his immediate object, he succeeded in producing the impression that, whatever side he joined, he could make Tissaphernes help. Under this impression, he was recalled by Thrasybulus and the armament at Samos, and appointed one of the generals. His appointment was followed by the victories at Cynossema, Abydos, and Cyzicus, and by the recovery of Chalcedon and Byzantium. On his return to Athens after these successes he was welcomed with every demonstration of joy (407 B.C.); all the proceedings against him were cancelled, and he was appointed general with full powers. His ill success, however, at Andros, and the defeat of his lieutenant at Notium, led the Athenians to dismiss him from his command. He thereupon retired to the Thracian Chersonesus; but after the battle of Ægospotami, and the establishment of the Spartan supremacy throughout Greece, he crossed the Hellespont, and took refuge with Pharnabazus in Phrygia. There an attack was made upon him, but by whom or for what cause historians are not agreed; his residence was set on fire, and on rushing out on his cowardly assassins, dagger in hand, he was killed by a shower of arrows, 404 B.C. By his wife Hipparete, Alcibiades left one son, who was named after himself.

ALCINOUS, a Platonic philosopher of uncertain date, author of a work entitled Ἐπιτομὴ τῶν Πλάτωνος δογμάτων, which has been translated into English by Stanley in his *History of Philosophy*. The best edition of the Greek original is that by Fischer, Lips. 1783, 8vo.

ALCINOUS, a mythical king of the Phæacians, in the island of Scheria, was son of Nausithous, and grandson of Neptune and Peribœa. He has been immortalised in the *Odyssey*, the description of his reception and entertainment of Ulysses, who when cast by a storm on the shore of the island was relieved by the king's daughter, Nausicaa, forming the main subject of books vi. to xiii. of that poem. The subjects of Alcinous loved pleasure and good cheer, yet were skilful seamen; and he himself is described as a good prince.

ALCIPHRON, the most eminent of the Greek epistolary writers, was probably a contemporary of Lucian. His letters, of which 116 have been published, are written in the purest Attic dialect, and are considered models of style. The imaginary authors of them are country people, fisherwomen, courtesans, and parasites, who express their

sentiments and opinions on familiar subjects in refined and elegant language, yet without any very apparent inconsistency. The new Attic comedy being the principal source from which Alciphron derived his information, these letters are valuable as delineating the private life of the Athenians at that period. The best editions are by Bergler, Lips. 1715, and Wagner, Lips. 1798.

ALCIRA, probably the *Sœtabicula* of the Romans, a Spanish town, on an island in the river Xucar, 25 miles S.W. of Valencia, in the province of that name. It is surrounded by walls, and has two fine bridges. There is a remarkable stalactite grotto in the vicinity. The principal productions are silk, rice, and oranges, which are largely exported. Population, 15,400.

ALCMAN, sometimes also called ALCMÆON, one of the most ancient, and, in the opinion of the Alexandrian critics, the most distinguished of the lyric poets of Greece. According to one account he was by birth a Lydian, while others state that he was a native of Sparta, where, at any rate, he lived from a very early age. The time at which he flourished is uncertain, but it is generally assumed that it embraced the period between the years 670 and 630 B.C. Alcman may in some respects be regarded as the father of lyric poetry among the Greeks, and it was probably for this reason that the Alexandrian critics put him at the head of their lyric canon. His poems, which seem to have formed a collection of six books, are known to us only from a number of small fragments. Many of them were of an erotic character, but others were hymns and didactic pieces. All were written in the vigorous broad dialect of the Dorians. The best collection of these fragments was published by F. G. Welcker, Giesen, 1815, 4to; they are also contained in Bergk's *Poetæ Lyrici Græci*, 1852, 8vo.

ALCMENE, the daughter of Electryon, king of Mycenæ, and wife of Amphitryon. She was the mother of Hercules by Jupiter, who assumed the likeness of her husband during his absence, and of Iphicles by Amphitryon.

ALCOCK, JOHN, doctor of laws, and bishop of Ely in the reign of Henry VII., was born at Beverley in Yorkshire before 1440, and educated at Cambridge. He was made dean of Westminster and master of the rolls in 1462. In 1470 he was appointed ambassador to the court of Castile, and in 1471 was consecrated bishop of Rochester. In 1477 he was translated to the see of Worcester; and in 1486 to that of Ely. He was a prelate of great learning and piety, and so highly esteemed by King Henry that he appointed him lord president of Wales, and afterwards lord keeper of the Great Seal. Alcock founded schools at Kingston-upon-Hull and Beverley, and built the spacious hall belonging to the episcopal palace at Ely. He was also the founder of Jesus College in Cambridge, for a master, six fellows, and as many scholars. This house was formerly a nunnery, dedicated to St Radigund; and Godwin says that the building being greatly decayed, and the revenues reduced almost to nothing, the nuns had all forsaken it, except two; whereupon Bishop Alcock procured a grant from the crown, and converted it into a college. But Camden and others tell us that the nuns of that house were so notorious for their incontinence, that King Henry VII. and Pope Julius II. consented to its dissolution. Bishop Alcock wrote several pieces, among which are the following:—1. *Mons Perfectionis;* 2. *In Psalmos Pœnitentiales;* 3. *Homiliæ Vulgares;* 4. *Meditationes Piæ*. He died at Wisbeach, October 1, 1500, and was buried in the chapel built by himself in Ely cathedral.

ALCOHOL, a volatile organic body, constantly formed during the fermentation of vegetable juices containing sugar in solution. It is extracted from spirituous liquors of different kinds by successive distillations or rectifications; the alcohol being more volatile than water, gradually accumulates in the first portion of each distillate. After a few operations the spirit obtained is as strong as it can be made by this process, and further repetition does not enable us to separate more water from it. In commerce the strongest spirit is known as spirit of wine, and contains about 90 per cent. of alcohol. The remaining 10 per cent. of water must be removed by some chemical agent that will combine with water and retain it at the boiling-point of the spirit, and be without any specific action on the alcohol. The dehydrating substances in general use are certain anhydrous salts, such as carbonate of potash, acetate of potash, or sulphate of copper. These rapidly absorb water at low temperature, and part with it at a red heat; so that they may be used over and over again. The most efficient dehydrating agent is caustic lime or caustic baryta. Lime is generally used in making the absolute alcohol of commerce. For this purpose the caustic lime is broken into small pieces about the size of a walnut, and placed in a retort; spirits of wine is now poured into the vessel, just sufficient to cover the lime, and the whole is left to digest for a night. During this time the lime gradually slakes from the absorption of water, and the anhydrous alcohol is left, ready to distill off at the temperature of the water-bath. Absolute alcohol is a very mobile colourless liquid, having a high refractive power, and possessing a feeble agreeable smell and an acid burning taste, which, however, diminishes as it is diluted with water. The caustic taste is in great part due to the rapidity with which it takes water from any living tissue with which it comes in contact, producing coagulation if the fluids are albuminous. Alcohol has a specific gravity of 0·794 at a temperature of 60° Fahr., and boils at 173°·1 Fahr., barometer being at 30 inches. It does not conduct electricity, and has never been obtained in the solid state, although at very low temperatures it becomes viscid. For this reason alcohol is always used to fill thermometers for registering low temperatures, as mercury freezes, and cannot be employed as an index of temperature below −39° Fahr. Its high co-efficient of expansion makes alcohol a very sensitive fluid for thermometric purposes. Alcohol has a great tendency to absorb water from the atmosphere, and must be kept in thoroughly sound vessels. It mixes with water in all proportions, and during the dilution there is a considerable amount of heat evolved. When alcohol and water are mixed, a contraction of volume occurs, which augments until 100 parts of alcohol are mixed with 116·23 parts of water; 103·775 volumes of alcohol and water mixed in that ratio contracting to 100. Addition of water beyond the proportion given above causes less and less contraction, and finally no diminution of volume can be observed. As alcohol is diluted with water its volatility and its power of dilatation diminish, whereas the specific gravity increases, continually approaching that of water. Next to water, alcohol is the substance most generally employed as a solvent. It dissolves many organic substances, and is especially used in the arts for the manufacture of varnishes. In medicine it is invaluable as a solvent of the active principle of many substances that are insoluble in water, and would soon decompose in aqueous solution. These alcoholic solutions are generally called tinctures.

Alcohol is an excellent antiseptic agent. As a preservative of animal structures it is generally used in the impure state—known in commerce as methylated spirit. This is spirits of wine mixed with 10 per cent. of commercial wood spirits, which does not interfere with its preservative or solvent powers, although it renders it unfit for use as a beverage.

Alcohol has the following chemical composition :—

Carbon	52·67 per cent.
Hydrogen	12·90 ,,
Oxygen	34·43 ,,
	100·00 ,,

Its formula in chemical symbols is C_2H_6O. During the fermentation of sugar the change that takes place is represented as follows :—

$$\underset{\text{Grape sugar.}}{C_6H_{12}O_6} = \underset{\text{Alcohol.}}{2\,C_2H_6O} + \underset{\text{Carbonic acid.}}{2\,CO_2}$$

The complex body, grape-sugar, breaks up by the action of the ferment or yeast into alcohol or carbonic acid, without anything being added. This kind of chemical change is sometimes called an action of presence, or catalytic action, because the substance inducing it does not enter into the composition of the products of the reaction. The alcohol ferment or yeast is a minute cellular plant that grows rapidly in sugar solution, especially if albumenoid matter is also present, and during the continuance of its vital functions causes a rearrangement of the atoms of the sugar. In order that fermentation may proceed regularly, a temperature of about 60° Fahr. is required, and an amount of sugar in solution not exceeding 10 per cent. The sugar is principally obtained from malt, which is barley that has been allowed to germinate for a certain time, and is then arrested in its growth by heating to a high temperature. During this process of germination there is a peculiar ferment produced called diastase; this has the remarkable property of changing starch into grape-sugar. When the malt is treated with water, the ferment causes all the starch originally present in the grain to appear in solution as grape-sugar. All kinds of starch may be changed into grape-sugar by boiling with dilute sulphuric acid, which in this case acts somewhat like a ferment, because it is not decomposed during the action. The sulphuric acid is afterwards separated by treating with lime, which produces insoluble sulphate of lime (gypsum), and leaves the sugar in solution. In this way sugar for the alcohol manufacture is now largely made from the potato and other starch-yielding plants. Cane-sugar is too expensive to be employed in the distillery. Molasses, or the uncrystallisable portion of the cane-sugar, is, however, largely used.

Alcohol, when acted on by other chemical substances, produces a great variety of new compounds. With acids a remarkable class of bodies are produced called ethers, of which ordinary ether is the type. The majority of them are very volatile fluids, that in many cases have a very agreeable odour, and are not readily soluble in water. Many ethers are obtained by simply heating a mixture of the acid and alcohol in a closed vessel to a temperature of 212° Fahr., and subsequently treating with water. The water dissolves the alcohol not acted upon, and leaves the ether floating on the surface.

When alcohol is treated with chlorine, absorption occurs, and hydrochloric acid is continuously evolved for many hours, the temperature rising considerably during the action. Many substances are formed in succession, but the principal product, after long-continued action, is the substance chloral, now largely used as an anæsthetic. Bromine produces a similar body called bromal. Iodine does not act on alcohol at ordinary temperatures, further than to pass into solution. When treated with a solution of chloride of lime, alcohol is violently attacked, and the result of the action is the well-known substance chloroform. Acted on by oxidising agents, alcohol gives two new substances—aldehyde and acetic acid. The ease with which acetic acid is produced by heating with a mixture of bichromate of potash and sulphuric acid gives a delicate method of detecting and estimating very small quantities of alcohol. When the vapour of alcohol is passed through a red-hot tube filled with fragments of pumice-stone, com plete decomposition takes place. Among the products are found naphthalin, benzol, hydrogen, marsh gas, ethylene, and other bodies.

The synthesis of alcohol has been effected by means of the hydro-carbon called olefiant gas, which may be made directly from carbon and hydrogen. When this gas is shaken with strong sulphuric acid it gradually combines with it; and if it is afterwards diluted with water and distilled, alcohol passes over. As olefiant gas is one of the constituents of common coal-gas, this substance may be used to make alcohol by the above method. The action that takes place is represented thus:—

$$\underset{\text{Olefiant Gas.}}{C_2H_4} + \underset{\text{Water.}}{H_2O} = \underset{\text{Alcohol.}}{C_2H_6O}$$

As the value of spirituous liquors depends mainly on the quantity of alcohol they contain, it is essential to find some simple and rapid means of ascertaining the percentage amount of the substance present. For this purpose three methods may be employed, viz., specific gravity determination, temperature of ebullition, or rate of expansion. The easiest plan, and the most generally used, is the density method. Very accurate tables are published of the specific gravity of mixtures of alcohol and water in all proportions, so that it is only necessary to refer to these tables to get the percentage composition. In the case of liquors, like wines or beers, that contain many other substances in solution in addition to alcohol, it is necessary to separate the alcohol from the extractive matters—sugar, salts, &c.—by distillation, and to take the density of the volatile portion. As wines contain many volatile ethers that would pass over with the alcohol in the above process, and interfere with accurate results being obtained, they are generally decomposed by heating with an alkali before the distillation commences.

The physiological action of alcohol is a subject to which considerable attention has been directed of late years, and many investigators have attacked the problem. The most important contribution to our knowledge of the subject is due to Dr Parkes, who has made a long series of observations on soldiers living on a constant diet with and without the use of alcohol. In these experiments the weight of the body, the amount of nitrogen in the urine and fæces, the amount of urea, the pulse, and the temperature of the body were all determined daily. The following are the principal conclusions deduced from the investigation:—

The elimination of nitrogen during exercise was unaffected by brandy; and since a similar result occurred in a series of experiments made during rest, it seems certain that in healthy men on uniform good diet alcohol does not interfere with the disintegration of nitrogenous tissues.

The heat of the body, as judged of by the axilla and rectum temperature, was unaffected by the amount given. The apparent heat after alcohol must therefore be owing to subjective feelings connected with the quickened circulation, rather than to an actual rise of temperature.

The pulse was increased in frequency by 4 ounces of brandy, and palpitation and breathlessness were brought on by larger doses to such an extent as greatly to lessen the amount of work the man could do, and to render quick movements impossible. As the effect of labour alone is to augment the strength and frequency of the heart's action, it would appear obviously improper to act on the heart still more by alcohol. Whether on a heart exhausted by exertion alcohol would produce good or bad effects is not shown by these experiments.

Neither exercise nor alcohol produced any effect on the phosphoric acid of the urine, or the free acidity, or the chlorine.

As the action of alcohol in dietetic doses on the elimination of nitrogen and on the bodily temperature is so entirely negative, it seems reasonable to doubt if alcohol can have the depressing effect on the excretion of pulmonary carbon which is commonly attributed to it. It can hardly depress, one would think, the metamorphosis of tissues or substances furnishing carbon, without affecting either the changes of the nitrogenous structures or bodily heat.

The elimination of alcohol from the body has been a matter of dispute between different observers. Previous to the year 1860 it was the generally-received opinion that the greater portion of any alcohol taken was oxidised in the system, and only a small fraction eliminated unaltered. In that year Messrs Perrin and Lallemand published an elaborate memoir on the subject, in which they maintained that all, or at least nearly all, the alcohol taken is eliminated unaltered. This subject has been recently reinvestigated by Dr Austin, Dr Thudichum, and especially by Dr A. Dupré. The main results of Dr Dupré's series of observations may be summed up as follows:—

The amount of alcohol eliminated per day does not increase with the continuance of the alcohol diet; and therefore all the alcohol consumed daily must of necessity be disposed of daily; and as it certainly is not eliminated within that time, it must be destroyed in the system.

The elimination of alcohol following the ingestion of a dose or doses of alcohol ceases in from nine to twenty-four hours after the last dose has been taken.

The amount of alcohol eliminated in both breath and urine is a minute fraction only of the amount of alcohol taken.

In the course of these experiments the author found that, after six weeks of total abstinence, and even in the case of a teetotaller, a substance is eliminated in the urine, and perhaps also in the breath, which, though apparently not alcohol, gives all the reactions ordinarily used for the detection of traces of alcohol. The quantity present in urine is, however, so small that the precise nature of the substance has not as yet been determined. The author points out an apparent connection between this substance and alcohol. It was found that, after the elimination due to the ingestion of alcohol had ceased, the amount of this substance eliminated in a given time at first remained below the quantity normally excreted, and only gradually rose again to the normal standard. A careful study of this connection may perhaps serve to throw some light upon the physiological action of alcohol.

ALCOY, one of the most thriving manufacturing cities of Spain, on the river Alcoy, in the province of Alicante, 24 miles N.N.W. of the town of that name. It is built on an elevated site at the foot of a gorge of the *Sierra de Mariola*, and presents a picturesque appearance. There are several handsome buildings and a number of public fountains, but the industry of the place is its chief characteristic. The principal employment is papermaking. About 200,000 reams are produced annually, the extraordinary quantity of 180,000 reams being a paper of light texture used for making cigarettes. Coarse woollen stuffs are also manufactured. A very curious festival is held annually in April in honour of St George, the patron saint of the town. Population, 27,000.

ALCUDIA, MANUEL DE GODOY, DUKE OF, "Prince of the Peace," Spanish statesman, was born of poor but noble parentage at Badajoz on the 12th May 1767 (died 1851). In 1784 he came to Madrid to join the royal body-guard, and by his handsome presence and agreeable manners soon attracted notice. The queen regarded him with great favour, and the weak-minded Charles IV. raised him rapidly from dignity to dignity, until in 1792, on the disgrace of Aranda, he became prime minister. One of the first steps he took on his accession to power was to declare war against the French convention. Though success at first attended the Spanish arms, the position of matters was reversed in a second campaign, and the war was concluded by the treaty of Basle, signed on the 22d July 1795, for negotiating which Godoy received his title of Prince of the Peace and a large landed estate. He was also made at the same time a grandee of Spain of the first class. In 1796 he formed an offensive and defensive alliance with the French republic, which involved Spain in a war with England. Next year he was married to Maria Theresa de Bourbon, niece of the king by a morganatic marriage of his brother Luis. As it was understood that Godoy had already married Dona Josef a Tudo, this second alliance, though it brought him nearer to the king, did much to increase his unpopularity with the nation. On the 28th March 1798 he found himself forced to resign his position in the ministry, but he never lost the favour of the king, who appointed him grand admiral in 1799. About the same time he was restored to power, and entered into an alliance with Napoleon, having for its object the partition of Portugal. The war, in which Godoy himself commanded, was of short duration, the treaty of Badajoz, signed on the 6th June 1801, securing from Portugal a subsidy to France and a cession of territory to Spain. Godoy was rewarded for his service with the title of Count of Evoramente, and an annual income of 100,000 piastres. In 1804 he became generalissimo of the land and sea forces of Spain; but the honours thus heaped upon him by the king were accompanied by growing dislike on the part of the nobility and the people. The higher classes regarded him with jealousy as a *parvenu*, and he was necessarily unpopular with a nation that attributed to him the defeat of Trafalgar, and the stoppage of its commerce through the blockade of the ports. A change of policy, by which he endeavoured to break off his alliance with France and enter into friendly relations with England, came too late to save his position. Napoleon determined to remove the Bourbons from the throne of Spain, and the invasion of the French troops gave Godoy's enemies the wished-for opportunity to secure his downfall. The prime minister had retired from Madrid, and was making arrangements for the removal of the king and queen to Mexico, when the project was discovered by the Prince of Asturias, the leader of the party opposed to him. On the 18th March 1808 Godoy was seized at Aranjuez by the mob, who were only restrained from executing summary vengeance upon him by the promise given them that he should undergo a fair trial. Napoleon, however, wishing to avail himself of his influence over Charles, sent Prince Murat to effect his release. He was removed in April to Bayonne, where on the 5th May he signed the deed by which Charles IV. abdicated in favour of the Prince of Asturias. He continued to enjoy the undiminished favour of Charles, whom he accompanied to Rome, his possessions in Spain having been confiscated. On the death of his royal master he removed to Paris, where he received a pension of 5000 francs from Louis Philippe. In 1836–8 he published memoirs of his life, in which he defends his policy. In 1847 his titles and the greater part of his estates were restored to him, and he received permission to return to Spain. He continued, however, to reside in Paris, where he died on the 4th October 1851.

ALCUIN, in Latin *Albinus*, surnamed *Flaccus*, an eminent ecclesiastic and a reviver of learning in the 8th century, was born in Yorkshire about 735 (died 804). He was educated at York under the direction of Archbishop Egbert, as we learn from his own letters, in which he frequently calls that prelate his beloved master, and the clergy of York the companions of his youthful studies. He succeeded Elbert as director of the seminary, and in later life modelled after it his famous school at Tours. He survived Bede about seventy years; it is therefore hardly possible that he could have received any part of his education under him, as some writers of literary history have affirmed; and it is worthy of observation that he never calls Bede his master, though he speaks of him with the highest veneration. It is not well known to what preferments he had attained in the church before he left England, though some say he was abbot of Canterbury. He was sent to Rome by Eanbald, the successor of Ethelbert, to procure the *pallium*, and, in returning, at Parma he met Charlemagne, who, as Alcuin had already visited the French court, was no stranger to his extraordinary merit. The emperor contracted so great an

esteem and friendship for him that he earnestly urged and at length induced him to take up his residence at court and become his preceptor in the sciences. Alcuin accordingly instructed Charlemagne and his family in rhetoric, logic, mathematics, and divinity. He particularly distinguished himself by his writings in defence of the orthodox faith against the adoptionists, Felix, bishop of Urgel, and Elipandus, archbishop of Toledo, convincing the former of his error after a six days' debate at Aix-la-Chapelle (799), and treating the latter in the most conciliatory manner; and on more than one occasion he was employed in important missions between Charlemagne and Offa, king of Mercia. "France," says one of our best writers of literary history, with some degree of truth, "is indebted to Alcuin for all the polite learning it boasted of in that and the following ages. The universities of Paris, Tours, Fulden, Soissons, and many others, owe to him their origin and increase, those of which he was not the superior and founder being at least enlightened by his doctrine and example, and enriched by the benefits he procured for them from Charlemagne." Alcuin, it is alleged, however, forbade the reading of the classical poets. In 790 he went to England in the capacity of ambassador, and returned to France in 792, never again to visit his native land. After Alcuin had spent many years in the most intimate familiarity with the greatest prince of his age, he at length, in 801, with great difficulty, obtained leave to retire from court to the abbey of St Martin at Tours, of which he had been appointed the head by Charlemagne in 796. Here he remained and taught till his death in 804. In his retirement he kept up a constant correspondence with Charlemagne, which displays, on the part of both, an ardent love of learning and religion, and great zeal and earnestness in contriving and executing noble designs for their advancement. Alcuin composed many treatises on a great variety of subjects, in a style much superior in purity and elegance to that of most writers of the age in which he flourished. His works were collected and published by Duchesne, in 1 vol. folio, Paris, 1617: a better edition is that of Froben, 2 vols. folio, Ratisbon, 1777. They consist of (1) Tracts upon Scripture; (2) Tracts upon doctrine, discipline, and morality; (3) Historical treatises, letters, and poems. It is not improbable that Alcuin was the writer of the famous *Caroline Books*, issued under the name of Charlemagne, which denounced as idolatrous every form of image-worship. A Life of Alcuin, by Lorenz, was published at Halle in 1829, and appeared in an English translation, by Slee, in 1837.

ALCYONIUS, or ALCIONIUS, PETRUS, a learned Italian, born at Venice in 1487 (died 1527). Distinguished as a classical scholar, he was employed for some time by Aldus Manutius as a corrector of the press, and in 1522 was appointed professor of Greek at Florence through the influence of Giulio de Medici. When the latter became pope, under the title of Clement VII., in 1523, Alcyonius followed him to Rome, and remained there until his death. Alcyonius published at Venice, in 1521, a Latin translation of several of the works of Aristotle, which was shown by the Spaniard Sepulveda to be very incorrect. He wrote a dialogue entitled *Medices Legatus, sive de Exilio*, in connection with which he was charged with plagiarism by his personal enemy, Paulus Manutius. The accusation, which Tiraboschi has shown to be groundless, bore that he had taken the finest passages in the work from Cicero's *De Gloria*, and that he had then destroyed the only existing copy of the original in order to escape detection. Two orations on the taking of Rome by Charles V., and another on the knights who perished at the siege of Rhodes, are also ascribed to Alcyonius.

ALDAN, a river of Siberia, in the government of Yakutsk, which rises about 55° N. lat., and 125° E. long., and after flowing more than 300 miles in a north-east direction, turns to the north-west, joining the Lena about 100 miles below Yakutsk. It has a total length of over 500 miles, for a considerable part of which it is navigable.

ALDAN MOUNTAINS, the name usually applied to a branch of the Stanovoi mountains, which strikes off from the main chain in the direction of the Aldan river, or to a part of this range. According to some geographers, however, the continuation of the Stanovoi range to Behring Strait, or even the whole mountain system of eastern Siberia, ought to receive the name.

ALDBOROUGH, a town of England, in the West Riding of Yorkshire, 16 miles W.N.W. of York. It formerly returned two members to parliament, but was disfranchised by the Reform Act of 1832. The place is remarkable only from its numerous ancient remains. It was the *Isurium* of the Romans, and here and in the neighbourhood the remains of aqueducts, spacious buildings, and tesselated pavements have been found, as well as numerous implements, coins, and urns. Population (1871) of the parish, which extends into the North Riding, 2165; of the town, 502.

ALDEBURGH, or ALDBOROUGH, a market-town and watering-place in the county of Suffolk, 25 miles E.N.E. of Ipswich. The borough was incorporated by a charter of King Edward VI., and in former times was a place of considerable extent; but the old town was gradually submerged by the encroachments of the sea. Further destruction is now stayed by the accumulated sandbanks, and the place has become a favourite resort of summer visitors. Fishing affords employment to many of the inhabitants. The town is noted as the birthplace of the poet Crabbe, who was born here on 24th December 1754. A marble bust of the poet has been placed in the parish church. Aldeburgh was formerly a parliamentary borough, but was disfranchised by the Reform Act of 1832. Population of the parish in 1871, 1990.

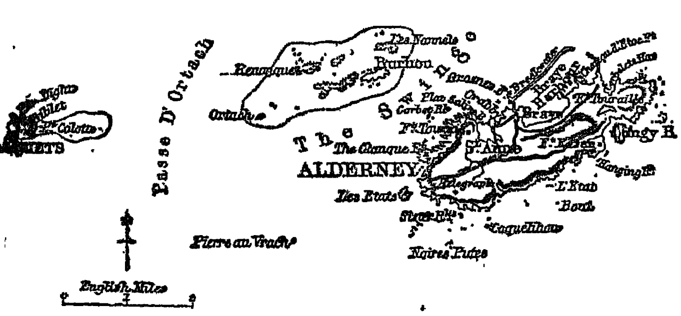
ALDEGREVER, or ALDEGRAF, HEINRICH, a German painter and engraver, born in 1502 at Paderborn, from which he removed in early life to Soest. From the close resemblance of his style to that of his master, Albert Dürer, he has sometimes been called the Albert of Westphalia. His numerous engravings, chiefly from his own designs, are delicate and minute, though somewhat hard in style, and entitle him to a place in the front rank of the so-called "Little Masters." Specimens of his painting are exceedingly rare. The genuineness of the works in the Vienna and Munich collections attributed to him is at least doubtful, the only unchallenged example being a portrait in the gallery at Berlin. Aldegrever died about the year 1562.

ALDER, a genus of plants (*Alnus*) belonging to the order *Betulaceæ*, the best known of which is the common alder (*A. glutinosa*). This tree thrives best in moist soils, has a shrubby appearance, and grows, under favourable circumstances, to a height of 40 or 50 feet. Under water the wood is very durable, and it is therefore used for piles. The supports of the Rialto at Venice, and many buildings at Amsterdam, are of alder-wood. Furniture is sometimes made from the wood, and it supplies excellent charcoal for gunpowder. The bark is astringent; it is used as a gargle, and also in tanning and dyeing.

ALDERMAN, a word derived from the Anglo-Saxon *ealdorman*, compounded of the comparative degree of the adjective *eald* (old) and *man*. The term implies the possession of an office of rank or dignity; and among the Anglo-Saxons, earls, governors of provinces, and other persons of distinction received this title. Thus we read

of the *aldermannus totius Angliæ*, who seems to have corresponded to the officer afterwards styled *capitalis justiciarius Angliæ*, or chief justice of England; the *aldermannus regis*, probably an occasional magistrate, answering to our justice of assize, or perhaps an officer whose duty it was to prosecute for the crown; and *aldermannus comitatus*, a magistrate with a middle rank between what was afterwards called the *earl* and the *sheriff*, who sat at the trial of causes with the bishop, and declared the common law, while the bishop proceeded according to ecclesiastical law. Besides these, we meet with the titles of *aldermannus civitatis, burgi, castelli, hundredi sive wapentachii*, &c. In modern times aldermen are office-bearers in the muncipal corporations of England and Wales, and Ireland. Before the passing of the Municipal Corporation Act their functions varied according to the charters of the different burghs. By the statute 5th and 6th Will. IV. c. 76, and 3d and 4th Vict. c. 118, the aldermen are elected by the councillors from among themselves (in Ireland, by the burgesses), for six years, one-half going out every three years. The number of councillors in each borough varies from 12 to 48, according to its magnitude. One-fourth of the municipal council consists of aldermen, and three-fourths of councillors. In the municipal corporations of Scotland there is no such title as alderman, the office-bearers of corresponding rank there being termed bailies. The corporation of London was not included in the Burgh Reform Act, and the antiquated system remains there in full force. The Court of Aldermen consists of twenty-six, twenty-five of whom are elected for life by the freemen of the respective wards, who return two persons, one of whom the Court of Aldermen elect to supply the vacancy. The city is divided into twenty-six wards; twenty-four of these send up one alderman each, the other two combine to choose a twenty-fifth. The twenty-sixth alderman serves for the independent borough of Southwark, and is appointed by the other aldermen, who generally select the senior from among themselves when a vacancy occurs. The lord mayor is elected from such of the aldermen as have served the office of sheriff; of these the Common Hall, which consists of the freemen of the different wards, select two, and the aldermen elect one of these to the mayoralty. The Court of Aldermen act as magistrates for the city of London, and also possess authority of a judicial nature in the affairs of the corporation. The aldermen are members of the Court of Common Council, the legislative body of the corporation, which consists in all of 232 members, the remainder being elected annually by the freemen. In the United States aldermen form as a rule a legislative rather than a judicial body, although in some cities they hold courts and possess very considerable magisterial powers.

ALDERNEY, one of the Channel Islands, and the most northerly of the four, lies between 49° 41′ and 49° 45′ N. lat., and 2° 9′ and 2° 14′ W. long., 7 miles to the westward



of Cape la Hogue, and is separated from the French coast by a narrow channel called the Race of Alderney. The passage through this strait is rendered very dangerous in stormy weather by its conflicting currents; but through it the scattered remnant of the French fleet under Tourville succeeded in escaping after the defeat of La Hogue in 1692. The harbour of Alderney is 20 miles distant from St Peter Port, Guernsey, 45 miles from St Helen's, Jersey, and 60 miles from Portland Bill, the nearest point of England. There is regular steam communication with Guernsey. The length of the island from N.E. to S.W. is 3½ miles; its width about 1 mile; its greatest elevation is 280 feet; and the area is about 4 square miles.

The greater part of Alderney is a level table-land, more or less cultivated. The land continues flat to the edge of the south-eastern and southern cliffs, which present a magnificent succession of broken and perpendicular walls of rock. Towards the north-west, north, and east, the coast is less rocky, and is indented by several bays of tame and naked aspect, of which those of Crabby, Braye, and Longy are the most noticeable. Sandstone, granite, and porphyry are the chief geological formations. From the importance of the island in a military sense, it has been fortified by a chain of defensive works, extending round the northern coast from the Clanque Fort on the west to Fort Essex on the east. The cliffs of the southern shore form a very strong natural bulwark. An extensive granite breakwater has been constructed, protecting the bay of Braye towards the west, intended to form an additional defence, and to convert the bay into a secure harbour of refuge. The works have cost upwards of a million and a quarter sterling; but the new harbour is not much resorted to, and the value of the breakwater as a means of defence has been questioned. Fort Touraille stands on the eastern side of the new harbour, and is a strong fortification, mounting 50 heavy guns, with bomb-proof barracks and powder magazine.

The population of Alderney has increased rapidly of recent years, on account of the extensive public works. In 1841 it was only 1030, in 1871 it was 2738. The inhabitants are Protestants, and Alderney forms part of the diocese of Winchester. Though a French *patois* lingers in the island, English is generally spoken and universally understood. The climate is healthy, and there is abundance of good water. Corn is grown, but much of the sandy soil is in grass, affording excellent pasture to the diminutive but pretty cows for which Alderney is famous. The only exports are cattle and early potatoes. St Anne's, the town of the island, is situated at some distance from the beach, overlooking the new harbour. It is plainly built, but has a fine new church in the early English style, erected as a memorial of the family of Le Mesurier, long the hereditary governors of the island. The only other architectural feature worthy of notice is a Gothic arch built as a memorial of the late Prince Albert of England.

Alderney seems to have been known to the Romans as *Riduna*, and Roman as well as Celtic remains have been discovered. It is subject to the British crown, and is a dependency of Guernsey. For its history and relation to English legislation, see the article on the CHANNEL ISLANDS. The internal government is vested in a judge appointed by the crown, and six *jurats*, chosen for life by the people; and these, with twelve *douzainiers*, who are popular representatives, but have not the power of voting, form the legislature. Justice is administered by the same judge and *jurats*, and several other officers. In civil cases an appeal may be taken to the royal court of Guernsey, while all criminal cases are referred to Guernsey for decision. Two companies of infantry and a battery of artillery compose the local militia.

Off the western coast of Alderney there are many uninhabited rocky islands; and six miles to the westward lie

the Casquets, a group of rocks extremely dangerous to ships coming up the English Channel. On these rocks there are three lighthouses, with revolving lights 112 feet above the water.

ALDERSHOTT CAMP, a standing garrison for a large force, situated about 35 miles from London, on the confines of Hampshire and Surrey. It was established in May 1855, and was intended as a military training school, especially for officers of the higher grades. Its germ is to be found in the temporary camp on Chobham Ridges, formed in 1853 by Lord Hardinge, then commander-in-chief, the success of which convinced him of the necessity of giving our troops practical instruction in the field, and affording our generals opportunities of manœuvring large bodies of the three arms. He therefore advised the purchase of a tract of waste land whereon a permanent camp might be established. His choice fell on Aldershott, a spot also recommended by strategic reasons, being so placed that a force holding it covered the capital. Nothing came of Lord Hardinge's proposal till the experience of the Crimean campaign fully endorsed his opinion. The lands at Aldershott—an extensive open heath country, sparsely dotted by fir woods and intersected by the Basingstoke canal—were then acquired by the Crown. The first occupants of the camp were two battalions of the Guards and seven of embodied militia. On the return of the Crimean army, cavalry, artillery, and infantry of the line arrived and took possession of the lines of wooden huts and the permanent barracks, which had by this time been erected. Since then Aldershott has varied little in its principal features. It is separated into two grand divisions, styled the north and south camps. Beyond the latter are the permanent cavalry and infantry barracks and the queen's pavilion. Farnham is the nearest town, being only 4 miles from the south camp; Guildford and Godalming are 10 and 12 respectively, Windsor 18½, and Reading 21 miles. The soil on which the camp stands is a light peat, and a fruitful source of discomfort to its inhabitants. A little wet turns it into tenacious mud, while a little sunshine produces a black dust, not soon forgotten by those who have campaigned in the "Long Valley." The force stationed at Aldershott at the beginning of 1874 was composed of 1 cavalry and 3 infantry brigades; in the former there were 3 full regiments, in the latter a total of 11 battalions, with several depots of regiments abroad. Besides these, there were 2 batteries of horse and 6 of field artillery, 2 companies of Royal Engineers, and 4 troops of Royal Engineers' train (with pontoon, &c.); 7 companies of the Army Service Corps and 2 of the Army Hospital Corps—to provide for transport, and the services of bakehouse and slaughter-house and hospital—made up the total strength of all ranks, as shown in the returns dated 1st January 1874, to 10,601 men, 2198 horses, and 48 guns. It is a lieutenant-general's command, and one highly prized, from its essentially military character and the practical experience it affords in handling a considerable force. Sir William Knollys (afterwards comptroller of the household to the Prince of Wales) was its first chief. He was succeeded by Sir John Pennefather; Sir James Scarlett followed; then Sir Hope Grant, who held the command in 1874. Naturally so large a military colony soon attracted other elements to Aldershott heath. Within a few years a town of Aldershott sprang up close by, and increased rapidly. Here the professions and all trades are well represented; there are respectable solicitors, surgeons, bankers, brewers, many schools, a steam printing press, a weekly military paper, and numerous shops. During the summer months or "drill season" the camp is a scene of incessant activity; field-days and parades follow in rapid succession, and owing to the camp's accessibility from London, the troops are often turned out at a few hours' notice to make a show for royalty or foreign visitors. Yet there is much to beguile vacant hours; many clubs—for cricket, croquet, racquets, and the drama—a gymnasium, and several excellent libraries. Admirable charities also exist for the assistance and relief of the soldiers' wives and children. (A. G.)

ALDHELM, or ADELM, ST, Bishop of Sherborne in the time of the Saxon heptarchy, was born about the middle of the 7th century. He is said to have been the son of Kenred, brother to Ina, king of the West Saxons; but, in the opinion of William of Malmesbury, his father was no more than a distant relation to the king. Having received the first part of his education in the school of Meildulf, a learned Irish monk, he travelled in France and Italy for his improvement. On his return home he studied some time under Adrian, abbot of St Augustin's in Canterbury, the most learned professor of the sciences who had ever been in England. The fame of his learning soon spread, not only in England, but in foreign countries. Learned men sent him their writings for his criticism; among others, a son of the king of Scotland is said to have sent his compositions to Aldhelm, "entreating him to give them the last polish by rubbing off their Scotch rust." He was the first Englishman who wrote in the Latin language, both in prose and verse; and he composed a book for the instruction of his countrymen on the prosody of that language. Bede says that Aldhelm "was a man of universal erudition, having an elegant style, and being wonderfully well acquainted with books both on philosophical and religious subjects." His Latin was in later times considered somewhat barbarous and corrupt. From one of his letters to Hedda, bishop of Winchester, concerning the nature of his studies whilst at Canterbury, he appears to have been indefatigable in his endeavours to acquire every species of learning in his power. For a copy of this curious epistle see Henry's *History*, vol. ii. p. 320. King Alfred declared that Aldhelm was the best of all the Saxon poets; and a favourite song, which was universally sung in his time, nearly 200 years after its author's death, was of his composition. He was a musician as well as a poet, and made his own songs the medium of instruction and refinement to his barbarous countrymen. After having governed the monastery of Malmesbury, of which he was the founder, about thirty years, he was made bishop of Sherborne, where he died in May 709.

He wrote—1. *De octo Vitiis Principalibus.* This treatise is extant in the *Bibliotheca Patrum* of Canisius. 2. *Ænigmatum Versus Mille.* This, with several other poems of his, was published by Martin Delrio at Mentz, 1701, 8vo. 3. A book addressed to a certain king of Northumberland named Alfrid, on various subjects. 4. *De Vita Monachorum.* 5. *De Laude Sanctorum.* 6. *De Arithmetica.* 7. *De Astrologia.* 8. A book on the mistake of the Briton concerning the celebration of Easter; printed by Sonius, 1576. 9. *De Laude Virginitatis;* published among Bede's *Opuscula.* Besides these, he wrote many sonnets, epistles, and homilies in the Saxon language.

ALDINE EDITIONS. See MANUTIUS.

ALDINI, GIOVANNI, a distinguished physicist, born at Bologna on the 10th April 1762 (died 1834), was the nephew of Galvani, and brother of the statesman Count Antonio Aldini. Devoted from his youth to the study of natural science, he was chosen in 1798 to succeed his former teacher Canterzani in the chair of physics at Bologna. His most important service consisted in the numerous experiments by which he sought to secure the better application of science to practical purposes. The subjects of galvanism, the illumination of lighthouses by gas, and an asbestos or fireproof fabric engaged his special attention, and on all of them he published the results of his researches. He was master of the leading European languages; and most of his works were published in Italian, French, and

English. Aldini was one of the founders of the National Institute of Italy, and among his scientific honours he counted the gold medal of the Royal Society of London, and the prize of the Institute of France. In recognition of his merits, the emperor of Austria made him a knight of the Iron Crown and a councillor of state at Milan, where he died on the 17th January 1834. He left by will a considerable sum to found a school of natural science for artisans at Bologna.

ALDRED, EALDRED, or ALRED, a prominent ecclesiastic in the 11th century, was successively abbot of Tavistock, bishop of Worcester, and archbishop of York. He was promoted to the see of Worcester in 1046, and in 1050 was sent on a special mission to Rome by Edward the Confessor. In 1054 he went as ambassador to the court of the Emperor Henry III. with the object of negotiating for the return of Edward the Ætheling from Hungary, and remained a year at Cologne. In 1058 he undertook and accomplished a journey to Jerusalem, a pilgrimage which no English bishop had ventured on before. He was appointed archbishop of York in 1060, and proceeded to Rome to obtain the pallium; but the pope at first refused to confirm the appointment. At length, however, Aldred was duly invested with the robe of office on condition of his resigning his former see, which he had continued to hold till that time. On the death of Edward (1066) Aldred sided with Harold, and officiated at his coronation; but after the battle of Hastings he made submission to William, and poured the sacred oil on the head of the Conqueror ere the year was completed in which he had crowned Harold. There are several traditions, which may be regarded as having some foundation in fact, that represent Aldred as administering rebuke to William in the interests of his countrymen or in defence of his church's rights. At the same time, he remained faithful to William, and when the English rose in the north against the Normans, he counselled submission. He died at York, Sept. 11, 1069, of grief, it is said, because of the threatened attack on his city by the combined forces of the English and Danes.

ALDRICH, Dr HENRY, theologian and philosopher, was born in 1647 at Westminster, and was educated at the collegiate school there, under Dr Busby. In 1662 he entered Christ Church College, Oxford, with which he continued to be intimately connected during his whole life. He took so conspicuous a part in the controversy with the Roman Catholics during the reign of James II., that at the Revolution the deanery of Christ Church was conferred upon him, Massey, the popish dean, having fled to the continent. In 1702 he was appointed rector of Wem in Shropshire, but continued to reside at Oxford, where he died on the 14th Dec. 1710. He was buried in the cathedral without any memorial, at his own desire. Aldrich was a man of unusually varied gifts. He is best known as the author of a *Compendium Artis Logicæ*, a work of almost no value in itself, but historically important as being for upwards of a century the manual in exclusive use at Oxford. His claims to distinction as a musician and an architect, though not so widely recognised, are much better founded than his reputation as a logician. He composed a number of anthems and church services of very considerable merit, which are still frequently sung in cathedrals. He also adapted much of the music of Palestrina and Carissimi to English words with great skill and judgment. The catch "Hark, the bonny Christ Church bells" is one of his most admired compositions in the lighter style. Aldrich wrote a treatise on architecture; and practical evidence of his skill in the art may be seen in the church and campanile of All Saints, Oxford, and in three sides of the so-called Peckwater Quadrangle of Christ Church College, which were erected after his designs.

In classical scholarship Dr Aldrich had some reputation. The *Musæ Anglicanæ* contains two specimens of his Latin verse, the subjects being the accession of King William and the death of the Duke of Gloucester. A humorous Latin version by Aldrich of the popular ballad—

"A soldier and a sailor,
A tinker and a tailor," &c.,

has been preserved by Sir John Hawkins. Another specimen of his wit is furnished by the following epigram, entitled "Causæ Bibendi," which some, however, have ascribed to Père Sirmond :—

Si bene quid memini, Causæ sunt quinque bibendi;
Hospitis Adventus, præsens Sitis, atque futura,
Aut Vini Bonitas, aut quælibet altera Causa.

The translation runs—

If on my theme I rightly think,
There are five reasons why men drink :—
Good wine; a friend; because I'm dry;
Or lest I should be by and by;
Or—any other reason why.

ALDROVANDI, ULISSE, a celebrated naturalist, born of noble parentage at Bologna on the 11th Sept. 1522 (died 1607). While a boy he was page in the family of a rich bishop, and afterwards apprentice to a merchant in Brescia. Commercial pursuits soon became distasteful to him, and he turned his attention to law and medicine, studying first in his native town and afterwards at Padua. In 1550, having been accused of heresy, he was compelled to proceed to Rome in order to vindicate himself before the Inquisition, which gave him a conditional acquittal. In Rome he published his first work, a treatise on ancient statuary. Here he made the acquaintance of the eminent naturalist Rondelet, from whom it seems not unlikely that he derived the impulse towards what became from that time his exclusive study. On his return to Bologna he devoted himself specially to botany, under the teaching of Lucas Ghino, then professor of that science at the university. In 1553 he took his doctor's degree in medicine, and in the following year he was appointed professor of philosophy and also lecturer on botany at the university. In 1560 he was transferred to the chair of natural history, which he continued to occupy until rendered infirm by age. At his instance the senate of Bologna established in 1568 a botanical garden, of which he was appointed the first director. He was also instrumental in founding the still existing public museum of Bologna, which contains, especially in the natural history department, a large number of specimens collected by Aldrovandi. To procure these it is believed that he visited personally most of the countries of Europe, though the details of his journeys have not been preserved. Some idea of the extent of his labours may be gathered from the fact that his herbarium occupied sixty large folio volumes. To the other offices held by Aldrovandi was added that of inspector of drugs, in which capacity he published in 1574 a work entitled *Antidotarii Bononiensis Epitome*, deserving of notice as furnishing the model according to which nearly all subsequent pharmacopæias have been compiled.

The results of Aldrovandi's various researches were embodied in his *magnum opus*, which was designed on the most complete scale, so as to include everything that was known about natural history. The first three volumes, comprising his ornithology, were published in 1599. Three more, treating of insects and mollusca, appeared during the author's lifetime. The seven volumes which completed the work were compiled from Aldrovandi's manuscript materials, under the editorship of several of his pupils, to whom the task was entrusted by the senate of Bologna. The work was enriched by a large number of pictorial illustrations, prepared at great expense, the author having, it is said, employed several celebrated artists for thirty years. Among these were Lorenzo Benini of Florence and Christopher Coriolanus of Nuremberg. It has been said, indeed, that the cost of the undertaking was so great as to exhaust its author's means, and that he died penniless and blind in the public hospital of Bologna. This, however, is probably incorrect, at least as regards the allegation of poverty. Published records of the senate of Bologna show that it liberally supported Aldrovandi in his undertaking, doubling his salary soon after his appointment as professor

and bestowing on him from time to time sums amounting in all to 40,000 crowns. If, therefore, he died in the public hospital, he probably went there for the better treatment of his disease. His death occurred on the 10th Nov. 1607.

Aldrovandi was chiefly remarkable for laborious and patient research. He seems to have been totally destitute of the critical faculty; and hardly any attempt is made in his great work to classify facts or to distinguish between the true and the fabulous, the important and the trivial. Much is thus included that is of no scientific value, but it also contains much information of very great interest to the naturalist.

ALDSTONE, or Alston Moor, a market-town of England, in the county of Cumberland, situated on an eminence near the South Tyne, 19 miles E.S.E. from Carlisle, with which it is connected by railway. The surrounding country, which is bleak and desolate, contains lead mines, mostly belonging to Greenwich Hospital, formerly very valuable, but now almost exhausted. Thread, flannel, and shot are manufactured in the town. Population (1871) of parish, 5680; of town, 2627.

ALE, a fermented liquor obtained from an infusion of malt, and differing from beer chiefly in having a less proportion of hops. Before the introduction of hops into England from Flanders, about 1524, ale was the name exclusively applied to malt liquor, the term beer being gradually introduced at a later period to describe liquor brewed with an infusion of hops. The two words, however, are now used with little distinction of meaning. Ale, the wine of barley, is said to have originally been made in Egypt. The natives alike of Spain, France, and Britain all use an infusion of barley for their ordinary liquor, which was called *cælia* and *ceria* in the first country, *cerevisia* in the second, and *curmi* in the third—all literally importing *the strong water*.

"All the several nations," says Pliny, "who inhabit the west of Europe have a liquor with which they intoxicate themselves, made of corn and water. The manner of making this liquor is sometimes different in Gaul, Spain, and other countries, and is called by many various names; but its nature and properties are everywhere the same. The people of Spain, in particular, brew the liquor so well that it will keep good a long time. So exquisite is the cunning of mankind in gratifying their vicious appetites that they have thus invented a method to make water itself intoxicate."

The method in which the ancient Britons and other Celtic nations made their ale is thus described by Isidorus and Orosius:—

"The grain is steeped in water, and made to germinate, by which its spirits are excited and set at liberty; it is then dried and ground; after which it is infused in a certain quantity of water, which, being fermented, becomes a pleasant, warming, strengthening, and intoxicating liquor."

This ale was most commonly made of barley, but sometimes of wheat, oats, and millet. Ale was the favourite liquor of the Anglo-Saxons and Danes. Before their conversion to Christianity, they believed that drinking large and frequent draughts of ale was one of the chief felicities which those heroes enjoyed who were admitted into the hall of Odin. Anciently the Welsh and Scots had two kinds of ale, called *common ale* and *spiced ale*, the relative values of which were thus appraised by law: "If a farmer had no mead, he shall pay two casks of spiced ale, or four casks of common ale, for one cask of mead." By this law a cask of spiced ale, nine palms in height and eighteen palms in diameter, was valued at a sum of money equal in value to £7, 10s. of our present money; and a cask of common ale of the same dimensions at a sum equal to £3, 15s. This is a sufficient proof that even common ale at that period was an article of luxury among the Welsh, which could only be obtained by the great and opulent.

For details as to the process of manufacture, statistics, &c., see Brewing.

ALE-CONNER, an officer appointed yearly at the court-leet of ancient manors for the assize of ale and ale-measures. The *gustatores cervisiæ*—called in different localities by the different names, "ale-tasters," "ale-founders," and "ale-conners"—were sworn to examine beer and ale, to take care that they were good and wholesome and were sold at proper prices. In London, four ale-conners are still chosen annually by the liverymen in common hall assembled, on Midsummer Day. Since ale and beer have become excisable commodities the custom of appointing ale-tasters has in most places fallen into disuse. (For the means now employed to test the quality of ales, see Adulteration, p. 172.)

ALEANDRO, Girolamo (Hieronymus), cardinal, commonly called "the Elder," to distinguish him from his grand-nephew of the same name, was born at Motta, near Venice, on the 13th of February 1480 (died 1542). He studied at Venice, and while still a youth acquired great reputation for learning. In 1508 he went to Paris, on the invitation of Louis XII., as professor of belles lettres, and he held for a time the position of rector in the university. Entering the service of the prince-bishop of Liege, he was sent by that prelate on a mission to Rome, where Pope Leo X. retained him, giving him (1519) the office of librarian of the Vatican. In the autumn of 1520 he went to Germany to be present as papal nuncio at the coronation of Charles V., and in the following spring he appeared at the diet of Worms, where he headed the opposition to Luther, advocating the most extreme measures to repress the doctrines of the Reformer. His conduct not merely called forth the fiercest denunciations of Luther, but estranged from him Erasmus, who had been his intimate friend at Venice. The edict against the Reformer, which was finally adopted by the emperor and the diet, was drawn up and proposed by Aleandro. After the close of the diet the papal nuncio went to the Netherlands, where he kindled the flames of persecution, two monks of Antwerp, the first martyrs of the Reformation, being burnt to ashes in Brussels at his instigation. In 1523, Clement VII., having appointed him archbishop of Brindisi and Oria, sent him as nuncio to the court of Francis I. He was taken prisoner along with that monarch at the battle of Pavia (1525), and was only released on the payment of a heavy ransom. He was subsequently employed on various papal missions, especially to Germany, but was unsuccessful in preventing the German princes from making a truce with the Reformers, or in checking to any extent the progress of the new doctrines. In 1538 Paul III. conferred upon him the cardinal's hat, when he took the title of St Chrysogonus. He died at Rome on the 31st January or 1st February 1542.

Aleandro compiled a *Lexicon Græco-Latinum*, and wrote Latin verse of considerable merit. The Vatican library contains a volume of manuscript letters and other documents written by him in connection with his various missions against Luther. Its historical value renders this the most important of his works.

ALEMAN, Louis, Archbishop of Arles, and Cardinal of St Cecilia, was born at Bugey in 1390. He was one of the presidents of the Council of Basle in 1431, and led the party that maintained the supremacy of councils over popes in opposition to the claims of Eugenius IV. It was on his motion that the latter was deposed by the council, and Felix V. elected in his stead. Eugenius thereupon deposed the arch-pope, and deprived Aleman of all his ecclesiastical dignities, but these were restored by Nicholas V. in 1447, Felix V. having previously resigned, on the advice of the cardinal. In 1527 Aleman was canonised by Pope Clement VII.

ALEMANNI, a large German tribe on the Upper Rhine. They are first mentioned by Dion Cassius, who relates that the Emperor Caracalla gained, in 213 A.D., a victory over them on the banks of the Maine, and thence assumed

the surname *Alemannicus*. The origin of this tribe, and the country from which they came, are unknown; but we have a distinct statement, which is apparently confirmed by the very name of the people, that they had flocked together from all parts, and were a mixed race. They proved most formidable enemies to the Romans as well as to the Gauls, their western neighbours, who to this day apply the name Alemanni (Allemands) to all the Germans indiscriminately, though the Alemanni, properly so called, occupied only the country between the Maine and the Danube. In the reign of Aurelian, 270 A.D., they attempted to invade Italy, but were repulsed. After the death of that emperor, however, they renewed their attacks by invading Gaul, and ravaging the country at different times. Several undertakings against them were of little avail, until in 357 A.D. the Emperor Julian completely defeated them in the neighbourhood of Strasburg, where all their forces were assembled under seven chiefs. This and other defeats, however, did not break the power of the Alemanni, who, being pressed on by other barbarians in the north, were forced to advance southward and westward to conquer new countries for themselves. Hence, after the middle of the 5th century, we find them established not only in the country now called Suabia, but also in a part of Switzerland and in Alsace. In these countries the Alemanni have maintained themselves ever since, and the greater part of the modern Suabians and the northern Swiss are descendants of that ancient race.

ALEMBIC (Arab. *alanbiq*, cognate to the Greek ἄμβιξ), an apparatus for distillation, used chiefly by the alchemists, and now almost entirely superseded by the retort and the worm-still. It varied considerably in form and construction, but consisted essentially of three parts—a vessel containing the material to be distilled, and called, from its gourdlike shape, the *cucurbit*; a vessel to receive and condense the vapour, called the *head* or *capital*; and a *receiver* for the spirit, connected by a pipe with the *capital*. The entire apparatus was sometimes constructed of glass, but as this rendered it very expensive and brittle, it was more usual to make the *cucurbit* of copper or earthenware, and the *capital* alone of glass.

ALEMTEJO (Spanish *Alentejo*), a province of Portugal, bounded on the N. by Beira, on the E. by Spanish Estremadura and Andalusia, on the S. by Algarve, and on the W. by the Atlantic and Portuguese Estremadura. It lies between 37° 20′ and 39° 40′ N. lat., and 6° 45′ and 8° 53′ W. long., and has an area of 10,225 square miles. Alemtejo is traversed by several mountain ranges, whose height does not generally rise much above 2000 feet, though one of the peaks of the Sierra de Monchique has an elevation of 4050 feet. The principal rivers are the Guadiana, which, crossing the Spanish frontier, flows southward through the province; and the Sado, which rises in the Sierra de Monchique, and flows to the north. Farther northward are the Soro and the Zatas, tributaries of the Tagus. All these rivers receive numerous affluents. There are several extensive plains, notably that of Alemtejo, the largest in Portugal, lying S.W. from the mountains of Portalegre; and that of Ourique, in the southern part of the province. Some portions of these plains are fruitful, others marshy, while large tracts are mere desolate wastes. The climate in the lower parts of the country is exceedingly hot, and is rendered unhealthy in summer by the stagnant marshes. Towards the Spanish frontier the soil is fertile, and in the south the country is covered by extensive forests of oak, pine, chestnut, cork, and holm, especially on the sides of the Sierras de Monchique and Caldeiraon. In the more fertile parts of the province, grapes, figs, citrons, pomegranates, and other fruits are produced. Wheat, maize, and rice are grown, and some attention is given to the rearing of mules, asses, goats, cattle, and sheep. Agriculture is, however, in a backward state, the sparse population being mostly concentrated in the towns, leaving extensive districts uncultivated and almost uninhabited. Droves of swine are fed on the waste lands, growing to a great size, and affording excellent hams. Minerals are to be found in the mountains, but they are little wrought. Manufactures scarcely exist, being confined to the preparation of olive oil of particularly good quality, and the making of earthenware, woollen cloths, and leather. For administrative purposes Alemtejo is divided into three districts—Beja, Evora, and Portalegre; and it contains 50 communal divisions and 315 parishes. The chief towns are Evora, Portalegre, Elvas, Beja, Estamoz, and Moura. There are no seaports of importance in the province. Population in 1868, 332,237.

ALENÇON, the chief town of the French department of Orne, situated in a wide and fertile plain, on the Sarthe, close to its confluence with the Briante. It is a clean, regularly-built town, with broad handsome streets. It is the seat of a bishop; and the Gothic church of Notre Dame, called the cathedral, is a fine building of the 16th century. The only remains of the ancient castle of Alençon are three towers that form part of the present town-hall. The lace known as "point d'Alençon" is the most noted manufacture of the town, although of late years its importance has somewhat diminished. Among the other industries are tanning, spinning, bleaching, linen manufacturing, and cider-making. The cutting of quartz crystals, often called Alençon diamonds, is also carried on. Alençon was a place of small importance when it was handed over to the Normans by Charles the Simple in the beginning of the 10th century. In 1025 it became subject to the De Belesmes, counts of Alençon, by whom it was enlarged and fortified. It was ceded to King Philip Augustus in 1221 by Alice, the heiress of the last count. The duchy of Alençon was created about the end of the 14th century, and remained with the original family, a branch of the house of Valois, until the middle of the 16th. The town was repeatedly taken and retaken in wars with Henry V. and Henry VI. of England, and also in the time of the League. In the war between France and Germany, Alençon was taken by the Germans under the Grand Duke of Mecklenburg on the 17th of January 1871. The townspeople did not offer much resistance. The mayor and municipality were, indeed, in favour of yielding without a struggle; but the newly-appointed prefect, an ultra-republican, insisted on a more martial policy. A feeble skirmish took place outside the town on the evening of the 16th of January, and the grand duke entered on the following morning without any further opposition. The Germans, as a punishment for the previous resistance, imposed on the citizens a fine of 300,000 francs, besides a large contribution of cattle, corn, and other provisions. Population (1872), 16,037.

ALENIO, GIULIO, a missionary of the Jesuit order, born at Brescia in 1582, died 1649. He became a member of the order in 1600, and arrived at Macao as a propagandist in 1610. For upwards of thirty years he laboured to spread Christianity in China, adopting, in accordance with the principles of his order, the dress and manners of the country. He was the first who planted the faith in the province of Kiang-Si, and he built several churches in the province of Fo-Kien. He composed a number of works in the Chinese language, of which he was thoroughly master, the most important being a *Life of Christ* and a *Cosmography*.

ALEPPO, or HALEB, a city of Syria, capital of the Turkish vilayet of the same name, in 36° 12′ N. lat., 37° 12′ E. long., 70 miles E. of the Mediterranean, near the N.W. extremity of the great Syrian desert. It occupies the site

of the ancient *Beroea*, and is a place of great antiquity. After the destruction of Palmyra it speedily became the great emporium of the trade between the Mediterranean and the countries of the East. It was overwhelmed by the flood of Saracen invasion in 638; and in 1260, and again in 1401, it was plundered and laid waste by the Tartars. It finally came into the possession of the Turks in 1517. To the east of the modern city extensive remains of its ancient grandeur have been discovered.

Aleppo is built on eight low hillocks, and is encircled by limestone hills of greater elevation, while beyond these stretches a fertile plain. The river Koeik, the ancient *Chalus*, flows through the town, and loses itself in a morass 18 miles distant. It is subject to floods in winter, when it overflows its banks, and inundates the neighbouring gardens. The city is surrounded by a stone wall, 40 feet high and 3½ miles in circuit, erected by the Saracens. This wall is flanked by frequent towers, but the ditch is partially choked up; and the city, being commanded by the adjacent heights, is entirely indefensible. The wall is pierced by seven gates, which are known by different names. Outside the city there are large irregular suburbs, erected after the great earthquakes of 1822 and 1830, and increasing the circuit of the place to 7 miles. The city suffered very severely by the earthquake of 1822; two-thirds of the inhabitants were swallowed up, the citadel and many of the mosques were overthrown, and a great part of the town was laid in ruins. Before the occurrence of these disasters Aleppo was the fairest and cleanest of Turkish cities; and although it has only partially recovered from their calamitous effects, it has still an attractive appearance, especially when the white minarets of its numerous mosques, and its houses, picturesquely placed on the terraces of the hills, are viewed from a distance. The houses are built of freestone, with flat roofs, and are generally of two or three storeys. One of the mosques, that of Zacharias, is held in peculiar veneration by the Moslem inhabitants. A new citadel has been erected in the N.W. part of the town; and besides many mosques, warehouses, and bazaars, there are several Christian churches and schools, and also Turkish schools, libraries, and hospitals. Aleppo is the seat of a Greek and Armenian patriarch, and of a Maronite bishop. The Mahometan, the Christian, and the Jewish portions of the population dwell in separate quarters of the town. Water is brought to the city by an aqueduct from a distance of 8 miles, and supplies upwards of 200 fountains, massive structures standing in the streets. Among the chief attractions of Aleppo are its gardens, which extend continuously for about 12 miles S.E. of the city. They are watered by the Koeik, and produce abundance of fruit and culinary vegetables; but their most celebrated production is the pistachio-nut, which is regularly cultivated.

Formerly Aleppo stood in the first-rank among the cities of Asia Minor as a place of trade; and it is still the emporium of Northern Syria, and has extensive commercial relations with Diarbekir and the upper parts of Anatolia, and also with Mosul and Baghdad. Large caravans resort to Aleppo from these and other eastern places, and the imported foreign goods are brought by caravans from the ports of Scanderoon or Alexandretta and Latakia. The construction of a carriage-road between Aleppo and Alexandretta has been commenced, but no progress whatever was made with it during 1872. Trade is conducted in Aleppo by more than 100 mercantile houses, several of them British; but no commercial bank has as yet been established in the province. The principal manufacture of the city consists of various kinds of cloth, of silk, cotton, and wool, some flowered and striped, others woven with gold and silver thread. These cloths have long been famous throughout the East, and the manufacture of them employs about 6400 looms. A large amount is invested in the manufacture of carpets, cloaks, and girdles. There are, besides, numerous soap, dyeing, and print works, and also rope-walks. In addition to cloths, the exports include wheat, sesame, wool, cotton, oil, scammony, galls, pistachio-nuts, camels' hair, &c.; while the imports chiefly consist of European manufactured goods and colonial produce. The aggregate value of the trade of the province exceeded £1,500,000 in 1872.

The air of Aleppo is dry and piercing, but not insalubrious. The city, however, as well as the environs, is subject to a singular epidemic disorder called the boil of Aleppo. It attacks the inhabitants chiefly in their childhood, and the ulcers, which last for a year, commonly break out on the face. This malady is seldom fatal, and does not leave any hurtful effects except the scars, by which almost all the inhabitants are disfigured. The causes of the disease have not been discovered, though some have supposed it due to the quality of the water. Aleppo is also subject to the ravages of the plague, the recurrence of which is anticipated by the inhabitants every ten years. Its effects are rendered the more deadly by the blind fatalism of the Turks, who cannot be persuaded to take any precautions against the progress of this dreadful disease. In the end of last century about 60,000 of the inhabitants were swept off by one visitation; and that of 1827 was also very severe.

By the visitations of the plague, the earthquakes, the cholera of 1832, and the oppression of the Egyptians while Syria was subject to Mehemet Ali, the population of Aleppo has been much reduced. In the earlier part of the century the inhabitants numbered over 200,000; but the population is now estimated at less than 100,000, of whom 15,500 are Christians, 4000 Jews, and the remainder mostly Mahometans. Although the Christians enjoy toleration at the hands of the Turkish government, they have nevertheless been exposed to frequent persecution through the jealousy of the turbulent Mahometan population. The tumults of 1850 and 1862 occasioned some bloodshed, and could only be suppressed by force of arms. In the former, property to the amount of a million sterling was destroyed.

ALES, or ALESS (ALESIUS), ALEXANDER, a celebrated divine of the school of Augsburg, was born at Edinburgh on the 23d April 1500 (died 1565). His name was originally Alane, and that by which he is more generally known (derived from ἀλεείνω) was assumed by him when he went into exile. He studied at St Andrews in the newly-founded college of St Leonards, where he graduated in 1515. Some time afterwards he was appointed a canon of the collegiate church, and in this office he at first contended vigorously for the scholastic theology as against the doctrines of the Reformers. His views were entirely changed, however, on the occasion of the execution of Patrick Hamilton in 1528. He had been chosen to meet Hamilton in controversy, with a view to convincing him of his errors, but the arguments of the Scottish proto-martyr, and above all the spectacle of his intrepid conduct at the stake, impressed Alesius so powerfully that he was entirely won over to the cause of the Reformers, though for a time he did not make the fact known. A sermon which he preached against the dissoluteness of the clergy gave great offence to Prior Hepburn, who cast him into prison, and might have carried his resentment to the extremest limit had not Alesius contrived to escape to the Continent in 1531. After travelling in various countries of northern Europe, he settled down at Wittenberg, where he made the acquaintance of Melancthon, and signed the Augsburg confession. Meanwhile he was tried in Scotland for heresy, and condemned without a hearing. In 1533 a

decree of the Scottish clergy, prohibiting the reading of the New Testament by the laity, drew from Alesius an ably-argued defence of the right of the people, in the form of a letter to James V. A reply to this by John Cochlæus, also addressed to the Scottish king, occasioned a second letter from Alesius, in which he not only restates and amplifies his argument with great force and beauty of style, but enters at some length into more general questions connected with the Reformation. In 1535, Henry VIII. having broken with the Church of Rome, Alesius was induced to remove to England, where he was very cordially received by the king and his advisers Cranmer and Cromwell. After a short residence at Lambeth he was appointed, through the influence of Cromwell, then chancellor of the university, to lecture on theology at Cambridge; but when he had delivered a few expositions of the Hebrew psalms, he was compelled by the opposition of the papal party to desist. Returning to London, he supported himself for some time by practising as a physician. In 1537 he attended a convocation of the clergy, and at the request of Cromwell, the president, conducted a controversy with Stokesley, bishop of London, on the nature of the sacraments. His argument, which was marked by great ability, was afterwards published at Leipsic. In 1539 Alesius was compelled to flee for the second time to Germany, in consequence of the enactment of the persecuting statute known as the Six Articles. He was immediately chosen to fill a theological chair in the university of Frankfort-on-the-Oder, where he was the first professor who taught the Reformed doctrines. In 1543 he quitted Frankfort for a similar position at Leipsic, his contention that it was the duty of the civil magistrate to punish fornication having given offence to some of the authorities of the former university. At Leipsic Alesius remained until his death, which occurred on the 17th March 1565. He enjoyed the intimate friendship of Melancthon, to whom he rendered valuable assistance in many of his disputations with the Catholic doctors.

Alesius was the author of a large number of exegetical, dogmatic, and polemical works. He displayed his warm interest in his native land by the publication (1544) of a *Cohortatio ad Concordiam Pietatis, missa in Patriam suam*, which had the express approval of Luther. In 1560 appeared his treatise, *De Necessitate et Merito Bonorum Operum*, a valuable contribution to the synergistic side in the controversy on good works.

ALESSANDRI, Alessandro (*Alexander ab Alexandro*), a learned jurisconsult, born at Naples about the year 1461 (died 1523). He studied at Naples and Rome, and afterwards practised for a time as advocate in both cities. At Naples he is said to have been royal proto-notary in 1490. Dissatisfied, according to his own account, with the corrupt administration of justice, he at length quitted the bar, and devoted himself entirely to literary pursuits, especially to the study of philology and antiquities. A sinecure appointment, which he owed to the favour of the pope, enabled him to lead a life of learned leisure at Rome, where he died on the 2d October 1523. What is known of his biography has been gathered chiefly from detached statements in his work entitled *Dies Geniales*, which appeared at Rome in 1522, and is constructed after the model of the *Noctes Atticæ* of Aulus Gellius, and the *Saturnalia* of Macrobius. The work consists of a confused mass of heterogeneous materials relating to philology, antiquities, law, dreams, spectres, &c., and shows great credulity and want of judgment on the part of its author.

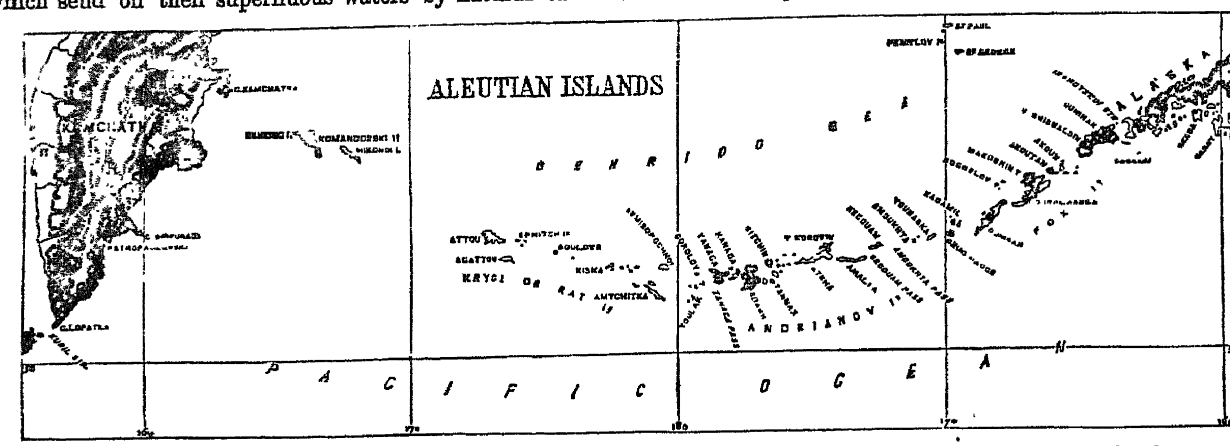
ALESSANDRIA, a province of Italy, in the former duchy of Piedmont, bounded on the N. by Novara, on the E. by Pavia, on the S. by Genoa, and on the W. by Turin; with an area of 1951 square miles. There are no hills of much elevation in the province, and the surface generally is flat. The chief rivers are the Po, the Tanaro, the Belbo, the Orba, and the Bormida. The soil is fertile, the chief products being wheat, maize, wine, silk, madder, hemp, flax, and fruit. The capital is Alessandria; population of the province in 1871, 683,361.

Alessandria, a city of Italy, the capital of the above province, is situated in a marshy district near the confluence of the Tanaro and the Bormida. It is a strongly fortified place, its citadel, on the left bank of the Tanaro, being one of the most important in Europe. The town itself, which lies chiefly on the right bank of the river, is the seat of a bishop, and contains a cathedral and more than a dozen other churches, besides monasteries and nunneries. The principal manufactures of Alessandria are silk, linen, and woollen goods, stockings, and hats. Large quantities of fruit and flowers are also produced in the neighbourhood. The trade of the city is extensive, and there are two important fairs held every year that are much resorted to by merchants from all parts of Italy. Alessandria was built in 1168 by the Lombard League as a bulwark against Frederick Barbarossa. It received its present name in honour of Pope Alexander III., but it was also called *Cesarea* for a time. In 1174 it was unsuccessfully besieged by Frederick Barbarossa, who nicknamed it in derision *Della Paglia, i.e.* "of straw." It was ceded to Savoy by the peace of Utrecht in 1713, after having belonged, at different periods, to the houses of Montferrat and Milan. Its fortifications were greatly enlarged and strengthened by Bonaparte during the French occupation, which lasted from 1800 to 1814. The citadel of Alessandria was taken by the Austrians after the battle of Novara in 1849. Near Alessandria is Marengo, where Napoleon defeated the Austrians in 1800. In consequence of this defeat the Austrians concluded the armistice of Alessandria, ceding all Italy north of the Mincio to the French. Population (1862), 27,027; of commune, 56,545.

ALESSI, Galeazzo (1500–72), a distinguished architect, born at Perugia, was a pupil of Caporali and a friend of Michael Angelo. He was an enthusiastic student of ancient architecture, and his style gained for him a European reputation. Genoa is indebted to him for a number of its most magnificent palaces, and specimens of his skill may be seen in the churches of San-Paolo and San-Vittoria at Milan, in certain parts of the Escurial, and in numerous churches and palaces throughout Sicily, Flanders, and Germany.

ALEUTIAN ISLANDS, so called from the Russian word *aleut*, signifying a bold rock, is the name given by the Russian discoverers to a chain of small islands situated in the Northern Pacific Ocean, and extending in an easterly direction from the peninsula of Kamtchatka, in Asiatic Russia, to the promontory of Alaska, in North America. This archipelago has been sometimes divided into three groups; the islands nearest Kamtchatka being properly called Aleutia, the central group the Andreanov or Andrenovian, and those nearest to the promontory the Fox Islands. They are all included between 52° and 55° N. lat., and 172° E. and 163° W. long. The Aleutian Islands were discovered by the Russian navigator Behring in 1728, and were carefully explored in 1760 by Captain Krenitzin, under a commission from the Empress Catherine. During his third and last voyage, in the year 1778, Captain Cook surveyed the eastern portion of the archipelago, accurately determined the positions of some of the most remarkable islands, and corrected many errors of former navigators. Subsequent expeditions of the Russians, aided by the settlement of fur traders on the islands, as well as on the neighbouring coasts of the American continent, have afforded further information as to this remarkable chain. The whole of the islands are

bare and mountainous; and their coasts are rocky and surrounded by breakers, by which the approach is rendered exceedingly dangerous. The land rises immediately from the coasts to steep bald mountains, gradually ascending into lofty ranges running from east to west. Springs take their rise at the bottom of the mountains, and either flow in broad and rapid streams into the neighbouring sea, or, collecting in the rocky vales and glens, form ample lakes, which send off their superfluous waters by natural canals into the adjacent bays. These islands bear evident marks of volcanic formation, and several of them have still active volcanoes, which continually emit smoke and sometimes flames. The most important group of the chain is that called the Fox Islands, of which the largest are Unimak and Ounalaska, both near the western extremity of Alaska. The thin argillaceous soil of the Aleutian Islands produces little vegetation, and agriculture is almost unknown. The climate is subject to sudden changes, and is very unfavour-



able to any attempts at cultivation. Few trees grow on the islands, but there are some stunted shrubs of birch, willow, and alder. The timber required for building purposes is obtained from the driftwood thrown on the coasts. The principal occupations of the Aleutians are fishing and hunting, and the preparation of the implements necessary for both. Since the end of last century the fur traders have had settlements here for the capture of the seal and the sea-otter, which are found in great numbers on the shores; and of the Arctic fox, which roams over the islands. Fish are abundant; and dogs and reindeer are common. The population of the whole group is about 8000, the natives being a kindred race to the inhabitants of Kamtchatka. They are described as rather low in stature, but plump and well-shaped, with short necks, swarthy faces, black eyes, and long straight black hair. They have nominally been converted to Christianity by the missionaries of the Greek Church, but are said to be unchaste in their habits, and addicted to intemperance whenever they have the opportunity. Until 1867 these islands belonged to Russia, but they were included in the transfer to the United States of the whole Russian possessions in America made in that year. They now form part of the United States territory of Alaska. (See Alaska.) From the position of the Aleutian Islands, stretching like a broken bridge from Asia to America, some ethnologists have supposed that by means of them America was first peopled.

ALEXANDER THE GREAT

ALEXANDER III., commonly called "The Great," son of Philip II., king of Macedonia, and of Olympias, daughter of the Molossian chief Neoptolemus, was born at Pella, 356 B.C. His father was a man of fearless courage and the soundest judgment; his mother was a woman of savage energy and fierce superstition. Alexander inherited the qualities of both his parents, and the result was the combination of a boundless ambition with the most sober practical wisdom. The child grew up with the consciousness that he was the heir of a king whose power was rapidly growing; and the stories told of him attest at the least the early awakening of a mind formed in the mould of the heroes of mythical Hellas. Nay, the blood of Achilles was flowing, as he believed, in his veins; and the flattery of his Acarnanian tutor Lysimachus, who addressed him as the son of Peleus, may have strengthened his love of the immortal poems which told the story of that fiery warrior. By another tutor, the Molossian Leonidas, his vehement impulses were checked by a wholesome discipline. But the genius of Alexander, the greatest of military conquerors, was moulded in a far greater degree by that of Aristotle, the greatest conqueror in the world of thought. At the age of thirteen he became for three years the pupil of a man who had examined the political constitutions of a crowd of states, and who had brought together a vast mass of facts and observations for the systematic cultivation of physical science. During these three years the boy awoke to the knowledge that a wonderful world lay before him, of which he had seen little, and threw himself eagerly, it is said, into the task of gathering at any cost a collection for the study of natural history. While his mind was thus urged in one direction, he listened to stories which told him of the great quarrel still to be fought out between the East and the West, and learnt to look upon himself as the champion of Hellas against the barbarian despot of Susa.

The future conqueror was sixteen years of age when he 340 B.C.
was left at home as regent while his father besieged Byzantium and Perinthus. Two years later the alliance of Thebes and Athens was wrecked on the fatal field of Chæronea, where Alexander, now eighteen years of age, en- 338 B.C.
countered and overcame the Sacred Band which had been foremost in the victories of Leuctra and Mantinea (see Epaminondas); but the prospects of Alexander himself became now for a time dark and uncertain. Philip had divorced Olympias and married Cleopatra, the daughter of Attalus. This act roused the wrath not only of Olympias, but of her son, who with her took refuge in Epirus. Cleopatra became the mother of a son. Her father, Attalus, rose higher in the king's favour, and not a few of Alexander's friends were banished. But the feuds in his family were subjects of serious thought for Philip, who sought to

counteract their ill effects by a marriage between his daughter and her uncle, the Epirot king Alexander, the brother of Olympias. The marriage feast was celebrated at Ægæ. Clothed in a white robe, and walking purposely apart from his guards, Philip was approaching the theatre when he was struck down by the dagger of Pausanias.

It is certain that Alexander, if he mourned his father's death at all, deplored it only as involving himself in political difficulties; but he took care to act as if he were grieved by it, and he revenged it, we are told, by putting out of the way some whose claims or designs might clash with his own. The Greeks of Thebes and Athens knew little what sort of man had taken the place of Philip. Demosthenes, who, although he was mourning for the death of his own daughter, appeared in festal attire to announce the death of the Macedonian king, held up Alexander to ridicule as a bragging and senseless Margites. But they had to reckon with one who could swoop on his prey with the swiftness of the eagle. Barely two months had passed from the death of his father before the youth of twenty years stood with his army on the plains of Thessaly. The argument of the Macedonian phalanx was not to be resisted. The Thessalians recognised him as the *Hegemôn* or leader of the Greeks; and the young king passed on to Thebes, the citadel of which had been held by a Macedonian garrison since the fight at Chæronea. Thence he took himself across the isthmus to Corinth. Here he was met by Athenian envoys, who brought him apologies more abject and honours more extravagant than any which had been paid to his father. He received them in an assembly, from which he demanded and obtained the title of supreme leader of the Hellenic armies, and to which he guaranteed, at the utmost with a feigned reluctance, the autonomy or independence of every Hellenic city. No one knew better than Alexander that from the whole armoury of weapons which might be employed to reduce Greeks to slavery, none could more effectually do his work than a theory of freedom which meant dissension, and of self-government which meant endless feud, faction, and war.

Alexander was now eager to carry out his great design against Persia; but he could not do so with safety until he had struck a wholesome terror of his power into the mountain tribes which hemmed in his dominions. His blows descended swiftly and surely on the Thracians of Mount Hæmus (*the Balkan*), on the Triballians, and on some clans of Getæ, whom he crossed the Danube to attack. But these expeditions led him away from the world of the Greeks. Silence led to rumours of his defeat, and the rumours of defeat were followed by more confident assertions of his death. At Thebes and at Athens the tidings were received by some with eager belief. The covenant made with Alexander was made only with him personally. The Theban exiles at Athens were anxious to repeat the attempt which half a century earlier had been made against the Spartan garrison of the Cadmea by Pelopidas. With help in arms and money from Demosthenes and other Athenians, they entered Thebes, and summoned the Macedonian garrison to surrender. The answer was a blunt refusal, and a double line of circumvallation was drawn around the citadel, while envoys were sent to call forth aid from every quarter; but these efforts could not affect the issue. The belief in Alexander's death was to be dispelled, by no gradual reports of his escape from the barbarians, but by his own sudden appearance at the Bœotian Onchestus. He had just defeated the Illyrians when he heard of the revolt, and he determined to smite the rebels without turning aside to take even a day's rest at Pella. In little more than a fortnight his army was encamped on the southern side of Thebes, thus cutting off all chances of aid from Athens. It was his wish to avoid an assault, and he contented himself with demanding the surrender of two only of the anti-Macedonian leaders. The citizens generally were anxious to submit, but the exiles felt or feared themselves to be too deeply committed; and the answer took the form of a defiance, accompanied by a demand for the surrender of Antipater and Philotas. They had sealed their own doom. Personal bravery was of no use against the discipline, the numbers, and the engines of the enemy. The defenders were driven back into the city; the invaders burst in with them; and the slaughter which followed was by no means inflicted by the Macedonians alone. The Platæans, Thespians, and Orchomenians felt that they had old scores to settle. To these and to the rest of his Greek allies Alexander submitted the fate of the city. The sentence was promptly pronounced. The measure which the Thebans had dealt to Platææ, and would have dealt to Athens, should now be dealt out to themselves. The whole town was razed to the ground, the house of the poet Pindar being alone spared from demolition, and his descendants alone allowed to retain their freedom. Alexander had gained his end. The spirit of the Greeks was crushed; a great city was blotted out, and the worship of its gods was ended with its ruin. These gods, it was believed, would in due time take vengeance on the conqueror; but for the present the only hindrance to his enterprise was removed from his path. Without turning aside to Athens, he went on to Corinth to receive the adulations of the independent Greeks, and to find, it is said, a less courtly speaker in the cynic Diogenes. From Corinth he returned to Macedonia, having left Greece for the last time.

Six months later he set off from Pella, crossed the Helles- 334 B.C.
pont at Sestus, to appease at Ilium by a costly sacrifice the wrath of the luckless Priam; and then marched on, with not more perhaps than 30,000 infantry and 4000 cavalry, and with a treasure-chest almost empty, to destroy the monarchy of Cyrus. With him went men who were to be linked with the memory of his worst crimes and of his most astonishing triumphs—Clitus, Hephæstion, Eumenes, Seleucus, Ptolemy the son of Lagos, and Parmenion, with his sons Philotas and Nicanor. The effects of Macedonian discipline were to be seen at once on the banks of the Granicus, a little stream flowing to the Propontis from the slopes of Ida. Losing, it is said, only 60 of his cavalry and 30 of his infantry, he annihilated the Persian force, 2000 out of 20,000 foot soldiers being taken prisoners, and nearly all the rest slain. The terror of his name did his work as he marched southwards. The citadel of Sardis might with ease have been held against him: before he came within eight miles of the city, the governor hastened to surrender it with all its treasure. At Ephesus he found the city abandoned by its garrison. Miletus he carried by storm. Before Halicarnassus he encountered a more obstinate resistance from the Athenian Ephialtes; but the generalship of the latter was of no avail. Alexander entered Halicarnassus, and the Rhodian Memnon remained shut up in the citadel. Leaving Ptolemy with 1000 men to blockade it, he spent
the winter in conquering Lycia, Pamphylia, and Pisidia, 333 B.C.
ending his campaign at Gordium, on the river Sangarius. Here was preserved the ancient waggon of Gordius, the mythical Phrygian king. Whoever could untie the knot, curiously twisted with fibres of the cornel tree, which fastened its pole to the yoke, was, so the story ran, to be lord of Asia. Alexander, as much at a loss as others to unloose it, cut it with his sword; but the prophecy was none the less held to be fulfilled. If he was thus favoured by sentiment, he was still more favoured by the infatuation which led Darius to abandon the policy of defence by sea

for offensive warfare by land. From all parts of his vast empire was gathered a host, numbering, as some said, 600,000 men; and the despot was as much elated at the sight as Xerxes, when he looked down on his motley multitudes at Doriscus. Like Xerxes he had one (the Athenian Charidemus) by his side to warn him that Asiatic myriads were not to be trusted in an encounter with the disciplined thousands of Alexander; but he lacked the generosity which made Xerxes dismiss Demaratus with a smile for his good-will. Darius seized the exile with his own hand, and gave him over to the executioner. "My avenger," said Charidemus, "will soon teach you that I have spoken the truth." The Persian acted as though he wished to bring about the speediest fulfilment of the prediction. The Greek mercenaries were withdrawn from the fleet to be added to the land forces; but although a hundred of these could have effectually barred the passage of Alexander across the range of Taurus, and the passes of the Amanian, Cilician, and Assyrian gates, the invader was suffered to cross these defiles without the loss of a man. Nay, so great was the contempt of Darius for the few thousands of the enemy, that he wished to give them a free path until they reached the plain from which he would sweep them away. But he could not wait patiently for them in his position to the east of the Amanian range. Alexander had been ill, and he had work to do in subjugating western Cilicia. When at length he set out on his march to the southern Amanian pass, Darius, with his unwieldy train, crossed the northern pass, and entered Issus two days after Alexander had left it. He had placed himself in a trap. In a space barely more than a mile and a half in width, hemmed in by the mountains on the one side and the sea on the other, Darius, in his royal chariot, in the midst of multitudes who had scarcely room to move, awaited the attack of Alexander, who fell suddenly on his right wing. The first onset was enough. The Persians broke and fled. Darius, thinking himself in danger, fled among the foremost. The Persian centre behaved well; but it mattered little now what they might do. Even the Greek mercenaries were pushed back and scattered. Four thousand talents filled the treasure-chest of the conqueror, and the wife, mother, and son of Darius, appearing before him as prisoners, were told that they should retain their royal titles, his enterprise being directed, not against Darius personally, but to the issue which was to determine whether he or Alexander should be lord of Asia.

The true value of armed Asiatic hordes was now as clear to all as the sun at noonday. Parmenion advanced to attack Damascus, but he needed not to strike a blow. The governor allowed the treasure in his charge to fall into his hands, and then surrendered the city. Alexander himself marched southward to Phœnicia. At Marathus he replied to a letter in which Darius demanded the restoration of his family and reproached him for his wanton aggression. His answer repeated what he had already said to his wife, adding that, if he wrote again, Darius must address him, not as his equal, but as his lord. "I am now master of Asia," he wrote, "and if you will not own me as such, I shall treat you as an evil-doer. If you wish to debate the point, do so like a man on the battlefield. I shall take care to find you wherever you may be." The island city of Aradus was surrendered on his approach. Sidon opened her gates. From the Tyrians he received a submission which demurred only to his
332 B.C. entering their city. A siege of seven months ended in its fall; and Alexander hanged 2000 of the citizens, it is said, on the sea-shore. The survivors, with the women and children, were sold as slaves. Before the catastrophe of the great Phœnician city he had received a second letter, in which Darius offered him his daughter in marriage, together with the cession of all lands to the west of the Euphrates. "Were I Alexander," said Parmenion (if we may believe the story), "I should take these terms, and run no further risk." "So should I," answered Alexander, "if I were Parmenion; but as I am Alexander, I cannot." "You offer me," he wrote accordingly to Darius, "part of your possession, when I am lord of all. If I choose to marry your daughter, I will do so whether you like it or not." Darius sent no more letters. The issue, he saw, must be determined by the sword. For the present he was left to himself. Alexander's face was turned towards Egypt. Gaza dared to resist; but a siege of two months was followed by a ruin as complete as that of Tyre. From Gaza a march of seven days brought him to Pelusium. The Persian governor opened its gates to receive him; and the Egyptians expressed their delight at exchanging a Persian for a Macedonian master. Marching in triumph to Memphis, he offered solemn sacrifice to the calf-god Apis; and then, with the true instinct of the ruler and the statesman, he hastened to found for his new kingdom a new capital, which, after more than two millenniums, remains a highway for the commerce of three continents.

Success thus unparalleled was, it would seem, already producing its effects upon him. Calmly reviewing the course of his march from Sestus and Ilium to Memphis, he could explain it only on the supposition that he was no child of a human father, and he determined to obtain from the oracle of Ammon, in the Libyan Oasis, a solution of this mystery. The response greeted him as the son, not of Philip, but of Zeus; and he returned, it is said, with the conviction that the divine honours paid to Hercules 331 B.C.
and Perseus were his own by indubitable right. Marching back through Phœnicia, he hastened to Thapsacus, and then crossed the Euphrates. Thence turning northwards, he made a sweep which brought him to the Tigris below Nineveh (*Mosul*), and there, without opposition, crossed a stream where the resistance of a few hundreds might have destroyed his army. After a few days' march to the south-east, he received the news that Darius, with all his host, was close at hand. Still convinced that mere numbers must, with ample space, decide the issue of any fight, and attributing his defeat at Issos only to the cramped position of his troops, he had gathered a vast horde, which some represent as more than a million, on the broad plain stretching from Gaugamela eastwards to Arbela. His hopes were further raised by changes made in the weapons of his troops, and more especially in the array of his war-chariots. For the Macedonians it is enough to say that they were led by a man whose consummate generalship had never shone more conspicuously than in the cautious arrangements which preceded the battle of Arbela, or rather of Gaugamela. All went as he had anticipated. As at Issus, Darius fled; and the bravery and even gallantry of the Persians opposed to Parmenion were of no avail when the main body had hurried away after the king. So ended the last of the three great battles (if such they may be termed) which sufficed to destroy the Persian empire, or rather to make Alexander king of Persia; and so ended the first act in the great drama of his life.

The victory of Gaugamela opened for the conqueror the gates of Babylon and Susa. The treasures found in the former furnished an ample donation for all his men: those of Susa amounted, it is said, to nearly twelve millions of pounds sterling. The Persian king had wasted men on the battlefield; he had hoarded coin which, freely spent in getting up a Greek army under Greek generals, might have rendered the enterprise of Alexander impossible. From Susa the conqueror turned his face towards Persepolis, the ancient capital of Cyrus. Before him lay the fortresses of the Uxii, to whom the Persian monarchs had

been accustomed to pay tribute when they went from the one capital of their kingdom to the other. The same demand was now made of Alexander, who told them to come to the pass and take it, and then, following a new track which had been pointed out to him, descended on their villages, and taught them that they had now to deal with a sovereign of another kind. With Persepolis, Pasargadæ, the city containing the tomb of Cyrus, opened its gates to receive the avenger of the iniquities of Xerxes. As such, he determined to inflict on Darius a signal punishment. Five thousand camels and a crowd of mules bore away the treasure, amounting, it is said, to nearly thirty millions of pounds sterling, and then the citadel was set on fire. The men in the city were killed, the women made slaves.

330 B.C. For a month Alexander allowed his main army to rest near Persepolis; for himself there could be no repose. With his cavalry he overran, and, in spite of the rigours of winter, subdued, the whole region of Farsistan. Then returning to Persepolis, he set forth on his march to Media, where the fugitive king had hoped to be safe from his pursuit. Darius had left Agbatana (Ecbatana) eight days before his pursuer could reach it. In this ancient fastness of the Median and Persian sovereigns Alexander deposited his treasures, exceeding, we are told, forty millions sterling in amount, under the charge of a strong Macedonian garrison headed by Parmenion. He then hastened on towards the Caspian gates, and learnt, when he had passed them, that Darius had been dethroned, and was now the prisoner of the Bactrian satrap Bessus. The tidings made Alexander still more eager to seize him. His efforts were so far successful that Bessus felt escape to be hopeless unless Darius could be made to leave his chariot and fly on horseback. He refused to obey, and was left behind, mortally wounded. Before Alexander could reach him, he was dead.

The conqueror now regarded, or professed to regard, himself as the legitimate heir and successor of Xerxes. His course of conquest was still unbroken; but successful forays against the Mardians on the northern slopes of Mount Elburz, against the Arians of the modern Herat, and the Drangians of the present Seistan, were followed by an exploit of another sort. He had heard that a conspiracy against himself had been revealed to Philotas, who for two days had kept the secret to himself. On being asked why he had done this, Philotas answered that the information came from a worthless source and deserved no notice. Alexander professed himself satisfied with the explanation; but Philotas, it seems, had spoken freely to his mistress Antigone of the large share which he and his father had had in the conquests of Alexander, and Antigone had in her turn become an informer. Of real evidence against Philotas there was none; and a letter from Parmenion to his sons, found when Philotas was treacherously arrested, could tell against them only in the eyes of one who was resolved that Philotas should die. But Alexander could not rest content with his death alone. There had been nothing yet, even in the way of shadowy slander, to criminate Parmenion, and he resolved that the needful charges should be drawn by tortures from his son. Hidden by a curtain, the conqueror of the world watched the agonies and scoffed at the screams of the friend who had fought by his side in a hundred fights. The issue was, or was said to be, what he desired. Philotas had confessed; and Alexander sent off to Ecbatana a man bearing two despatches, one to cheat Parmenion into a false security, the other carrying to the officers next to him in command the real order for his assassination. The old man was reading the lying letter of the despot when he received a mortal stab in his back. The soldiers, on hearing of what had been done furiously demanded the surrender of the murderers, and were with difficulty withheld from taking summary vengeance on seeing the written orders of Alexander. The command of Philotas, who had been at the head of the companion-cavalry, was shared between Clitus and Hephæstion; and Alexander turned from private murder to public war. The autumn and winter 329 B.C. were spent in overrunning parts of the modern Afghanistan and Cabul, in the formation of the Caucasian Alexandria, and in the passage of the Hindu-Kush. He was now in the satrapy of Bessus. The surrender of Aornus and Bactra was followed by the passage of the Oxus and by the betrayal of Bessus, who was sent naked and in chains to the city which had been his capital. His next exploit (there is but slender ground for calling it into question) was the slaughter, in Sogdiana, of the descendants of the Milesian Branchidæ, who, having incurred the hatred of their fellow Greeks by surrendering to Xerxes the treasures of their temple, had followed the despot on his retreat, and by him had been placed in these distant regions. Five generations had passed away since that time, when Alexander gave the order that not one of them, man, woman, or child, should be left alive. From the ruined city, by way of Maracanda (*Samarkand*), he reached the Jaxartes (which he believed to be the Tanais or *Don*), and having laid on its banks the foundation of another Alexandria, he crossed the river to chase some Scythians who had shown themselves on the further side. The end of this chase marked the northernmost point reached in his campaigns. The winter was spent in the Bactrian city of Zariaspa, 329-328 B.C. where Alexander, summoning Bessus before him, had his nose and ears cut off, and then sent him to be killed by his countrymen at Ecbatana.

In the following summer his army was gathered again at Maracanda. Repose from field-work left room for the display of the overbearing pride to be expected from one who had convinced himself that he was a god, and for the boundless flattery of those who found their interest in keeping up the delusion. But there were not wanting others to whom this arrogance and servility were intensely disgusting, and whose anger was the more fierce from the necessity of avoiding all open expression of it; and in the banquets of the divine son of Ammon there was always a risk that these pent-up feelings might burst forth like a winter torrent. The catastrophe was not long in coming. In a feast at Maracanda, Alexander, boasting of all that he had done since the death of his father, took credit further for the victories of Philip in the later years of his reign. The patience of Clitus had long been severely taxed, and in the heat of the revel all thought of prudence was cast aside. He spoke his mind plainly, telling Alexander that all his exploits taken together were not equal to those of the man who had found Macedonia a poor and distracted country, and had left it a mighty and coherent state; and that his own greatest victories had been won through the aid of Philip's old soldiers, some of whom he had murdered. Stung to the quick, Alexander gave utterance to his rage; but his retort only led Clitus to remind him of the battle-field of the Granicus, where he had saved him from death by cutting off the arm of the Persian whose sword was raised to smite him, and to warn him that, if he could not bear to listen to the words of truth, he should confine himself to the society of slaves. Alexander felt for his dagger: it had purposely been placed out of his reach. He called to his guards to sound an alarm: they hesitated to obey the orders of a raving drunkard. Some of the more sober and moderate of the party held him in their arms, praying him to do nothing hastily. By way of answer he reviled them for keeping him a prisoner as Bessus had kept Darius, and shaking himself free, snatched a pike from one of the guards, and thrust it through the body of

Clitus, bidding him go to Philip and Parmenion. The rage of the tiger was followed by a furious remorse, in which, with considerable truth, he denounced himself as unfit to live. For three days he would neither eat nor drink; and the army, alarmed at the threatened starvation of their king, voted that Clitus had been justly slain, and that his body should not receive the rites of burial. By reversing this vote, Alexander seemed to feel that he had gone a long way towards acquitting himself; whatever might be yet lacking to restore his self-complacence was supplied by the prophets, who assured him that the disaster had been brought about wholly by the Theban wine-god Dionysus, to whom he had offered no sacrifice on the day of the banquet.

[illegible] B.C. A few weeks after this murder Alexander captured the Sogdian rock, a fastness from which common care would have sent him away baffled. Having next reduced the rock of Chorienes, he returned to Bactra to celebrate his marriage with Roxana, the daughter of Oxyartes, who had been
327 B.C among the captives taken on the Sogdian rock. The feast was seized by Alexander as an opportunity for extracting from his Greek and Macedonian followers a public acknowledgment of his divinity. It was arranged that the sophist Anaxarchus (or, as some said, the Sicilian Cleon) should make a speech, advising all to worship at once the man whom they would certainly have to worship after his death. The speech was delivered. The silence of most of the Macedonian officers showed their disgust; but none ventured to speak until the Olynthian Callisthenes, the nephew of Aristotle, insisted on the impiety of all attempts to confound the distinctions between gods and men. Conceding to the conqueror the highest place amongst military leaders and the first rank amongst statesmen, he rebuked Anaxarchus for making a suggestion which ought to have come from any one rather than from himself. The applause which his words drew from the Macedonians taught Alexander that open opposition would be useless; but he was none the more turned from his purpose, nor was it long before he found a pretext for carrying it out. A conspiracy was discovered amongst his pages. These unfortunate men were tortured (but without extracting from them anything to implicate Callisthenes), and then stoned to death,—as Alexander would have it, not by his orders, but by the loyal impulse of his army. Callisthenes he was resolved, he said, to punish himself, together with those who had sent him,—an insinuation, manifestly, against his uncle Aristotle, possibly also against all other Greeks, for whom freedom of speech and action had not yet altogether lost its value. The philosopher who had extolled Alexander as the greatest of earthly generals and statesmen was first tortured and then hanged; and the conqueror went calmly on to subdue the regions between the Hindu-Kush and the right bank of the Indus, and to storm the impregnable rock of Aornus.

326 B.C. The next river to be crossed was the Indus. The bridge was constructed by Hephæstion and Perdiccas, probably near the present Attock. The surrender of Taxila left Alexander an open path until he reached the Hydaspes (*Jhelum*), where Porus was beaten only after a severe struggle. The Indian prince was taken prisoner, and treated with the courtesy which the family of Darius had received after the battle of Issus. Here died Alexander's horse Boukephalos (Bucephalus), and the loss was commemorated by the founding of Bucephalia. The passage of the Acesines (*Chenab*), running with a full and impetuous stream, was not accomplished without much danger; that of the Hydraotes (*Ravee*) presented less formidable difficulties, but he was encountered on the other side by Indians, who entrenched themselves in their town of Sangala. Their resistance ended, it is said, in the slaughter of 17,000 and the capture of 70,000. About 40 miles further to the south-east flowed the Hyphasis (*Sutlej*). Alexander approached its bank, the limit of the Panjab, in the full confidence that a few days more would bring him to the mighty stream of the Ganges; but he had reached the goal of his conquests. The order for crossing the river called forth murmurs and protests at once from his officers and his soldiers, who expressed plainly their refusal to march they knew not whither. Alexander in vain laid before his officers his schemes of further conquest; and when he offered the sacrifice customary before crossing a river, the signs were pronounced to be unfavourable. The die was cast. Twelve huge altars remained to show that Alexander had advanced thus far on his conquest of the world; and, in the midst of deluges of rain, the army set out on its westward journey. The reinforcements which Nov. 326-Aug. 325 B.C. he found on reaching the Hydaspes might, if they had advanced as far as the Hyphasis, have turned the scale in favour of progress to the east; they enabled Alexander to undertake with greater ease a voyage down the Hydaspes to its junction with the Indus after receiving the waters of the Acesines, Hydraotes, and Hyphasis, and thence onwards to the Indian Ocean. From the mouth of the Indus he ordered his admiral Nearchus to take the fleet along the shores of the ocean and the Persian Gulf to the mouth of the Tigris. The army marched by land through the Gedrosian desert, suffering more from thirst and sickness than they had suffered in all their battles and forced marches. At length he reached Pasargadæ, to find the tomb of Cyrus broken open and plundered, and to avenge the insult offered to the man whom he now regarded as the founder of his own dynasty. Early in the following year he entered Susa, and there, celebrating his marriage with Statira, the daughter of Darius and of Parysatis the daughter of his predecessor Ochus, he offered to pay the debts of those soldiers who would follow his example by taking to themselves Persian wives—a strange mode of inviting sober and steady men who had no debts, but an effectual argument for the spendthrifts and ruffians of his army. His new levies of Persian youths, armed and disciplined after the Macedonian fashion, had now made him independent of his veteran soldiers; and his declared intention of sending home the aged and wounded among them called forth the angry remonstrances of their comrades, who bade him complete his schemes of conquest with the aid of his father Ammon. Alexander rushed into the throng, seized some and had them executed, and then disbanded the whole force. For two days he shut himself up in his palace; on the third he marshalled his Persian levies (*Epigoni*, as he called them) into divisions bearing the Macedonian military titles, under Persian officers. The spirit of the veterans was broken by this ignoring of their existence. They threw down their arms at the palace gates, and begged forgiveness with cries and tears. Alexander accepted their contrition, and the restoration of harmony was celebrated by a sumptuous sacrifice.

But for Alexander past victories were only a stimulus to further exploits. Arabia still remained unsubdued, and for this conquest a large addition was needed to his fleet. Orders were sent to Phœnicia for the construction of ships, 324 B.C. which were to be taken to pieces and sent overland to Thapsacus on the Euphrates, while others were to be built at Babylon. His journey to Ecbatana was marked by a violent quarrel between Eumenes and Hephæstion. Their reconciliation was soon followed by the death of the latter from an attack of fever. The grief of the conqueror was as fierce as that of Achilles, if we may not set it down as a manifest imitation of it. For two days he neither ate nor drank; he cut his hair short, and ordered that the horses and mules in his army should have their manes

decked also. Human blood could scarcely be shed with prudence on his pyre; but he was resolved that his friend should begin his life in the unseen world with unstinted wealth, and the precious things destined to be consumed on his funeral pile represented, it is said, a sum of nearly two millions and a half pounds sterling. Messengers were sent to the Egyptian oracle to ask if the dead man might be worshipped as a god, and Eumenes, with many others, took care to anticipate its answer by offering him such honours as might fall in with the humour of the divine mourner. His grief seemed only to render his bursts of passion more fearful. None dared to address him except in language of the most grovelling flattery; and, in the words of Plutarch, his only consolation was found in his old habit of man-hunting. The diversion was this time
323 B.C. furnished by some mountain tribes between Media and Farsistan. His march to Babylon steeped him still more in the intoxication of success. As he advanced on his road he was met by ambassadors not only from Illyrians and Thracians, from Sicily and Sardinia, from Libya and Carthage, but from Lucanians and Etruscans, and, as some said, from Rome itself. The lord of all the earth could scarcely look for wider acknowledgment or more devout submission; but his self-gratulation may have been damped by the warning of the Chaldean priests that it would be safer for him not to enter the gates of Babylon. For a while he hesitated, but he had more to do than to heed their words. The preparations for his Arabian campaign must be hurried on; all that might be needed must be done to improve the navigation of the Euphrates, and a new city must be built to rival, perhaps, the Alexandria which he had founded by the banks of the Nile. More than all, he had to celebrate the obsequies of Hephæstion, whose body had been brought to Babylon from Ecbatana. The feasting which everywhere accompanied the funeral rites of the ancient world was exaggerated by the Macedonians, as by other half rude or savage tribes, into prolonged revelry. Alexander spent the whole night drinking in the house of his friend Medius, and the whole of the next day in sleeping off his drunkenness. Throughout the following night the same orgies were repeated. When he next awoke he was unable to rise. Fever had laid its grasp upon him, and each day its hold became tighter, while he busied himself incessantly with giving orders about his army, his fleet, his generals, until at length the powers of speech began to fail. When asked to name his successor, he said that he left his kingdom to the strongest. His signet-ring he took from his finger and gave to Perdiccas. Throughout the army the tidings of his illness spread consternation; old grudges were all forgotten; his veterans forced themselves into his presence, and with tears bade farewell to their general, who showed by signs that he still knew them. A few hours later Alexander died, after a reign of less than thirteen years, and before he had reached the age of thirty-three.

That the schemes of conquest with which almost to the last moment he had been absorbingly busied would, if he had lived, have been in great part realised, can scarcely be doubted, unless we suppose that causes were at work which at no distant period would have disturbed and upset the balance of his military judgment, and deprived him of that marvellous power of combination and of shaping means to circumstances in which Hannibal and Napoleon are perhaps his only peers. It would be rash to say that such a darkening of his splendid powers might not have been brought about, even before he could reach middle age, by habits which, if we may judge from the history of his later years, were fast becoming confirmed. In truth, except as a general, he had lost the balance of his mind already. The ruling despot who fancied himself a god, who could thrust a pike through the body of one friend and sneer at the cries drawn forth from another by the agonies of torture, was already far removed from the far-sighted prudence of the politic statesman and ruler. His conquests served great ends; and before he set out on his career of victory he may have had a distinct vision of these ends. Desire for knowledge; the wish to see new forms of human and animal life; the curiosity of traversing unknown lands, of laying open their resources, of bringing them all within the limits and the influence of the Macedonian, or, as he preferred to put it, the Greek world; the eagerness to establish over all known, possibly over all unknown, regions a mighty centralised empire, which should avail itself of all their forces, and throw down the barriers which rendered the interchange of their wealth impossible,—may have mingled with his alleged or his real purpose of avenging on the Persian king the misdoings of Xerxes, Darius, and Cyrus. But there is little evidence or none that these motives retained their power undiminished as he advanced further on his path of victory, while there seems to be evidence, only too abundant, that all other motives were gradually and even fast losing strength as the lust of conquest grew with his belief or his fancy of his superhuman power and origin. During his sojourn with Aristotle he must have learnt that real knowledge can be reached and good government insured only where there is freedom of thought and speech, and where the people obey their own laws. A few years later he had come to look on Aristotle as an enemy to be punished with scarcely less severity than Callisthenes. But at the least it must be remembered that his work was left unfinished; possibly he may have regarded it as little more than begun. Looking at it from this point of view, we can neither shut our eyes to the solid benefits accruing from his conquests both for the East and the West, nor, in spite of his awful crimes, can we place him in the rank of those scourges of mankind among whom Alaric and Attila, Genghiz, Timour, and Napoleon stand pre-eminent. Of the several accounts of his career which have come down to us, not one, unhappily, is strictly contemporary; and mere fairness calls upon us to give him the benefit of a doubt, when doubt can be justly entertained, in reference even to deeds which carry with them an unutterable horror and shame. It is impossible to deny that with a higher sense of duty Alexander would better have deserved the title of Great; but the judgment which may be passed on some of his actions cannot affect his transcendent glory as the most consummate general of ancient times, and perhaps even of all ages.

For an examination of the sources of the history of Alexander the Great, see Freeman, *Historical Essays*, second series, essay v. The history itself is presented in various aspects by Thirlwall, *History of Greece*, chaps. xlvii.–lv.; Grote, *History of Greece*, part ii., chaps. xci.–xciv.; Niebuhr's *Lectures on Ancient History*, lectures xxiv.–lxxx.; Williams, *Life of Alexander the Great;* St Croix, *Examen Critique des Anciens Historiens d'Alexandre le Grand;* Droysen, *Geschichte Alexanders der Grossen.* See also Finlay, *Greece under the Romans*, chap. i.; Arnold, *History of Rome*, chap. xxx. For the geography of Alexander's Indian campaigns, see Cunningham's *Ancient Geography of India;* and for the scientific results of his conquests, Humboldt's *Kosmos*, vol. ii., part ii., section 2.

(G. W. C.)

ALEXANDER OF APHRODISIAS, the most celebrated of the Greek commentators on the writings of Aristotle, and styled, by way of pre-eminence, ὁ ἐξηγητής, *the Expositor*. He was a native of Aphrodisias in Caria, and taught the Peripatetic philosophy at Athens in the end of the 2d and the beginning of the 3d centuries of the Christian era. Commentaries by Alexander on the following works of Aristotle are still extant:—The *Analytica Priora*, I.; the *Topica;* the *Meteorologica;* the *De Sensu;* and the *Metaphysica*, I.–V., together with an abridgment of what he wrote on the remaining books of the *Metaphysica*. His commentaries were greatly esteemed among the Arabians, who translated many of them. There are also several original writings by Alexander still extant. The most important of these are a work *On Fate*, in which he argues against the Stoic doctrine of necessity; and one *On the Soul*, in which he contends that the undeveloped reason in man is material (νοῦς ὑλικός), and inseparable from the body. He identified the active intellect (νοῦς ποιητικός), through whose agency the potential intellect in man becomes actual, with God. Several of Alexander's works were published in the Aldine edition of Aristotle, Venice, 1495–98; his *De Fato* and *De Anima* were printed along with the works of Themistius at Venice, 1534; the former work, which has been translated into Latin by Grotius and also by Schulthess, was edited by Orelli, Zurich, 1824; and his commentaries on the *Metaphysica* by Bonitz, Berlin, 1847. Nourisson has treated of his doctrine of fate, Paris, 1870.

ALEXANDER OF HALES (ALEXANDER HALENSIS), surnamed *Doctor Irrefragabilis* and *Fons Vitæ*, a celebrated English theologian of the 13th century. Born in Gloucestershire, and trained in the monastery of Hales, from which he takes his name, he was early raised to an archdeaconry. Relinquishing this position, however, he went, like most of the scholars of his day, to study at the university of Paris, where he took the degree of doctor, and became celebrated as a teacher of philosophy and theology. Among his pupils was Bonaventura; but it is evident from a comparison of dates that he did not teach Duns Scotus and Thomas Aquinas, as has been frequently asserted. In 1222, when at the height of his fame, Alexander entered the order of Minorite Friars, and thenceforward lived in strict seclusion. He refused, however, to renounce his degree of doctor, and was the first of his order who continued to bear that title after initiation. He died in 1245, and was buried in the convent of the Cordeliers at Paris, where he had spent the last twenty-three years of his life. The most celebrated work of Alexander was his *Summa Theologiæ* (Nuremberg, 1452; Venice, 1576), undertaken by the orders of Pope Innocent IV., and approved by Alexander IV., after he had submitted it to the examination of seventy learned theologians as a system of instruction for all the schools in Christendom. Based on the *Sentences* of Peter Lombard, it is divided into four parts; the first treating of the nature and attributes of the Deity; the second of the creation and of the various orders of creatures; the third of the scheme of redemption, the incarnation of Christ, the law, and grace; and the fourth of the sacraments. The form is that of question and answer, and the method is rigidly scholastic.

ALEXANDER OF TRALLES (ALEXANDER TRALLIANUS), a medical writer, was a native of Tralles, a city of Lydia, and lived probably about the middle of the 6th century. He is the author of a work, divided into twelve books, in which he treats of bodily distempers. He was the first to open the jugular vein, and to use cantharides as a blister for the gout. Dr Freind, in his *History of Physic*, styles him one of the most valuable authors since the time of Hippocrates.

See also Dr Milward's *Trallianus Reviviscens; or, An Account of Alexander Trallian, one of the Greek Writers that flourished after Galen, being a Supplement to Dr Freind's History of Physic*, London, 1734, 8vo. The Greek text of his principal work was first published by Jac. Goupylus, Lutet. 1548, fol. It was reprinted, and was then accompanied with a Latin version by Jo. Guinterius, Basil, 1556, 8vo. He is likewise the author of an epistle on worms, *De Lumbricis*, which was published, in Greek and Latin, by Mercurialis, in his *Variæ Lectiones*, Venet. 1570, 4to.

ALEXANDER BALAS (a surname that probably means "lord"), a man of low birth who professed to be the son of Antiochus Epiphanes, and eventually became king of Syria. His claims were recognised by the Romans, who desired to revenge themselves on Demetrius Soter; and their example was followed by the king of Egypt and other monarchs. Demetrius was at first victorious, but in 150 B.C. was slain in battle, and Balas obtained possession of the kingdom. The new king soon made himself hateful to his subjects by his voluptuousness and debauchery, and this encouraged Demetrius Nicator, the eldest son of Demetrius Soter, to claim his father's crown. Alexander took the field against him, but was defeated in a pitched battle, and fled to Abæ in Arabia, where he was murdered by the emir, with whom he had sought refuge, 145 B.C.

ALEXANDER JANNÆUS, king of the Jews, succeeded his brother Aristobulus in 104 B.C., and died in 79 B.C. His reign, which he commenced by putting to death one of his brothers who claimed the throne, was disgraced by the cruelties that he perpetrated in order to keep himself in power.

ALEXANDER SEVERUS, Roman emperor. See SEVERUS.

ALEXANDER was the name of eight POPES:—

ALEXANDER I., bishop of Rome, succeeded Evaristus in 108 or 109 A.D., and, according to Eusebius, suffered martyrdom under Hadrian in the year 119. Catholic writers ascribe to him the introduction of holy water, and of the custom of mixing sacramental wine with water.

ALEXANDER II., whose family name was *Anselmo Baggio*, was born at Milan, and occupied the papal chair from 1061 to 1073. He had previously, as bishop of Lucca, been an energetic coadjutor with Hildebrand in endeavouring to suppress simony, and to enforce the celibacy of the clergy; and his efforts to augment the influence of the Roman see prepared the way for the complete ascendancy which was established by his celebrated successor. The imperial sanction being withheld from Alexander's election, a council at Basle chose as anti-pope Cadolaus, bishop of Parma, who assumed the name of Honorius II., and marched to Rome. He was deposed, however, by a council held at Mantua, and Alexander's position remained unchallenged. Alexander was succeeded by his associate Hildebrand, who took the title of Gregory VII.

ALEXANDER III. (*Rolando Ranuci* of Siena), cardinal and chancellor of the Roman church, was elected to the popedom in 1159, and reigned until 1181. His career is of great historical importance on account of the vigour and ultimate success with which he carried out the ideas and policy of Hildebrand in opposition to Frederick Barbarossa and Henry II. of England. Three anti-popes (Victor IV., 1159; Pascal III., 1164; Calixtus III., 1168) were confirmed by the German emperor in succession. Alexander, however, steadfastly maintained his rights, though compelled to take refuge in France between the years 1162 and 1165. The contest between pope and emperor was continued with varying fortune until, on the 29th May 1176, Frederick was decisively defeated at Legnano, when he at once withdrew his support from the anti-pope and submitted to Alexander. On the 1st August 1177 the emperor yielded the customary homage to the pope at Venice by kissing his foot, and was freed from the ban of

excommunication under which he had been placed ten years previously. There seems to be no historical authority for the common story that during the ceremony Alexander placed his foot upon the emperor's neck.

In England the papal supremacy was strenuously maintained against Henry II. by Thomas à Becket. Here, as in the case of Germany, the struggle was protracted and severe, but in the end the victory lay with the pope. À Becket was canonised soon after his assassination, and Henry II. was compelled to submit to a humiliating penance. A contest with William the Lion of Scotland, who insisted on instituting his chaplain Hugo, and not the papal nominee, into the see of St Andrews, ended in the excommunication of the king in 1181.

Alexander introduced several important changes in the organisation and administration of the church. Chief among these were the restriction of the right of canonisation to the pope alone, the still-existing law requiring the votes of two-thirds of the cardinals for a valid papal election, and the exemption of the clergy from civil control and of church lands from civil burdens. Several of these measures were ratified by the third general council of the Lateran, summoned by Alexander in 1179.

Alexander IV., *Count Rinaldo de Segni*, cardinal-bishop of Ostia, occupied the papal chair from December 1254 till his death in May 1261. He seems to have been of a weak character, and in the struggle against the house of Hohenstaufen, which he inherited from his predecessors, he did little to strengthen the position of the papacy. The opposition which he offered to Manfred, natural son of Frederick II., proved unavailing, although he obtained the aid of England by promising the disputed sovereignty of the Two Sicilies to the English Prince Edward. Manfred was crowned king at Palermo in 1258, and in 1260 he invaded the States of the Church, and compelled the pope to recognise him as legitimate sovereign. The ecclesiastical administration of Alexander was signalised by his efforts to unite the Greek and Latin churches, by the establishment of the Inquisition in France (1255), and by the support he gave to the orders of Mendicant friars. The last years of his pontificate were passed at Viterbo, where he was compelled to take refuge on account of the violent struggles at Rome between the factions of the Guelphs and the Ghibellines.

Alexander V. (*Pietro Philargi*), a native of Candia, enjoyed the dignity of Pope for only ten months, from the 26th June 1409 to the 3d May 1410. Born of poor parentage, he owed his admission to a religious house to a Franciscan monk, who noticed him begging. He studied at Paris and Oxford, where he acquired such reputation for scholarship, that on his return to Italy he was rapidly promoted from dignity to dignity. In 1402 he was appointed, through the influence of Galeazzo Visconti, to the archbishopric of Milan, and in 1405 he was made a cardinal by Innocent VII. The council of Pisa, after deposing Benedict XIII. and Gregory XII., elected him pope on the understanding that he would set himself to reform the abuses of the church. The weakness of his character and the shortness of his pontificate, however, prevented anything effectual being done. He died, as was generally believed, of poison administered by Balthasar Cossa, who became his successor under the title of John XXIII.

Alexander VI. (*Rodrigo Borgia*), memorable as the most characteristic incarnation of the secular spirit of the papacy of the 15th century, was born at Xativa in Valencia, 1st January 1431. His biographers all but unanimously assert his patronymic to have been Lenzuoli (in its original Valencian form, Llançol), and the name of Borgia (or more properly Borja) to have been assumed on his adoption by his maternal uncle. Francisco Escolano, however, a compatriot, positively affirms (*Cronica*, lib. vi. cap. 33), that Llançol was his mother's name, and that his father was Giofré Borja. It is also disputed whether he originally followed the legal or the military profession; the former appears more probable. In either case, his career was determined by his uncle's elevation to the papacy as Calixtus III., 8th April 1455, and his own immediate summons to Rome, where he was reserved *in petto* as cardinal in the ensuing February, publicly promoted in September, and by an unparalleled act of nepotism elevated to the lucrative and dignified office of vice-chancellor in the following July. He also succeeded his uncle as archbishop of Valencia. An elder brother, Pedro Luis, was made generalissimo of the papal forces by land and sea. The animosity created by so invidious an exaltation prepared Rodrigo's subsequent feud with the Roman patriciate. For the moment he was all-powerful, and the letters of that dexterous courtier Æneas Sylvius attest the importance attached to his good word. We must here notice the ridiculous fiction concerning the parentage of Borgia's natural children, which owes its currency to the uncritical credulity of Gordon, his first formal biographer. An anonymous MS. romance, professing to record the secret history of the Borgia family, exists in many Italian libraries; a copy is in the British Museum. Gordon fell in with this fiction, and whether from lack of judgment or love of marvel, adopted it into his narrative. According to this version, Rodrigo, when summoned to Rome, was living with a beautiful Valencian courtesan, Rosa Vanozza, by whom he had already had several children. Despatching his family to Venice under the care of a major-domo, he entered upon a course of austere hypocrisy, designed to secure his exaltation to the papacy, thus remaining apart from his mistress and children for a period of nearly forty years! This legend, originally circulated as a prime piece of scandal, has been accepted as a vindication by Rodrigo's apologists. Vanozza, they contend, was not his concubine but his wife, and her decease must have preceded his ordination: Cæsar and Lucretia were consequently legitimate. The Abbé Ollivier goes a step further still, and disposes of two scandals at a stroke by identifying Vanozza with Giulia Farnese, whose charms, during Alexander's pontificate forty years afterwards, notoriously procured her brother's elevation to the cardinalate. It is sufficient to reply that in this case the beautiful Lucretia must have espoused the Duke of Ferrara at forty, and have borne him children at sixty. The date of Cæsar's birth, moreover is known to an hour, being fixed by the horoscope preserved in Junctinus (tom. i. p. 171) at 18th September 1475. Nor is the history of Vanozza any longer a secret. It is known that her family name was De' Cattanei; that after bearing five children to Alexander she was twice married, on each occasion to a petty official about the papal court; that she possessed houses and other property in Rome; that she survived Alexander many years, and made use of the name of Borgia (*Reumont*, Bd. 3, pp. 202, 203).

The fortune of the Borgia brothers seemed menaced with eclipse on the death of their uncle, 8th August 1458. Pedro Luis, who had incurred the bitter enmity of the Orsini family, escaped under the escort of Cardinal Barbo to Cività Vecchia, where a fever soon carried him off. Rodrigo remained for the conclave. No papal election is more dramatically narrated in that edifying collection, *Conclavi de' Pontefici Romani*, than the one which resulted in the choice of Æneas Sylvius (Pius II.) Borgia's share in it had earned Pius's gratitude; he was, nevertheless, compelled to submit to some diminution of the authority and emoluments of the vice-chancellorship; and a subsequent indiscretion in the too public indulgence of his

taste for female society while discharging a legation at Siena procured him one of the severest reprimands ever addressed to a cardinal by a pope. Pius's reproof is preserved in Raynaldus (Append. ad ann. 1460, num. 31), and alone refutes the fiction of Borgia's religious hypocrisy. Cardinal Barbo, however, who succeeded as Paul II., was the same spirited patrician who had befriended the Borgias in their hour of need, and his ostentatious pontificate ushered in the era of Rodrigo's unbroken prosperity. "He is," writes at this time Gaspar Veronensis (Muratori, tom. iii. pt. 2, p. 1037), "a comely man of cheerful countenance and honeyed discourse, who gains the affections of all the women he admires, and attracts them as the loadstone does iron; it is indeed supposed that he proceeds no further." A supposition rather pious than probable.

On the death of the jovial Paul (1471), Borgia is mentioned, along with Cardinals Orsino and Gonzaga, as one of the three who chiefly contributed to place the tiara on the brows of the then famous preacher and exemplary ascetic Sixtus IV., who immediately (*per fuggire l'ingratitudine*) bestowed on him the opulent abbey of Subiaco, and raised him to the dignity of cardinal-bishop. About the same time must have commenced his intimacy with Vanozza. In 1473 he undertook a legation to Spain, avowedly with the purpose of visiting his diocese and of composing differences between the kings of Castile and Portugal, but in reality to display his magnificence to his countrymen. His demeanour on this occasion is represented in the most unfavourable light by the cardinal of Pavia, who had previously composed for him that elegant oration to his Valencian flock which the Abbé Ollivier has the simplicity to attribute to Borgia himself. The cardinal, however, is too much of a time-server and a rhetorician for his account to be altogether trustworthy. More certain is the occurrence of a tremendous tempest on Borgia's return, in which part of his retinue perished, while he himself narrowly escaped. Innocent VIII., the successor of Sixtus, owed his election to Borgia's coalition with the late pope's nephew, and the fortunes of the former remained unimpaired throughout his tranquil pontificate. The long malady which terminated it afforded scope for the intrigues of aspirants to the succession; and when the cardinals entered into conclave (August 1492), already the rumour ran that a Spaniard would be pope. The simoniacal character of the election is indisputable. We need not believe that the opulent and high-spirited Cardinal Ascanio Sforza was tempted with four mule-loads of silver, but his instant elevation to the vice-chancellorship speaks for itself. Cardinal Orsino was bought with Borgia's palace in Rome; Cardinal Colonna with the abbey of Subiaco; money gained the minor members of the Sacred College; five cardinals alone are recorded as incorruptible. Borgia's uneasiness was betrayed by his hasty assumption of the pontifical vestments, and premature announcement of the election to the expectant crowd. He assumed the name of Alexander VI. His allocution to the cardinals breathed spirit and dignity: an admonitory discourse to his son Cæsar, which may be read in Gordon, is an invention of the anonymous romancer. The pomp of his coronation far surpassed preceding examples, and the compliments of foreign ambassadors on the majesty of his mien and the maturity of his wisdom were echoed by a public accustomed to simony, relieved at their deliverance from a period of anarchy, and sensible of their need of a firmer hand. This hope Alexander justified and surpassed. Ere long he had divided Rome into judicial districts, placed a magistrate at the head of each, and himself established a weekly audience, at which, by the admission of the malcontent Infessura, "he administered justice after a marvellous sort."

Alexander's pontificate might have been less eventful but for a circumstance beyond his control. The political system of Italy was on the eve of dissolution. Ludovico the Moor, anxious to confirm himself in his ill-gotten duchy of Milan, was already tempting the French monarch across the Alps by the bait of the kingdom of Naples. As of old in Greece, so now dissensions and political corruption were about to cast down the civilisation of Italy at the feet of the stranger. The passion for family aggrandisement on this occasion impelled Alexander to a patriotic course. His third son Giofré had espoused the illegitimate daughter of the king of Naples, and received as dower the principality of Squillaca. When, therefore, the French envoys demanded the investiture of Naples, they met with a flat refusal. This encouraged Alexander's enemies. Cardinal della Rovere (Julius II.) withdrew from the papal court, seized upon Ostia, and from thence addressed urgent appeals to the French king to march upon Rome, convene a council, and purge Christendom of the simoniacal pope. On this side Alexander felt himself indeed vulnerable. Casting about for alliances, he despatched an envoy to the Sultan; the ambassador was arrested as he returned with a favourable reply; and the publication of his instructions created a fresh scandal. Others still, had Roman manners been less lax, might have arisen from the marriage of the pope's acknowledged daughter Lucretia to the Lord of Pesaro, under the auspices of the whole Sacred College, and from the elevation of his second son Cæsar to the cardinalate at the age of eighteen, unblushing perjury being employed to conceal his illegitimate birth. Yet, at the same period, the successor of Peter appeared for the last time in history as the undisputed bestower of kingdoms and the ultimate tribunal of appeal for Christian nations. Spain and Portugal resorted to him for the adjustment of their claims to the New World; and by tracing a line upon a map he disposed of three-fourths of the human race. Never, according to mediæval ideas, had a pope exerted his prerogative with equal grandeur; but the mediæval conception of the papacy was passing away, and no one's faith in it was feebler than the pope's.

Charles VIII. passed the Alps in the autumn of 1494; city after city fell before him, and by the end of the year Rome was added to the number. Alexander had retired into the castle of St Angelo. His deposition was universally expected, most of all by himself. But Charles's minister, Briçonnet, had been gained by the promise of a cardinal's hat. On 16th January the reconciliation of king and pontiff was officially celebrated: they rode together through the city; but distrust still prevailed between them. With really surprising firmness Alexander continued to refuse the investiture of Naples, with which Charles may have thought himself able to dispense. Nothing, indeed, could have been more rapid than his conquest, except his loss of that kingdom. By March the triumph of the French seemed complete: on 6th July their retreating army cut its way through the Italian hosts at Taro in Upper Italy; on 7th July the King of Naples re-entered his capital. Nothing remained of the French incursion except a fatal contagion, and the more fatal revelation of the weakness of Italy.

The retreat of the French left Alexander at liberty to pursue what must have been the main object of any pope of intelligence and spirit in his place—the extirpation of the petty feudal vassals of the church, and the establishment of the temporal independence of the papacy. This was in truth but a phase of the great struggle of the crown and the people against the aristocracy, universally a characteristic of that age; but the pope's principal motive was unquestionably the insatiable appetite of family

aggrandisement. The incurable vice, however, of his policy was imposed upon him by the lack of men and money to carry it into effect. To obtain the former, he was compelled to incline alternately to France and Spain, degrading the majesty of the Holy See, and forfeiting his liberty of action as a member of the Italian body politic. The finances had to be recruited by the sale of offices and spiritual privileges of every kind. Such practices had long been prevalent at Rome, but never had they attained the enormity, the effrontery, or the method imparted to them by Alexander.

His enterprise was at first unfortunate. After some petty successes the papal forces were routed by the Orsini, January 1497. Spanish aid was invoked; the Great Captain checked the Orsini and recovered Ostia. Alexander's spirits rose; on 7th June he alienated Benevento in favour of his eldest son, the Duke of Gandia. That day week the duke disappeared; his body, pierced with wounds, was soon found in the Tiber. The public voice attributed the murder to the pope's second son, the Cardinal Cæsar Borgia, but on no other grounds than his capability of any atrocity, and the gain that accrued to him by this. Some historians know what he said to the pope in confessing his fratricide, and can report the pope's rejoinder; so is history written. Alexander secluded himself in a passion of grief. He talked of abdication, and actually appointed a commission to inquire into the abuses of the Church. While it ineffectually deliberated on reforms, the stake was preparing for a real reformer. The history of Savonarola must be related elsewhere; it can only be said here that Alexander appears to have been most unwilling to proceed against him, and only to have consented to do so when the Dominican's hostile attitude rendered further forbearance impossible.

Cæsar Borgia, meanwhile, was bent on improving the opportunity which he had found or made. Three months after Savonarola's death he propounded to the assembled cardinals his desire to renounce ecclesiastical orders for his soul's health, and was soon at liberty to contract a royal alliance. After encountering a refusal from the daughter of the King of Naples he repaired to France, and there (May 1499) espoused a princess of the house of Navarre, receiving the title of Duke of Valentinois from the French king. Lucretia also benefited by her family's enlarged views; her alliance with the lord of Pesaro was dissolved on a pretext of nullity, and she married the Duke of Bisceglia, a natural son of the King of Naples. This had occurred a year previously, when Alexander still attached weight to the Neapolitan alliance; but the political horizon was now changed. In October 1499 a French army crossed the Alps and conquered Lombardy, almost without resistance. The watchword was thus given for the papal campaign in the Romagna. Caterina Sforza, regent of Imola and Forli, received a summons to discharge certain arrears long owing to her suzerain. Cæsar Borgia followed with an army on the heels of the messenger, and although the intrepid princess defended herself stoutly by sword and poison, she was compelled to succumb to the "Gonfalonier of the Church." The Borgias' enterprise coincided fortunately with the commencement (according to the then method of reckoning) of the new century and the mighty concourse of pilgrims to Rome for the jubilee, each representing some substantial contribution to the papal exchequer. France and Spain, meanwhile, had concerted their secret arrangement for the dispossession of the King of Naples, and Cæsar Borgia prepared to remove the only obstacle to his own participation in it. In July 1500 the Duke of Bisceglia, Lucretia's Neapolitan husband, was attacked by assassins in broad-day, and left desperately wounded. The pope placed guards over the prince; Lucretia and her sister-in-law prepared his food to avoid poison; but none the less "quum ex vulneribus sibi datis mori noluisset"—Alphonso of Bisceglia was strangled by men in masks. "All Rome," writes the Venetian ambassador, "trembles before the duke." The worst times of the empire seemed returned, even to the amusements of the amphitheatre, where Cæsar, whose tastes were those of a Spaniard, despatched six bulls successively, severing the head of one from the shoulders at a stroke. The pope looked on helplessly at the Frankenstein of his own creation; "he loves and hugely fears his son," reports the Venetian, who adds that Cæsar had pursued his father's favourite secretary to his arms, and there butchered him, the pope's robe being saturated with the gushing blood. Alexander's easy temper stood him in good stead. "The pope," according to the same authority, "grows younger every day, and is extremely cheerful; his cares and troubles endure only for a night; he thinks continually of aggrandising his children—*ne d'altro ha cura.*" In his conversations with foreign envoys he excused his son's violence as the error of youth. "The duke," he said, "is really a good fellow; it is only a pity that he cannot endure to be offended." Lucretia is extolled by all as "lovely, discreet, and bountiful." Rumour, indeed, imputed to her an incestuous connection with her brother; but this aspersion, like all others upon her, is to this day utterly destitute of proof.

"These devils cannot be cast out by holy water," Cardinal Juan Borgia had formerly reported of the turbulent occupants of the Romagna. The experiment of casting out Satan by Beelzebub remained to be tried. In April 1501 Cæsar entered upon his second campaign, and by perfidy or force quickly added Pesaro, Rimini, and Faenza to his former possessions. Attentive to the maxims of sagacious tyranny, he governed with substantial justice. If his coffers had to be filled by oppression, the odium would be cast on some subordinate agent, whose body, his mission fulfilled, would be found dismembered in the market-place. France and Spain, meanwhile, proceeded to the spoliation of the defenceless king of Naples, and Cæsar (July 1501) shared in the conquest and the booty. In September Alexander himself undertook a campaign against the Colonnas, and humbled those haughty patricians by the capture of all their castles. Lucretia, to the general scandal, represented him in his absence. Worse scandals were in store, could we implicitly credit the contemporary diarist's account of the scenes enacted in the apostolic palace after Alexander's return, but the passage is probably interpolated. At this period the papal court was engrossed with preparations for Lucretia's marriage to Alphonso, son of the Duke of Ferrara, which was celebrated by proxy in December. The pope's daughter, cardinals and prelates in her train, undertook a stately progress through Italy to Ferrara, where she was received with extraordinary splendour. Piombino was reduced at this time, and in July Cæsar treacherously rendered himself master of Urbino. Immediately afterwards his power received a severe shock from the defection of his principal *condottieri*. Cæsar temporised until, to the admiration of Machiavelli, then Florentine envoy at his camp, his adversaries were decoyed into his hands, seized, and executed (31st December 1502). The news gave the signal at Rome for the arrest of the Orsini and the occupation of their castles; thus was the humiliation of the Roman aristocracy completed. Cardinal Orsino was committed to Saint Angelo, where the services of the papal master of the ceremonies were soon required for his interment. "But I," remarks Burcardus with quaint naiveté, "turned the business over to my assistant, for I did not want to know more than was good for me." It must be owned that in

that age it would have been impossible to bring a cardinal publicly to the block. This apology does not apply to the charges of secret poisoning which have mainly given the Borgias their sinister celebrity, and which became fearfully rife in Alexander's latter years. They are unproved as yet, but are certainly countenanced by the opulence of the supposed victims, and the avidity with which the pope pounced upon their effects, especially in the case of his rapacious datary, Cardinal Ferrari.

By May 1503 Spain had dispossessed France of her share of ill-gotten Naples. A general war seemed imminent; Alexander and Cæsar leaned to the side of Spain. The Sacred College was already full of Spanish cardinals, docile instruments of their countryman, and Alexander might well deem that he had fettered the Church to the fortune of his house. Men looked for the proclamation of Cæsar as king of Romagna, and the division of the temporal and the spiritual power. The ancient mutual relations of pope and emperor would have been revived, but on the narrow area of Central Italy. But this was not to be. On the morning of 12th August "Pope Alexander felt ill;" so did Cæsar Borgia. Every one knows the story of the supper given to the ten cardinals in the villa, and the fatal exchange of the poisoned flask. This picturesque tale is almost certainly a fiction. An attempt to destroy ten cardinals at once is inconceivable; it would be easier to believe Cardinal Castellesi's assertion that he was to have been the victim, as his sickness at the time is confirmed from an independent source. But his character does not stand high, and the symptoms of his disorder, as described by himself, differ totally from Alexander's, which were those of an ordinary Roman fever. The progress of the pope's malady may be minutely traced in the diary of Burcardus and the despatches of the Ferrarese envoy. He expired on the evening of 18th August, duly provided with all the needful sacraments of the Church. From his own point of view his life probably appeared fortunate and glorious; but the vicissitude of human affairs is ever dramatically illustrated by the death of a pope. Ere the corpse was cold the pontifical apartments were pillaged by the satellites of Cæsar Borgia; at the funeral a brawl between priests and soldiers left it exposed in the body of the church; when placed before the altar, its shocking decomposition confirmed the surmise of poison; finally, stripped of its cerements and wrapped in an old carpet, it was forced, with blows and jeers, into a narrow coffin, and flung into an obscure vault. The remains were subsequently transferred to the Spanish church of St Mary of Montserrat, where they repose at this day.

Alexander has become a myth, and his "acts" are in some respects almost as legendary as those of the primitive saints and martyrs. The peculiar odium attached to his memory rests partly on the charge of incest, of which he must be acquitted; partly on that of secret poisoning, which is at least not established; partly on the confusion between his actions and Cæsar Borgia's. Nearly everything actually criminal in his pontificate is subsequent to the preponderance of the latter. Profligate alike in public and private life, he was no malignant tyrant,—affable, familiar, easy, he justly took credit for his moderation towards notorious malcontents, and his indifference to personal injuries. These virtues, however, as well as his family affection, were merely constitutional with him,—as the many beneficial acts of his administration were rather prompted by a sense of policy than a sense of duty. His ability as a ruler is evinced by the tranquillity he maintained in Rome, his effectual provision against dearth, the regular discharge of financial obligations, the energetic prosecution of useful public works. As a statesman he ranks high in the second class. He was too destitute of morality to have the least insight into the tendencies of his times; but from the point of view of political expediency, his policy was eminently sagacious and adroit. He cannot be accused of preparing the misfortunes of Italy, but he did not disdain to profit by them. His licentiousness and contempt of ecclesiastical decorum are partly palliated by the circumstances of his initiation into the Church. He was untrained to the ecclesiastical profession, never felt himself a priest, and was wholly regardless of the Church's interest as such. In this respect he is almost unique among the successors of St Peter. Were controversies regulated by reason rather than by convenience, the parties to this would change sides,—Alexander's accusers would become his advocates, and his advocates his accusers. The Church in her secret heart must rate him the lowest of her chiefs; the world must feel that he deserves much better of it than many much better popes.

The principal contemporary authority for the reign of Alexander is the diary of the papal master of the ceremonies, Joannes Burcardus, a record replete with trivialities and not exempt from interpolations, but containing indisputable evidence of perfect candour. An excellent edition, commenced in 1855 by the Abbé Gennarelli, was discontinued after the publication of a few parts. The uncritical histories of Gordon and Tomasi are indebted to Burcardus for any value they possess. The paltry productions of modern Roman Catholic apologists (Jorry, Favé, Cerri, &c.) are beneath contempt. The Abbé Ollivier (*Alexandre VI. et les Borgia*, tom. i., Paris, 1870) excites respect by his good faith and amusement by his strange alliance of perverse ingenuity with infantine unsuspiciousness. Of late years the archives of the Italian courts have become accessible, and the transactions of Alexander's reign have been sagaciously investigated from this source by two German scholars, Von Reumont (*Die Stadt Rom*, Bd. 3, Abth. 1, Berlin, 1868) and Gregorovius (*Rom in Mittelalter*, Bd. 7, Stuttgart, 1870). The latter is the more copious, but his general estimate of Alexander is much too low. By far the ablest English contribution to the history of Alexander is a notice of Gregorovius in the *North British Review*, vol. lii., entitled *The Borgias and their Latest Historian*. (R. G.)

ALEXANDER VII. (*Fabio Chigi*), was born at Siena on the 13th February 1599, and occupied the papal chair from the 7th April 1655 to the 22d May 1667. Before his elevation he had filled successively the offices of inquisitor at Malta, vice-legate at Ferrara, and nuncio to Germany at the conference of Munster. The conclave elected him in the belief that he was strongly opposed to the nepotism and other abuses that had characterised the reign of his immediate predecessor, Innocent X., and at the beginning of his pontificate he went so far in this direction as to forbid his relatives even to visit Rome. In a year, however, all was changed, and nepotism prevailed to as great an extent as under any former pontiff. Alexander was a patron of learning, and himself wrote a volume of Latin poems which appeared at Paris in 1656 under the title *Philomathi Labores Juveniles*. He also encouraged architecture, and in particular constructed the beautiful colonnade in the piazza of St Peter's. The most noteworthy events of his pontificate were the reception of the ex-queen Christina of Sweden into the Catholic Church, the promulgation of a bull against the Jansenists, and a protracted dispute with Louis XIV. of France, during which the papal see lost possession of Avignon (1662). Alexander canonised Francis of Sales in 1665.

ALEXANDER VIII. (*Pietro Ottoboni*), born at Venice in 1610, was raised to the pontificate in October 1689 in succession to Innocent XI. He assisted his native state in its wars with the Turks. Although an enemy of the Jansenists, he condemned certain doctrinal errors of the Jesuits as advanced by Professor Bougot of Dijon. He carried nepotism to such an extent that the salaries and gifts bestowed on his relatives during his reign, short though it was, exhausted the papal treasury. He added

by purchase the books and manuscripts of Queen Christina to the Vatican library. He died in Feb. 1691.

ALEXANDER I., King of Scotland, son of Malcolm Canmore, succeeded his brother Edgar in 1107, and died in 1124. He was better educated than any of his predecessors, owing to the care of his mother, the amiable Margaret of England. All the qualities of his nature, both good and bad, were strongly marked; from the terror he inspired, he was styled by his subjects *the Fierce*. His reign is distinguished by the determined opposition he offered to any interference on the part of English bishops in the affairs of the Scottish Church. He contrived by energy and valour to subdue the turbulence of his kingdom; specially noticeable are the promptness and vigour he displayed in suppressing the insurrection of Angus, grandson of Lulach, a son of Macbeth's queen. He died at Stirling, and, being childless, was succeeded by his brother David I.

ALEXANDER II., King of Scotland, was born at Haddington in 1198 (died 1249), and succeeded his father, William the Lion, in 1214. Though still young, he exhibited the same prudence and firmness which marked his whole conduct in life. He was excommunicated in 1216 for associating with the English barons in their opposition to King John; but his prudence enabled him to recover the good opinion of the pope, and placed him on the best footing with the English king, Henry III., John's successor. His fidelity to Henry was shown by the assistance he rendered him in protecting, during Henry's absence in France, the northern borders of England, and the friendliness of the kings was strengthened by the marriage of Alexander to Henry's sister Joan (1221). Joan died in 1238, and in May 1239 Alexander married Mary de Coucy. In 1244 Henry marched against Scotland to force from Alexander the homage due to him for the lands he held in the north of England, but in August a peace was concluded at Newcastle. Like Alexander I., he was zealous in defence of the privileges of the Scottish Church; and in 1222 he put to death 400 persons who had been implicated in the murder of the bishop of Caithness. While engaged in quelling an insurrection in Argyleshire, he died of fever in the island of Kerrera in 1249.

ALEXANDER III., King of Scotland, son of Alexander II. by his second wife, Mary de Coucy, was born at Roxburgh on the 4th September 1241 (died 1286), and succeded to the throne on the death of his father in 1249. The fact that in this case the succession of a minor was unopposed is noteworthy, as showing that the hereditary principle had now established itself. By a provision of the treaty of Newcastle Alexander had been betrothed in infancy to the daughter of the king of England, and it suited Henry's policy to insist on an early fulfilment of the contract. Notwithstanding the extreme youth of the parties, the marriage was celebrated at York on the 25th December 1251. On this occasion Alexander is said by Matthew Paris to have done homage for his estates in England, and to have refused homage for his kingdom of Scotland, on the ground that he had not consulted on the matter with his proper advisers. The story, however, seems inconsistent with Henry's policy at the time, and is therefore questionable. With a king so young, in times so unsettled, the hopes and efforts of contending factions were naturally stimulated. At the commencement of his reign Alexander was under the power of the Comyns, the most influential family among the Scottish nobility. A rival party, under the leadership of Durward the justiciar, was supported by England, and in 1254 succeeded in seizing Edinburgh castle, and freeing the king and queen from the domination of the Comyns. Meanwhile Henry had himself marched to Scotland with an army, and in September he met Alexander at Roxburgh. There a regency was arranged, from which the Comyns were entirely excluded. In 1257, however, the latter regained their ascendancy, and obtained possession of the person of the king, whom they kept prisoner at Kinross and Stirling. In the following year a new regency was formed, in which both the opposing parties were represented, and the king was liberated. In 1260 he and his queen paid a visit to the court of England. While at Windsor the queen gave birth to a daughter, Margaret, afterwards married to Eric of Norway. An account of the invasion of Scotland in 1263 by Haco, king of Norway, and of the disastrous defeat at Largs, belongs rather to the history of the country than to the personal biography of the king. Three years after the invasion, Magnus, king of Norway, ceded to Alexander the Isle of Man and the Western Isles, receiving in return a ransom of a thousand marks and an annual rent of a hundred marks. The Orkney and Shetland islands still remained under the dominion of Norway. Alexander was involved in a protracted and on the whole successful struggle with the papal power for the independence of the Scottish Church. The chief matter in dispute was the proper valuation of church lands for the purpose of taxation. In connection with this, Boiamund or Bagimond came from Rome in 1275 with a commission to draw up the valution known as Bagimond's roll, which remained the basis for the taxation of church lands down to the time of the Reformation. The internal condition of the country seems to have improved greatly during the latter years of Alexander's reign. A wise and vigorous administration ensured peace and consequent prosperity. The prospect of Scotland was perhaps never brighter in all her early history than towards the close of his reign, but it was suddenly overcast. A series of calamities, following each other in quick succession, left the nation at the mercy of its foes within and without. In 1275 Alexander's wife died, and a few years later he lost both his children. The succession in the direct line was thus left to the precarious chance of the single life of the infant princess known in history as the "Maid of Norway." In 1285 Alexander married Joletta, daughter of the Count of Dreux. Any hope of strengthening the succession by this union was, however, destroyed by the calamitous event of the following year. On the 12th March 1286 the king was killed by a fall from his horse while riding on the coast of Fife opposite Edinburgh. A spot near Kinghorn, known as the King's Wud End, is pointed out as the scene of the tragical event. The death of Alexander was a turning-point in Scottish history. The national independence, which he maintained so steadfastly against the insidious claims of England, while avoiding an open rupture, was once more placed in jeopardy. The popular estimate of the calamity is well expressed in the following lines, believed to be the earliest specimen of Scotch poetry extant:—

> "Quhen Alysander our kyng was dede,
> That Scotland led in luve and le,
> Awaye was sons of ale and brede,
> Of wyne and wax, of gamyn and glé.
> Our gold was changyd into lede.
> Cryst, born into virgynyte,
> Succour Scotland and remede,
> That stad is in perplexyte."

ALEXANDER, PAULOVICH, Emperor of Russia—born on 28th December 1777, died 1825—was the son of Paul, afterwards emperor, by Maria, daughter of Prince Eugene of Würtemberg. His early education was conducted under his excellent mother, and afterwards was carefully directed by his grandmother, the Empress Catherine II., who con-

fided its general superintendence to Frederick Cæsar de La Harpe. On the assassination of his father Paul in 1801, Alexander succeeded to the Russian throne. He had been married in 1793 to the Princess Louisa Maria of Baden, but the union proved an unhappy one, and had no issue.

The policy of the young emperor was indicated by his concluding a peace with Britain, against which his father had declared war. In 1805 he joined Austria and Sweden in a coalition with Great Britain against the pretensions of France. The war that followed was disastrous to the allies. The armies of Austria were totally defeated in a succession of battles between the 6th and 13th October of that year; and the combined Austrian and Russian armies, under the two emperors, were defeated by Napoleon in the great battle of Austerlitz on the 2d December. Austria concluded a separate treaty of peace, and Alexander led the remains of his army into his own dominions. Prussia, which had injudiciously stood neutral while France was humbling Austria and Russia, rashly engaged in hostilities with Napoleon in 1806, while her allies, the Russians, were still beyond the Vistula; but the defeats at Auerstadt and Jena laid Prussia prostrate; and in the succeeding year the battles of Eylau and Friedland, in which the Russians were fairly beaten, led to the dismemberment of Prussia, and the treaty of Tilsit with Russia. A few days after the last battle, Alexander and Napoleon met on a raft anchored in the river Niemen, and agreed to the treaty, which was signed at Tilsit on July 7. By a secret article of this treaty Alexander was not only to withdraw from his connection with Britain, but to become her enemy; and he declared war against her on the 26th October.

For nearly five years Alexander appeared attached to the alliance of France; but the privations of his subjects by the interruption of the commerce with England, and the intolerable load of Napoleon's "Continental System," at length induced him to return to his old alliance, and to declare war against France on March 19, 1812. On the 24th April he left St Petersburg to join his armies on the west frontier of Lithuania. Napoleon assembled the most numerous and magnificent army that had ever been brought together in modern times, augmented by the unwilling levies of Prussia and Austria, and entered Russia on the 25th June 1812. The first encounter was at Borodino, where there was a well-contested action, in which each army suffered the loss of 25,000 men. The burning of Moscow, and the subsequent retreat of Napoleon, during which his army was all but annihilated, are among the best known events of modern history.

In 1813 the advancing Russians were successively joined by the forces of Prussia, Austria, and Sweden. Alexander continued with the allied armies, and in particular was present at the battles of Dresden and Leipsic. Napoleon had made wonderful exertions to repair his losses in the early part of 1814; but the victories of Wellington in Spain, and his advance into the heart of France, favoured the progress of the allies; and on March 30, 1814, 150,000 men of the allied armies took possession of Paris, which was entered next day by Alexander and the king of Prussia.

After the deposition of Napoleon the allied sovereigns visited England. By the treaty of Vienna, Alexander was acknowledged king of Poland; but before the congress of Vienna broke up, Napoleon had escaped from Elba, and was enthusiastically received at Paris. The two eastern emperors and the king of Prussia remained together until the battle of Waterloo gave peace to Europe. On the advance of the British and Prussians to Paris, the three allied sovereigns again made their entry into that capital, where they concluded, on September 26, the treaty which has been designated *the Holy Alliance.*

Alexander was henceforward chiefly occupied in the internal administration of his vast dominions, which certainly improved more during the twenty-five years of his reign than under any of his predecessors from the time of Peter I. The gradual abolition of the feudal servitude of the peasantry, begun by the most enlightened of his predecessors, was continued under Alexander. Education, agriculture, manufactures, commerce, were also greatly extended; while literature and the fine arts were liberally encouraged. His disposition has been represented by his subjects as mild and merciful; yet his influence in the affairs of Europe was not exerted in the cause of public liberty. But this could hardly be expected from the autocrat of an unmitigated despotism in his own territories. He will, however, bear very favourable comparison with any Russian sovereign, or even with any contemporary monarch.

Early in the winter of 1825 he left St Petersburg for the last time on a tour of inspection of his southern provinces. About the middle of November he was attacked by a violent intermittent fever, which proved fatal at Taganrog on December 1, 1825. In foreign countries his death has been attributed to poison; but this is refuted by the history of his disease, and is very improbable, from his great popularity with his countrymen. He was succeeded, in accordance with a family compact, by his second brother Nicholas.

ALEXANDER JAROSLAWITZ NEVSKI, Saint, Grand Duke of Wladimir, second son of the Grand Duke Jaroslaw II., was born at Wladimir in 1219, and died 14th November 1263. He became prince of Novgorod on the resignation of his father in 1239, his elder brother having died. While Batu Khan was sweeping with his Tatars over the south, the Swedes, Danes, and Livonian knights took advantage of this to oppress the north of Russia; Alexander accordingly directed his arms against them, and gained a brilliant victory with his small army on the 15th July 1240. His surname of *Nevski* was derived from this event, which took place near the Neva, and in the vicinity of the modern St Petersburg. In a second campaign in 1241 he was no less successful, and drove his enemies out of Pleskow in Kiew. In a third campaign he defeated them near lake Peipus (1242), and forced the Livonian knights to sue for peace and retire from the district of Pskow, which they had conquered a short time before. On his father's death in 1247, a younger brother (Andrew) opposed Alexander, and seized the duchy of Wladimir; but in 1251 the latter was established in his rights by the khan of Kaptchak, the district which the Mongolian Batu had taken under his immediate authority. He firmly opposed the proposal of Pope Innocent IV. to unite the Greek with the Roman church. He died at Gorodetz, 14th November 1263, on his return from a visit to Kassimcow. Towards the close of his life he is said to have taken holy orders, but the tradition rests on no sure basis. At his death the people universally spoke of him as their father and protector, and afterwards recorded his deeds in their songs, and honoured him as a saint. Peter the Great, when founding St Petersburg, erected a magnificent monastery to the east of the city in honour of the victory won there by his great predecessor, and created in 1722 one of the eight Russian orders, that of Alexander Nevski. The monastery is now one of the wealthiest in Russia, and has, according to Eckhardt, a yearly revenue of half a million silver roubles.

ALEXANDER, Archibald, D.D., a Presbyterian divine of America, was born of a family, originally Scotch, in Rockbridge county, Virginia, on the 17th April 1772 (died

1851). After completing his preliminary education at Timber Ridge, he came under the influence of the religious movement known as the "great revival," and devoted himself to the study of theology. Licensed to preach in 1791, he was engaged for seven years as an itinerant missionary in his native state, and acquired during this period the facility of extemporaneous speaking for which he was remarkable. For a time president of Hampden Sidney College, he resigned that position in 1807 to become pastor of Pine Street church, Philadelphia. In 1810 the degree of doctor of divinity was conferred upon him by the college of New Jersey, and in the following year he was appointed first professor in the newly-established Presbyterian theological seminary at Princeton. He filled the chair until his death in 1851. Dr Alexander wrote a considerable number of works in theology, which have had a large circulation. Among these may be mentioned his *Outlines of the Evidences of Christianity* (1823), which has passed through several editions, and been translated into various languages; and his *Treatise on the Canon of the Old and New Testament* (1826). He was also a frequent contributor to the *Biblical Repertory*, edited by Professor Hodge.

ALEXANDER, Joseph Addison, D.D., third son of the preceding, one of the most eminent biblical scholars of America, was born in Philadelphia in 1809 (died 1860). He studied at New Jersey, devoting himself specially to Hebrew and other Oriental languages. He graduated in 1826, and from 1830 to 1833 was adjunct professor of ancient languages and literature in his *alma mater*. In 1838 he was appointed professor of biblical criticism and ecclesiastical history in the theological seminary at Princeton. He was transferred in 1852 to the chair of biblical and ecclesiastical history, which he occupied till his death in January 1860. Dr Alexander wrote several valuable works in his own department, the most important being a *Translation of and Commentary on the Psalms*, a *Critical Commentary on the Prophecies of Isaiah*, and a treatise on primitive church government. He also contributed numerous articles to the *Biblical Repertory* and the *Princeton Review*. At the time of his death he was engaged along with Dr Hodge in the preparation of a commentary on the New Testament.

ALEXANDER, Sir William, earl of Stirling, poet. The family of Alexander of Menstrie—*i.e.*, of the poet—is of ancient lineage, "tracing its descent from Somerled, lord of the Isles, in the reign of Malcolm IV., through a misty Highland genealogy, to John, lord of the Isles, who married the Princess Margaret, daughter of King Robert II. Their son, Alexander, was father of Angus, who founded the family of Macalister of Loup, and of Alexander, who obtained from the Argyle family a grant of the lands of Menstrie in Stirlingshire, and settled there—his descendants assuming his christian name of Alexander as their surname. The fifth in descent from this personage was Alexander Alexander, whose successor was his son, William Alexander, the poet" (Works: *Introductory Memoir*, vol. i. p. ix., 1870). From his (rare) engraved portrait, William was, it appears, aged 57 in 1637; so that he must have been born (at Menstrie House, where afterwards was born Sir Ralph Abercromby) in 1580. The grammar school of neighbouring Stirling probably furnished his early education; of his later, it is simply known that he attended the university of Glasgow. On leaving it he proceeded on his travels with Archibald, seventh earl of Argyle. It is supposed that it was during his sojourn on the Continent he composed his series of sonnets, afterwards published under the title of *Avrora* (1604). He was tutor to the young earl. Upon his return he proceeded to court, and won for himself speedily a name as a gentleman of parts and learning. The first of his *Monarchicke Tragedies* had been published at Edinburgh in 1603, viz., *The Tragedie of Darivs*, which, like his *Parenesis to the Prince* (1604), bore on the title-page simply, "By William Alexander of Menstrie." In 1604 he reprinted *Darivs* along with a new tragedy of *Cœsar*, giving the two the afterwards more celebrated title of *Monarchicke Tragedies* — ultimately increased by *The Alexandraean* and *Julius Cœsar* (1607). In 1607 he describes himself as "William Alexander, gentleman of the prince's privy chamber." King James was much taken with him. He held his office with the prince of Wales until his lamented death in 1612, on which he published his *Elegie on the Death of Prince Henrie* (Edinburgh, 1612). In 1612 he was made master of bequests, and knighted; his title-page of the *Elegie* bearing to be by "Sir William Alexander of Menstrie." In 1614 appeared his *Doomesday; or, the Great Day of the Lord's Ivdgement* (Edinburgh). In 1621 (September 21) he received the most prodigious "gift" ever bestowed on a subject, viz., "a gift and grant" of Canada, inclusive of Nova Scotia, or Acadie, and Newfoundland—a fact declarative of royal ignorance of what the gift really was. Yet was it subsequently confirmed by Charles I. In 1624, Alexander, in relation to his grant, published *An Encouragement to Colonies*—twice at least reprinted (1625 and 1630). The gift and grant belong to history rather than biography, and their later results to the romance of the peerage and of law In 1626 he was appointed Secretary of State for Scotland, and in 1630 created a peer, as Lord Alexander of Tullibody, and Viscount Stirling. In 1631 he was made an extraordinary judge in the Court of Session. In 1632 he built Argyle House, a quaint building, which remains one of the "lions" of Stirling. In 1633 he was advanced a step in the peerage, being created Earl of Stirling and Viscount Canada; and in 1639 Earl of Dovan. In 1637 he collected his poetical works, and issued them as *Recreations with the Muses*, "by William, Earle of Sterline," with his portrait engraved by Marshall. This folio did not include either *Avrora* or the *Psalms of King David* (Oxford, 1631), although there seems little doubt that he, rather than King James, was the main author of the latter. It, however, first gave his second sacred poem (incomplete) of *Jonathan*. He died in London on 12th February 1640, and later his remains were transferred to Stirling. Lauded by Sir Robert Ayton and William Drummond of Hawthornden, the Earl of Stirling, nevertheless, soon fell out of men's memories. The recent careful and beautiful edition of his *Poetical Works* (3 vols.) ought to revive his fame; for while there is too often a wearying wordiness, the student-reader is rewarded with "full many a gem of purest ray serene." His *Doomesday* has some grand things; his *Avrora* suggests comparison with Sidney's *Astrophel and Stella*. (Works as above; Laing's *Baillie's Letters and Journals*, iii. 529; *Drummond MSS.*, by Laing; *Hunter's MSS.*, in Brit. Museum.) (A. B. G.)

ALEXANDRETTA. See Scanderoon.

ALEXANDRIA, a city of Lower Egypt, and for a long time its capital, was situated on the Mediterranean, 12 miles west of the Canopic mouth of the Nile, in 31° 11′ N. lat., and 29° 52′ E. long. The ancient city was oblong in form, with a length from east to west of 3 to 4, a breadth from north to south of 1, and, according to Pliny, a circumference of 15 miles. Lake Mareotis bathed its walls on the south, and the Mediterranean on the north; on the west was the Necropolis, and on the east the Hippodrome. The city was laid out in straight parallel streets, one of which, about 200 feet wide, ran westward from the Canopic gate to the Necropolis. This street was decorated with magnificent houses, temples, and public buildings, and

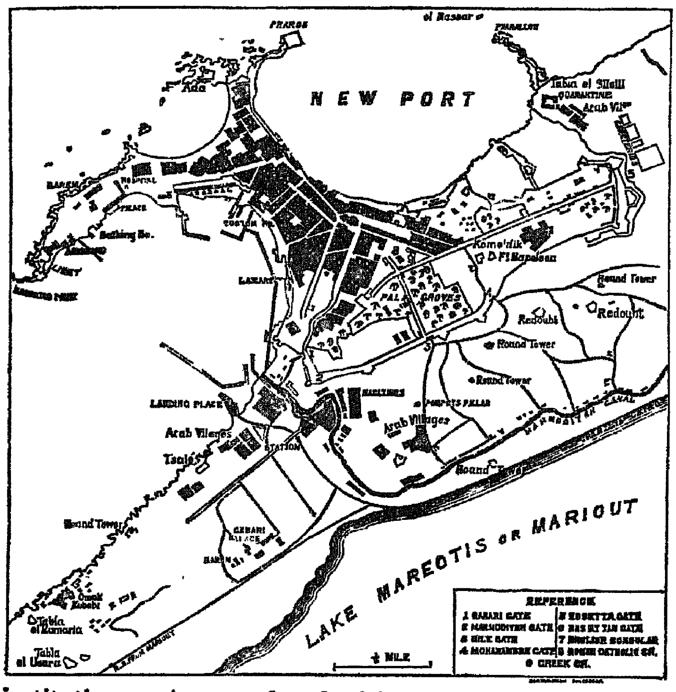
was intersected by another of the same breadth and magnificence, running from south to north. Ancient Alexandria was divided into three regions: (1.) The *Regio Judæorum*, or the Jews' quarter, forming the north-east portion of the city. (2.) *Rhacotis* on the west, occupied chiefly by Egyptians. Its principal building was the Serapeum, or temple of Serapis, containing an image of the god, brought probably from Pontus. A large part of the famous library of Alexandria was placed in the Serapeum. (3.) *Brucheum*, the Royal or Greek quarter, forming the remaining and most magnificent portion of the city In the Brucheum were the chief public buildings of Alexandria, the most noted of which was the splendid palace of the Ptolemies, on a peninsula called the Lochias, which stretched out into the Mediterranean towards the east of the city; the library proper, and the museum, a sort of college, with a dining-hall and lecture-rooms for the professors (see LIBRARY); the *Cæsarium*, or temple of the Cæsars, where divine honours were paid to the emperors; and the *Dicasterium*, or court of justice. An artificial mole, called the *Heptastadium*, nearly a mile in length, stretched from the continent to the isle of Pharos. Between this mole and the peninsula of Lochias was the greater harbour; on the other side of the mole was the harbour called *Eunostos*, or Safe Return. The two were connected with each other by two breaks in the mole, crossed by two bridges, which could be raised at pleasure. Within the harbour of Eunostos was an artificial basin called *Kibotos*, *i.e.*, the Chest, communicating with lake Mareotis by a canal, from which a separate arm stretched eastward to the Canopic mouth of the Nile. On the eastern point of the island of Pharos was the famous lighthouse, said to have been 400 feet high. It was begun by Ptolemy Soter, and finished by his successor, Philadelphus. It cost 800 talents, which, if Alexandrian, is equivalent to £248,000. In the time of Diodorus Siculus (50 B.C.), the population of Alexandria was estimated at 300,000 freemen, with probably at least as many slaves.

The city was founded by Alexander the Great 332 B.C.; but the island of Pharos was from an early period a refuge of Greek and Phœnician sea-rovers, a fact commemorated in the name "Pirates' Bay," given to a deep indentation on the north side of the island; and on the mainland was the little town of Rhacotis, subsequently incorporated in the quarter of that name. The architect employed by Alexander was the celebrated Dinocrates, who had acquired a high reputation by rebuilding the temple of Diana at Ephesus. The new city prospered greatly as a centre both of commerce and of learning, particularly during the reigns of the earlier Ptolemies, to whose enlightened liberality, indeed, its literary importance was largely due. But the later monarchs of the house of Lagus were mostly weak and vicious men, under whom the city declined in influence. In 80 B.C. Ptolemy Alexander bequeathed his city to the Romans; but the bequest did not immediately take effect owing to the civil convulsions in Italy, into which Alexandria itself was eventually drawn, and it was not until 30 B.C. that the city submitted to Augustus. It was by him made an imperial city, governed by a prefect appointed by the emperor, while the functions of the Alexandrian senate were suspended, a state of matters which continued until 196 A.D., when Severus restored its municipality.

Alexandria seems from this time to have regained its old prosperity, becoming an important granary of Rome, which, doubtless, was one of the chief reasons that induced Augustus to place it directly under the imperial power. In 215 A.D. the emperor Caracalla visited the city; and, in order to repay some insulting satires that the inhabitants had made upon him, he commanded his troops to put to death all youths capable of bearing arms. This brutal order seems to have been carried out even beyond the letter, for a general massacre was the result. Notwithstanding this terrible disaster, Alexandria soon recovered its former splendour, and for a time was esteemed the first city in the world after Rome. As the power of the Cæsars decreased, however, their hold over Alexandria was weakened, and the city itself suffered from internal commotions and insurrections, which gradually destroyed its importance. In 616 it was taken by Chosroes, king of Persia; and in 640 by the Arabians, under Amru, after a siege that lasted fourteen months, during which Heraclius, the emperor of Constantinople, did not send a single ship to its assistance. Notwithstanding the losses that the city had sustained, Amru was able to write to his master, the caliph Omar, that he had taken a city containing "4000 palaces, 4000 baths, 12,000 dealers in fresh oil, 12,000 gardeners, 40,000 Jews who pay tribute, 400 theatres or places of amusement." The following story, relating to the destruction of the library, is told by Abulfaragius:—John the Grammarian, a famous Peripatetic philosopher, being in Alexandria at the time of its capture, and in high favour with Amru, begged that he would give him the royal library. Amru told him that it was not in his power to grant such a request, but promised to write to the caliph for his consent. Omar, on hearing the request of his general, is said to have replied that if those books contained the same doctrine with the Koran, they could be of no use, since the Koran contained all necessary truths; but if they contained anything contrary to that book, they ought to be destroyed; and therefore, whatever their contents were, he ordered them to be burnt. Pursuant to this order, they were distributed among the public baths, of which there was a large number in the city, where, for six months, they served to supply the fires. Shortly after its capture, Alexandria again fell into the hands of the Greeks, who took advantage of Amru's absence with the greater portion of his army. On hearing what had happened, however, Amru returned, and quickly regained possession of the city. About the year 646 Amru was deprived of his government by the caliph Othman. The Egyptians, by whom Amru was greatly beloved, were so much dissatisfied by this act, and even showed such a tendency to revolt, that Constantine, the Greek emperor, determined to make an effort to reduce Alexandria. The attempt proved perfectly successful, Manuel, Constantine's general, capturing the city with inconsiderable loss. The caliph, perceiving his mistake, immediately restored Amru, who, on his arrival in Egypt, drove the Greeks within the walls of Alexandria, but was only able to capture the city after a most obstinate resistance by the defenders. This so exasperated him that he completely demolished its fortifications, although he seems to have spared the lives of the inhabitants as far as lay in his power. Alexandria now rapidly declined in importance. It was captured by Andalusian adventurers in 823; by the Moghrebins in 924, and again in 928. The building of Cairo in 969, and, above all, the discovery of the route to the East by the Cape of Good Hope in 1497, nearly ruined its commerce; and after this we hear little of the city until the beginning of the present century.

ALEXANDRIA, the modern city, stands partly on what was the island of Pharos, now a peninsula, but mostly on the isthmus by which it is connected with the mainland. This was originally an artificial dyke connecting the island with the land opposite; but, through the constant accumulation of soil and ruins, it has attained its present dimensions. The principal public and government buildings are on the peninsula. The ancient city was situated on the mainland, adjacent to the modern town, and the extent of the ruins that still exist sufficiently attests its

greatness. The general appearance of Alexandria is by no means striking; and from its situation its environs are sandy, flat, and sterile. It was formerly surrounded by strong turreted walls, with extensive outworks, but in various parts the walls have lately been destroyed to make way for improvements. In the Turkish quarter the streets are narrow, irregular, and filthy, and the houses mean and ill-built. The Frank quarter, on the other hand, presents the appearance of a European town, having handsome streets and squares, and excellent shops. The streets have been much improved lately by being nearly all paved. The principal hotels, shops, and offices are situated in the Great Square, the centre of which forms a very agreeable promenade, being planted with trees, and well provided with seats. It has also a fountain at each end. In the suburbs are numerous handsome villas, with pleasant gardens. Among the principal public buildings are the palace of the pasha, the naval arsenal, the naval and military hospitals, custom-house, bourse, two theatres, several mosques, churches, convents, &c. There is an important naval school, and a number of other educational



institutions. Among the charities worthy of mention is the hospital of the Deaconesses of Kaisersworth. Formerly the town was supplied with water by means of the ancient reservoirs formed under the old city, which are in many cases as perfect now as when first made, 2000 years ago. These were annually filled with water by means of the canal from the Nile, at the time of inundation; but a system of water-works has been formed by a public company, and a constant supply of water is now obtained from the canal at some distance from the town. The principal streets, squares, and railway stations, are lighted with gas.

Few of the remains of the ancient city are now visible. Most of those that were to be seen a few years ago have since disappeared, but frequently in making excavations portions of ancient masonry, broken columns, and fragments of statues are discovered. Among the best known of the ancient relics are the two obelisks commonly called "Cleopatra's Needles." They were originally brought from Heliopolis to Alexandria in the reign of Tiberius, and were set up in front of the temple of Cæsar. They are of red granite, and covered with hieroglyphics. One is still standing, and is 71 feet high and 7 feet 7 inches in diameter at the base. The other, which is fallen and covered with debris, is in a less perfect state, and not quite so long as the former. It was offered to the English government by Mehemet Ali, but after some consideration was declined. Near the obelisks are the ruins of an old round tower, commonly called the "Roman Tower." But the most striking of the ancient monuments is the column styled "Pompey's Pillar." It stands on a mound of earth about 40 feet high, and has a height of 98 feet 9 inches. The shaft consists of a single piece of red granite, and is 73 feet long and 29 feet 8 inches in circumference. The capital is Corinthian, 9 feet high, and the base is a square of about 15 feet on each side. From an inscription it appears to have been erected in honour of the emperor Diocletian, and it was formerly surmounted by a statue of that monarch. To the S.W. of the city are the catacombs, which served for the burial of the dead, and are formed by excavations in the calcareous rock of which the shore is composed. They are of great extent, and one of the chambers is remarkable for its elegance. The climate of Alexandria is mild and salubrious. The heats of summer are modified by the N.W. winds from the sea, which prevail during nine months of the year, the thermometer seldom rising above 85° Fahr. In winter a good deal of rain falls, and throughout the year the atmosphere is generally moist, being saturated with a saline vapour from the sea.

Alexandria has been mainly indebted for its prosperity to the advantages of its position for trade. It was this that first attracted the attention of its far-seeing founder to the site, and its subsequent history in no way belied his penetration. It soon rose to be the most important commercial city in the world, and the great emporium of trade between Europe and the East. Subsequently its fortunes fluctuated with those of its possessors, but the great blow to its prosperity was the discovery of the route to India by the Cape of Good Hope, and under the Turks it sank into insignificance, numbering only about 6000 inhabitants. Soon after Mehemet Ali became ruler of Egypt he turned his attention to the restoration of Alexandria. One of the most important works that he effected with this view was the opening of the Mahmoudieh Canal in 1820. This was accomplished at a cost of about £300,000, and, for want of proper management, at a melancholy loss of human life. It is about 50 miles in length, with an average width of about 100 feet, and communicates with the Rosetta branch of the Nile at the village of Atfeh. Since Alexandria became the centre of the steam communication between Europe and India, and the principal station on the Overland Route, its progress has been rapid. It has now regular communication with England, Marseilles, Brindisi, Constantinople, &c. In 1851 Mr Stephenson was instructed to form a railway between Alexandria and Cairo, which was accomplished, and the line opened for traffic, in 1856. This was shortly afterwards extended to Suez, and several extensions have since been made to the cotton districts of the Delta. A short line of railway (not belonging to the government) connects the town with Ramleh, a sea-bathing village about 7 miles distant.

Alexandria has two ports, an eastern and a western. The latter, called also the Old Port, is by far the larger and better of the two. It extends from the town westward to Marabout, nearly 6 miles, and is about a mile and a-half in width. It has three principal entrances. The first, or that nearest the city, has about 17 feet of water, but is narrow and difficult of access, and only used by small vessels and boats. The second or middle, which is also the principal entrance, is about a quarter of a mile wide, and has, where shallowest, 27 feet of water. The eastern side of this entrance is marked by buoys, and there are landmarks for guiding to the channel. The third or western entrance has its western boundary about three-

eighths of a mile from Marabout Island, is about half a mile wide, and has from 25 to 27 feet of water where shallowest. Within the harbour ships may anchor close to the town in from 22 to 40 feet of water. Further improvements, in course of construction by a firm of English contractors (at a cost to the Egyptian government of little short of two millions sterling), will eventually render this one of the finest and most capacious harbours on the Mediterranean. Among these are the formation of a breakwater, extending in a south-westerly direction parallel to the shore for 2550 yards south-west of the lighthouse on Cape Eunostos; a mole, springing from the shore, and extending in a northerly direction for 1100 yards, and having a width of about 100 feet; and the construction of nearly 3 miles of quays and wharves, for vessels of the largest size, and with railway connection. The foundation-stone of the breakwater was laid by the viceroy on 15th May 1871. The area of deep water, 30 feet and upwards, enclosed within the outer breakwater, is 1400 acres; the area of 28 feet of water, enclosed by the harbour mole, will be 177 acres. The workshops of the company are at the quarries of Mex, about 3 miles west of the town. In the harbour is a magnificent floating dock, nearly 500 feet long and 100 feet broad. The old lighthouse, on the site of the ancient Pharos, having been found insufficient, a new lighthouse has been erected on Ras-el-teen (1842), bearing a one-minute revolving light, visible at a distance of 20 miles. The eastern or new port, formerly the only port open to Christians, is now little used, being exposed to the northerly gales, and having very limited space for anchorage.

In 1861 the total value of the exports was £2,638,822; and in 1871 this had risen to £10,251,608, of which £7,706,442 was to England. The value of the imports for the latter year was £5,753,020, of which £2,469,026 was from England. The principal articles of export were cotton (£6,402,756), cotton seed (£1,008,278), beans (£753,462), corn (£573,766), sugar (£379,456), gums (£307,932), coffee (£122,110), ivory, wool, linseed, senna, and other drugs. The principal articles of import were manufactured goods (£1,695,870), wool (£307,495), oils (£251,158), wines and liqueurs (£239,944), raw silk, fruits. During that year there entered 1841 sailing vessels and 883 steam vessels with cargoes, and 143 sailing vessels and 54 steam vessels in ballast; and there left 1085 sailing vessels and 843 steam vessels with cargoes, and 797 sailing vessels and 62 steam vessels in ballast. The total tonnage of the vessels that entered was 1,262,602; and that left, 1,267,381. The opening of the Suez Canal will no doubt serve to withdraw a portion of the traffic from Alexandria, but the improvements that are now being made on its harbour, and its direct railway communication with Suez, must still give it certain advantages over the other route, while it must continue to be the great emporium for the rapidly extending trade of Egypt itself.

The population of Alexandria is of a very mixed character, consisting, besides the native Turks and Arabs, of Armenians, Greeks, Syrians, Italians, French, English, Germans, &c. At one time the ancient city is believed to have contained 600,000 inhabitants; but at the beginning of this century the number probably did not exceed 6000. In 1825 this had increased to 16,000, in 1840 to 60,000, and in 1871 to 219,602, of whom 53,829 were foreigners.

ALEXANDRIA, a town of Scotland, in the parish of Bonhill, Dumbartonshire, pleasantly situated on the west bank of the river Leven, about 3 miles from Dumbarton, with which it is connected by a branch railway. It is a place of comparatively recent growth, owing its origin almost entirely to the cotton print and bleaching works of the vicinity, for which there is an abundant supply of excellent water. Population (1871), 4650.

ALEXANDRIA, a town and port of entry of the United States, capital of Alexandria county, Virginia, is beautifully situated on the right bank of the Potomac, 7 miles below Washington. It is neat and well-built, with a good harbour, and exports considerable quantities of grain and flour; but its foreign trade has decreased. The Chesapeake and Ohio canal begins here, and the town is connected with Washington by railway. Population (1870), 13,570.

ALEXANDRIAN MS. (*Codex Alexandrinus*), the name given to a Greek manuscript of the Old and New Testaments, now in the British Museum. This celebrated MS. is known to biblical scholars as Codex A. This abbreviation of Alexandrinus was first employed by Bishop Walton to indicate the various readings of this MS., appended to the text of the Septuagint and of the New Testament in his great Polyglott Bible, and was adopted by Wetstein in conformity with an arrangement, since followed by all editons of the Septuagint and Greek Testament, by which the capital letters of the alphabet are applied to designate the uncial MSS. of the Greek Bible. The MS. was presented in the year 1628 to King Charles I. through his ambassador at the Porte, Sir Thomas Rowe, by Cyrillus Lucaris, patriarch of Constantinople. There seems no good reason to doubt that Cyrillus had brought the document from Alexandria, where he had held the office of patriarch, although Wetstein is of opinion, upon what seems inadequate evidence, that he procured it from the monastery of Mount Athos, where he had resided prior to his coming to Alexandria. It was transferred in 1753 from the king's private library to that of our national museum, where the volume containing the text of the New Testament is now, or was lately, open to public inspection under a glass case. The entire MS. consists of four small folio volumes, three of which contain the text of the Old, and one that of the New Testament. The portion, however, containing the Old Testament is more complete than that which contains the New, the *lacunæ* in the former occurring chiefly in the book of Psalms; while in the New Testament the following portions are wanting—viz., the whole of Matthew's Gospel up to chap. xxv. 6, from John vi. 50 to viii. 52, and from 2 Cor. iv. 13 to xii. 6. Occasionally, also, single letters, as well as the titles of certain divisions, have been destroyed by the operations of the bookbinder. The material of which the MS. is composed is very thin vellum, the page being about 13 inches high by 10 broad, containing from 50 to 52 lines in each page, each line consisting of about 20 letters. The number of pages is 773, of which 640 are occupied with the text of the Old Testament, and 133 with that of the New. The characters are *uncial*, but larger than in the Vatican MS. B. There are no accents or breathings, no spaces between the letters or words save at the end of a paragraph; and the contractions, which are not numerous, are only such as are found in the oldest MSS., and are indicated by a line drawn over the word which is abbreviated, as $\overline{\Theta\Sigma}$ for Θεός. The punctuation consists of a point placed at the end of a sentence, usually on a level with the top of the preceding letter. As regards the date of the MS. very opposite opinions have been held. One critic placed it as low down as the 10th century, but this supposition has been justly characterised by Tregelles as so opposed to all that is known of palæography as not to deserve a serious refutation. From the circumstance that the MS. does not exhibit any traces of *stichometry*—a mode of arranging the text in lines consisting of a larger or smaller number of words, at the end of which the reader was to pause, which was applied to the Pauline epistles by Euthalius of Alexandria in the year 458, and which soon came into general use—it has been inferred that the MS. is not of later date than the middle of the 5th century. Again, the presence, in the text of the Gospels of the Ammonian sections and Eusebian canons, and of the epistle of Athanasius (who died in 373) to Marcellinus, which is prefixed to the Psalms, shows that it could not be older

than the end of the 4th century. In addition to this external testimony, palæographic reasons, such as the general style of the writing, and the formation of certain letters, would seem to refer the MS. to about the middle of the 5th century, and this date is now generally acquiesced in by scholars. There is an Arabic inscription, indeed, written on the page which contains the list of the various books of the Old and New Testament, which states that the MS. was written by the hand of the martyr Thecla, while a Latin inscription by Cyril himself gives the tradition that the Thecla who wrote the MS. was a noble Egyptian lady who lived shortly after the Council of Nice. No reliance, however, can be placed on these statements, for, according to Scrivener,

> "Tregelles explains the origin of the Arabic inscription on which Cyril's statement appears to rest, by remarking that the New Testament in our MS. at present commences with Matt. xxv. 6, this lesson (Matt. xxv. 1–13) *being that appointed by the Greek Church for the festival of St Thecla.* The Egyptian, therefore, who wrote this Arabic note, observing the name of Thecla in the now mutilated upper margin of the codex, where such rubrical notes are commonly placed by later hands, hastily concluded that she wrote the book, and thus has perplexed our biblical critics. It is hardly too much to say that Tregelles's shrewd conjecture seems to be certain, almost to demonstration."

This MS. contains the last twelve verses of St Mark's Gospel. It is defective in that part of St John's Gospel where the *pericope adulteræ* occurs in the ordinary text, but Scrivener shows by an enumeration of the letters in each page that the two missing leaves did not contain the suspected passage. It is almost unnecessary to say that 1 John v. 7 is not found in this or in any uncial MS. of the New Testament. The reading of the MS. in 1 Tim. iii. 16 has given rise to a good deal of discussion. Woide in his fac-simile edition gave the reading $\overline{\Theta\Sigma}$ for ΘΕΟΣ. The element of uncertainty was whether the cross bar of the theta had not been added by a later hand, so that the original reading may have been ΟΣ. Bishop Ellicott carefully examined the passage with the aid of a strong lens, and the result of his investigation, as given in a note appended to his Critical Commentary on First Timothy, in his edition of the *Pastoral Epistles,* was to satisfy him that the original reading was ὅς, the cross bar of the theta having arisen from the central line of ε in the word εὐσεβεία, which is directly opposite, shining through the leaf, and being mistaken by a scribe for part of the theta, and being touched up accordingly,—a view which was maintained by Wetstein. On the other hand, both Tregelles and Scrivener, who made the same investigation, are of opinion that the stroke of the epsilon cuts the theta much too high to be mistaken by any ordinary scribe for the cross bar of the theta. When critics of such distinguished reputation differ, the question of the original reading will probably remain for ever uncertain.

The first use that was made of the MS. for critical purposes was by Bishop Walton, who had the various readings which it presents inserted in his great Polyglott Bible, under the texts of the Septuagint and New Testament respectively. It was collated by both Mill and Wetstein for their editions of the Greek Testament. In 1786 the New Testament was published in a fac-simile edition by Dr Woide, at that time librarian to the British Museum; the types of this edition were cut so as to represent the general appearance of the letters; and the edition exhibits the MS. page for page, line for line, and letter for letter. The work was accompanied by valuable prolegomena on the history, age, &c., of the MS.; and is allowed to have been executed with remarkable accuracy. In 1828 the Rev. H. H. Baber completed the publication of the Old Testament portion in three large folio volumes (1816–1828) also in fac-simile with useful prolegomena and notes. Tischendorf considers the editorial accuracy of Baber as inferior to that of Woide, and enumerates a number of instances where the readings of the original have been incorrectly given by Baber (Prolegomena to Tischendorf's 4th ed. of the Septuagint, p. 69, *sq.*) In 1860 the text of the New Testament was published in common type by B. H. Cowper, the defective portions being supplied from Küster's edition of Mill's Greek Testament, and some inaccuracies in Woide's edition corrected from the original. In 1864 there was published at Oxford, under the editorship of Mr Hansell, the text of the *Codex Alexandrinus,* along with that of three of the most ancient MSS., viz., *Codd.* B, C, D, with the Dublin *Cod.* Z, and a collation of the *Cod. Sinaiticus.* The work is arranged in parallel columns, and thus presents, at one view, the readings of four of our earliest authorities for the text of the New Testament. (F. C.)

For more minute information regarding this MS. we refer to the prolegomena of Woide and Baber; to Scrivener's *Introduction to the Criticism of the New Testament,* Cambridge, 1861; to the fourth volume of Horne's *Introduction to the New Testament,* by Tregelles, London, 1856; and to Davidson's *Biblical Criticism,* vol. ii., Edinburgh, 1852. We subjoin a list of the books of the Old and New Testament in the order in which they are found in the MS.:—

Tom. I.

Γενεσις Κοσμου	Genesis.
Εξοδος Αιγυπτου	Exodus.
Λευιτικον	Leviticus.
Αριθμοι	Numbers.
Δευτερονομιον	Deuteronomy.
Ιησους Ναυη	Joshua, son of Nun.
Κριται	Judges.
Ρουθ	Ruth.
Βασιλειων α'	Samuel I. (or Kings I.)
Βασιλειων β'	Samuel II. (or Kings II.)
Βασιλειων γ'	Kings I. (or III.)
Βασιλειων δ'	Kings II. (or IV.)
Παραλειπομενων α'	Chronicles I.
Παραλειπομενων β'	Chronicles II.

Tom. II.

Ωσηε	Hosea.
Αμως	Amos.
Μιχαιας	Micah.
Ιωηλ	Joel.
Αβδειου	Obadiah.
Ιωνας	Jonah.
Ναουμ	Nahum.
Αμβακουμ	Habakkuk.
Σοφονιας	Zephaniah.
Αγγαιος	Haggai.
Ζαχαριας	Zechariah.
Μαλαχιας	Malachi.
Ησαιας	Isaiah.
Ιερεμιας	Jeremiah.
Βαρουχ	Baruch.
Θρηνοι	Lamentations.
Επιστολη Ιερεμιου	Epistle of Jeremiah.
Ιεζεκιηλ	Ezekiel.
Δανιηλ	Daniel.
Εσθηρ	Esther.
Τωβιτ	Tobit.
Ιουδειθ	Judith.
Εσδρας α'	Esdras I.
Εσδρας β'	Esdras II., including *Νεεμια*, and part of the canonical Book of Ezra.
Μακκαβαιων α'	Maccabees I.
Μακκαβαιων β'	Maccabees II.
Μακκαβαιων γ'	Maccabees III.
Μακκαβαιων δ'	Maccabees IV.

Tom. III.

Αθανασιου Επιστολη	Epistle of Athanasius to Marcellinus on the Psalms.
Ευσεβιου Υποθεσεις (*sic*)	Hypothesis of Eusebius on the Psalms.
Ψαλτηριον μετ' Ωδων	Psalms 151, Hymns 15.
Ιωβ	Job.
Παροιμιαι	Proverbs.
Εκκλησιαστης	Ecclesiastes.
Ασμα Ασματων	Canticles.
Σοφια Σολομωντος	Wisdom of Solomon.
Σοφια Ιησου υιου Σιραχ	Ecclesiasticus, or Wisdom of Jesus, son of Sirach.

Tom. IV.

Ευαγγελιον κατα Ματθαιον	Matthew.
Ευαγγελιον κατα Μαρκον	Mark.
Ευαγγελιον κατα Λουκαν	Luke.
Ευαγγελιον κατα Ιωαννην	John.
Πραξεις Αποστολων	Acts of the Apostles.
Επιστολαι Καθολικαι ζ'	Seven Catholic Epistles, viz., 1 of James, 2 of Peter, 3 of John, and 1 of Jude.
Επιστολαι Παυλου ιδ'	Fourteen Epistles of Paul.
Αποκαλυψις Ιωαννου	Revelation of John.
Κλημεντος Επιστολη α'	1st Epistle of Clement to the Corinthians.
Κλημεντος Επιστολη β'	2d Epistle of Clement to the Corinthians.
Ψαλμοι Σολομωντος η'	Eight Psalms of Solomon.

ALEXANDRIAN SCHOOL. Under this title are generally included certain strongly-marked tendencies in literature and science which took their rise in the city of Alexandria. That city, founded by Alexander the Great about the time when Greece, in losing her national independence, lost also her intellectual supremacy, was in every way admirably adapted for becoming the new centre of the world's activity and thought. Its situation brought it into commercial relations with all the nations lying around the Mediterranean, and at the same time rendered it the one communicating link with the wealth and civilisation of the East. The great natural advantages it thus enjoyed were artificially increased to an enormous extent by the care of the sovereigns of Egypt. Ptolemy Soter (reigned 306–285 B.C.), to whom, in the general distribution of Alexander's conquests, this kingdom had fallen, began to draw around him from various parts of Greece a circle of men eminent in literature and philosophy. To these he gave every facility for the prosecution of their learned researches. Under the inspiration of his friend Demetrius Phalereus, the Athenian orator, this Ptolemy laid the foundations of the great library, and originated the keen search for all written works, which resulted in the formation of a collection such as the world has seldom seen. He also built, for the convenience of his men of letters, the Museum, in which, maintained by the royal bounty, they resided, studied, and taught. This Museum or academy of science was in many respects not unlike a modern university. The work thus begun by Ptolemy Soter was carried on vigorously by his descendants, in particular by his two immediate successors, Ptolemy Philadelphus and Ptolemy Euergetes. Philadelphus (285–247 B.C.), whose librarian was the celebrated Callimachus, bought up all Aristotle's collection of books, and also introduced a number of Jewish and Egyptian works. Among these appears to have been a portion of the Septuagint. Euergetes (247–222 B.C.) largely increased the library by seizing on the original editions of the dramatists laid up in the Athenian archives, and by compelling all travellers who arrived in Alexandria to leave a copy of any work they possessed.

The intellectual movement so originated extended over a long period of years. If we date its rise from the 4th century B.C., at the time of the fall of Greece and the foundation of the Græco-Macedonian empire, we must look for its final dissolution in the 7th century of the Christian era, at the time of the fall of Alexandria and the rise of the Mahometan power. But this very long period falls into two divisions. The first, extending from about 306 B.C. to about 30 B.C., includes the time from the foundation of the Ptolemaic dynasty to its final subjugation by the Romans; the second extends from 30 B.C. to 640 A.D. The characteristic features of these divisions are very clearly marked, and their difference affords an explanation of the variety and vagueness of meaning attaching to the term Alexandrian School. In the first of the two periods the intellectual activity was of a purely literary and scientific nature. It was an attempt to continue and develop, under new conditions, the old Hellenic culture. This direction of effort was particularly noticeable under the early Ptolemies, Alexandria being then almost the only home in the world for pure literature. During the last century and a half before the Christian era, the school, as it might be called, began to break up and to lose its individuality. This was due partly to the state of government under some of the later Ptolemies, partly to the formation of new literary circles in Rhodes, Syria, &c., whose supporters, though retaining the Alexandrian peculiarities, could scarcely be included in the Alexandrian school. The loss of active life, consequent on this gradual dissolution, was much increased when Alexandria fell under Roman sway. Then the influence of the school was extended over the whole known world, but men of letters began to concentrate at Rome rather than at Alexandria. In that city, however, there were new forces in operation which produced a second grand outburst of intellectual life. The new movement was not in the old direction—had, indeed, nothing in common with it. With its character largely determined by Jewish elements, and even more by contact with the dogmas of Christianity, this second Alexandrian school resulted in the speculative philosophy of the Neo-Platonists and the religious philosophy of the Gnostics and early church fathers.

There appear, therefore, to be at least two definite significations of the title Alexandrian School; or rather, there are two Alexandrian schools, distinct both chronologically and in substance. The one is the Alexandrian school of poetry and science, the other the Alexandrian school of philosophy. As regards the use of the word "school" to denote these movements, it must be observed that the term is misleading. It has not the same meaning as when applied to the Academics or Peripatetics, the Stoics or Epicureans. These consisted of a company united by holding in common certain speculative principles, by having the same theory of things. There was nothing at all corresponding to this among the Alexandrians. In literature their activities were directed to the most diverse objects, they have only in common a certain spirit or form. There was among them no definite system of philosophy. Even in the later schools of philosophy proper there is found a community rather of tendency than of definite result or of fixed principles.

Alexandrian School of Literature.—The general character of the literature of the school appears as the necessary consequence of the state of affairs brought about by the fall of Greek nationality and independence. The great works of the Greek mind had formerly been the products of a fresh life of nature and perfect freedom of thought. All their hymns, epics, and histories were bound up with their individuality as a free people. But the Macedonian conquest at Chæronea brought about a complete dissolution of this Greek life in all its relations, private and political. The full, genial spirit of Greek thought vanished when freedom was lost, with which it was inseparably united. A substitute for this originality was found at Alexandria in learned research, extended and multifarious knowledge. Amply provided with means for acquiring information, and under the watchful care of a great monarch, the Alexandrians readily took this new direction in literature. With all the great objects removed which could excite a true spirit of poetry, they devoted themselves to minute researches in all sciences subordinate to literature proper. They studied criticism, grammar, prosody and metre, antiquities and mythology. The results of this study constantly appear in their productions. Their works are never national, never addressed to a people, but to a circle of learned men. Moreover, the very fact of being under the protection, and, as it were, in the pay of an absolute monarch, was damaging to the character of their literature. There was introduced into it a courtly element, clear traces of which, with all its accompaniments, are found in the extant works of the school. One other fact, not to be forgotten in forming a general estimate of the literary value of their productions, is, that the same writer was frequently or almost always distinguished in several special sciences. The most renowned poets were at the same time men of culture and science, critics, archæologists, astronomers, or physicians. To such writers the poetical form was merely a convenient vehicle for the exposition of science.

The forms of poetical composition chiefly cultivated by the Alexandrians were epic and lyric or elegiac. Great

epics are wanting; but in their place, as might almost have been expected, are found the historical and the didactic or expository epics. The subjects of the historical epics were generally some of the well-known myths, in the exposition of which the writer could exhibit the full extent of his learning and his perfect command of verse. These poems are in a sense valuable as repertories of antiquities; but their style is on the whole bad, and infinite patience is required to clear up their numerous and obscure allusions. The best extant specimen is the *Argonautica* of Apollonius Rhodius; the most characteristic is the *Alexandra* or *Cassandra* of Lycophron, the obscurity of which is almost proverbial.

The subjects of didactic epics were very numerous; they seem to have depended on the special knowledge possessed by the writers, who used verse as a form for unfolding their information. Some, *e.g.*, the lost poem of Callimachus, called Αἴτια, were on the origin of myths and religious observances; others were on special sciences. Thus we have two poems of Aratus, who, though not resident at Alexandria, was so thoroughly imbued with the Alexandrian spirit as to be with reason included in the school; the one is an essay on astronomy, the other an account of the signs of the weather. Nicander of Colophon has also left us two epics, one on remedies for poisons, the other on the bites of venomous beasts. Of many other epic poets only the names are known, as Dicæarchus, Euphorion, Rhianus, Dionysius, Oppianus. The spirit of all their productions is the same, that of learned research. They are distinguished by artistic form, purity of expression, and strict attention to the laws of metre and prosody, qualities which, however good in themselves, do not compensate for want of originality, freshness, and power.

In their lyric and elegiac poetry there is much worthy of admiration. The specimens we possess are not devoid of talent or of a certain happy art of expression. Yet, for the most part they either relate to objects thoroughly incapable of poetic treatment, where the writer's endeavour is rather to expound the matter fully than to render it poetically beautiful, or else expend themselves on short isolated subjects, generally myths, and are erotic in character. The earliest of the elegiac poets was Philetas, the sweet singer of Cos. But the most distinguished was Callimachus, undoubtedly the greatest of the Alexandrian poets. Of his numerous works there remain to us only a few hymns, epigrams, and fragments of elegies. Other lyric poets were Phanocles, Hermesianax, Alexander of Ætolia, and Lycophron.

Some of the best productions of the school were their epigrams. Of these we have several specimens, and the art of composing them seems to have been assiduously cultivated, as might naturally be expected from the court life of the poets, and their constant endeavours after terseness and neatness of expression. Of kindred character were the parodies and satirical poems, of which the best examples were the Σίλλοι of Timon.

Dramatic poetry appears to have flourished to some extent. There are still extant three or four varying lists of the seven great dramatists who composed the Pleiad of Alexandria. Their works, perhaps not unfortunately, have perished. A ruder kind of drama, the amœbæan verse, or bucolic mime, developed into the only pure stream of genial poetry found in the Alexandrian School, the *Idylls* of Theocritus. The name of these poems preserves their original idea; they were *pictures* of fresh country life.

The most interesting fact connected with this Alexandrian poetry is the powerful influence it exercised on Roman literature. That literature, especially in the Augustan age, is not to be thoroughly understood without due appreciation of the character of the Alexandrian School.

Before the Alexandrians had begun to produce original works, their researches were directed towards the masterpieces of ancient Greek literature. If that literature was to be a power in the world, it must be handed down to posterity in a form capable of being understood. This was the task begun and carried out by the Alexandrian critics. These men did not merely collect works, but sought to arrange them, to subject the texts to criticism, and to explain any allusion or reference in them which at a later date might become obscure. The complete philological examination of any work consisted, according to them, of the following processes:—*διόρθωσις*, arrangement of the text; *ἀνάγνωσις*, settlement of accents; *τέχνη*, theory of forms, syntax; *ἐξήγησις*, explanation either of words or things; and finally, *κρίσις*, judgment on the author and his work, including all questions as to authenticity and integrity. To perform their task adequately required from the critics a wide circle of knowledge; and from this requirement sprang the sciences of grammar, prosody, lexicography, mythology, and archæology. The service rendered by these critics is invaluable. To them we owe not merely the possession of the greatest works of Greek intellect, but the possession of them in a readable state. The most celebrated critics were Zenodotus; Aristophanes of Byzantium, to whom we owe the theory of Greek accents; and Aristarchus of Samothrace, confessedly the Coryphæus of criticism. Others were Alexander of Ætolia, Lycophron, Callimachus, Eratosthenes, and many of a later age, for the critical school long survived the literary. These philological labours were of great indirect importance, for they led immediately to the study of the natural sciences, and in particular to a more accurate knowledge of geography and history. Considerable attention began to be paid to the ancient history of Greece, and to all the myths relating to the foundation of states and cities. A large collection of such curious information is contained in the *Bibliotheca* of Apollodorus, a pupil of Aristarchus, who flourished in the 2d century B.C. Eratosthenes was the first to write on mathematical and physical geography; he also first attempted to draw up a chronological table of the Egyptian kings, and of the historical events of Greece. His Egyptian chronology, along with that of Manetho, is still of great interest to scholars; and Bunsen speaks with the highest admiration of his researches in Greek history. The sciences of mathematics, astronomy, and medicine were also cultivated with assiduity and success at Alexandria, but they can scarcely be said to have their origin there, or in any strict sense to form a part of the peculiarly Alexandrian literature. The founder of the mathematical school was the celebrated Euclid: among its scholars were Archimedes; Apollonius of Perga, author of a treatise on *Conic Sections*; Eratosthenes, to whom we owe the first measurement of the earth; and Hipparchus, the founder of the epicyclical theory of the heavens, afterwards called the Ptolemaic system, from its most famous expositor, Claudius Ptolemæus. Alexandria continued long after the Christian era to be celebrated as a school of mathematics and science.

Alexandrian School of Philosophy.—Although it is not possible to divide literatures with absolute rigidity by centuries, and although the intellectual life of Alexandria, particularly as applied to science, long survived the Roman conquest, yet at that period the school, which for some time had been gradually breaking up, seems finally to have succumbed. The later productions in the field of pure literature bear the stamp of Rome rather than of Alexandria. But in that city, for some time past, there had been various forces secretly working, and these coming in contact with great spiritual changes occurring in the world around, produced a second outburst of intellectual activity.

Among the natives of foreign countries transplanted to Alexandria by its founder had been a few Jews. These gradually increased in number, until, about the time of the Christian era, they formed an influential part of the populace of Egypt, inhabited two of the five quarters of the capital, and held high offices in the state. They had been well treated by the Ptolemies, and for some time experienced similar treatment from the Romans. The new movement of thought was in great measure due to the presence of this Jewish element. The contact of free Greek speculation with the peculiar Jewish ideas of the transcendence of God, of a special revelation, and of a singular subjective ecstasy, the prophetic state, could not fail to have a strong effect on the mode of thought of the most highly cultured Jews. From many causes they were more than ordinarily open to receive foreign ideas. Their isolated position had been broken in upon by their long residence as a small minority in the midst of an atmosphere of Greek custom and thought, and in the most highly cultivated city in the world. Their separation from their native country had tended to broaden their views by weakening the strong political convictions which united their destiny and their sacred writings with a definite land. It was a necessary consequence that they should endeavour so far as possible to assimilate their principles to Greek ideas. The two systems were not, they found, in total contradiction; they had several points in common. This was specially the case with the Platonic writings. There thus arose among the Jews a constantly increasing tendency to modify or widen their doctrines so as to admit of Greek conceptions, and then, with the aid of these conceptions, to systematise their own somewhat vague religious views. In this way philosophy and religion would be united or identified. There is truth in all philosophy, for philosophy is but a mangled reproduction of the sacred record in which all truth is contained. The Scriptures contain all philosophy, but not explicitly; they require to be interpreted. The system thus developed has a philosophical aspect, yet never ceases to be essentially Jewish, for the ultimate resort is always to a body of doctrine expressly revealed. Progress in this direction was possible in two ways. First, the pure Greek metaphysical thought rejected a body of truth said to have been revealed to a special people, but retained the idea of revelation to the individual thinker. A doctrine was thus evolved which contained most of the oriental or Jewish theosophical ideas, but in logical sequence and based for the most part on the earlier works of Greek thinkers. Religion was retained, but was explained or had a meaning given by philosophy. To this powerful movement of thought the name Neo-Platonism is given; its chief representatives were Ammonius Saccas, Plotinus, Porphyry, Jamblichus, and Proclus. Second, the introduction of the peculiar Christian dogmas could not fail to produce a lively effect on the Alexandrian thinkers. These dogmas had to be reconciled with philosophy, or the one must yield to and be absorbed by the other. The attempt to solve the problem of their mutual relation gave rise to Gnosticism in all its phases, and was the cause of the speculative element in the works of such fathers as Clement of Alexandria and Origen.

To the whole of this great movement the title Alexandrian philosophy must be given, although that term is sometimes identified with Neo-Platonism. Of the exact historical origin of it we have no certain notice. Some thinkers are of opinion that even in the Septuagint traces of rationalism can be discovered. (See Frankel, *Historisch-kritische Studien zur Septuaginta*, 1841.) In Aristobulus (160 B.C.) is found a thoroughgoing attempt to show that early Greek speculations were in harmony with the divine record, because they had been borrowed from it. Traces of allegorical interpretation are also found in him, but no conception of a theosophical system. In the peculiar tenets of the *Therapeutæ*, so far as these can be known, may perhaps be traced another stream of influence, the Neo-Pythagorean. The complete representative of the Jewish religious philosophy was Philo, surnamed Judæus, who lived at Alexandria during the Christian era. In him are found a complete and elaborate theosophy fusing together religious and metaphysical ideas, a firm conviction that all truth is to be found in the sacred writings, and a constant application to these writings of the principle of allegorical interpretation. His system is a syncretism of Oriental mysticism and Greek metaphysics, and the effort at such a combination from the Jewish side could go no further. After Philo Judæus there remained as possible courses either Neo-Platonism or Gnosticism.

Of Alexandrian literature there are notices in histories of Greek literature, as Müller and Donaldson, or Bernhardy; of Alexandrian philosophy, in general histories of philosophy and of early Christianity. Special works, which, however, devote most attention to the Neo-Platonists, are—

Matter, *Histoire de l'Ecole d'Alexandrie*, 2d ed. 3 vols. 1840–44; Simon, *Histoire de l'Ecole d'Alexandrie*, 2 vols. 1844–45; Vacherot, *Histoire critique de l'Ecole d'Alexandrie*, 3 vols. 1846–51; Kingsley, *Alexandria and her Schools*, 1854; Gfrörer, *Philo und die Alexandrinische Theosophie*, 1835; Daehne, *Geschicht - Darstellung der Jüdisch-Alexandrinischen Religionsphilosophie*, 2 vols. 1834.

ALEXANDRINE VERSE, a name given to the leading measure in French poetry. It is the heroic French verse, used in epic narrative, in tragedy, and in the higher comedy. There is some doubt as to the origin of the name; but most probably it is derived from a collection of romances, published early in the 13th century, of which Alexander of Macedon was the hero, and in which he was represented, somewhat like our own Arthur, as the pride and crown of chivalry. Before the publication of this work most of the trouvère romances appeared in octo-syllabic verse. The new work, which was henceforth to set the fashion to French literature, was written in lines of twelve syllables, but with a freedom of pause which was afterwards greatly curtailed. The new fashion, however, was not adopted all at once. The metre fell into disuse until the reign of Francis I., when it was revived by Jean Antoine de Bœuf, one of the seven poets known as the Pleiades. It was not he, however, but Ronsard, who made the verse popular, and gave it vogue in France. From his time it became the recognised vehicle for all great poetry, and the regulation of its pauses became more and more strict. The following is an example of the verse as used by Racine—

"Où suis-je? qu'ai-je fait? ‖ que dois-je faire encore?
Quel transport me saisit? ‖ quel chagrin me dévore?"

Two inexorable laws came to be established with regard to the pauses. The first is, that each line should be divided into two equal parts, the sixth syllable always ending with a word. In the earlier use of this metre, on the contrary, it frequently happened that the sixth and seventh syllables belonged to the same word. The other is, that, except under the most stringent conditions, there should be none of what the French critics call *enjambement*, that is, the overlapping of the sense from one line on to the next. Ronsard completely ignored this rule, which was after his time settled by the authority of Malherbe. Such verses as the following by Ronsard would be intolerable in modern French poetry—

"Cette nymphe royale est digne qu'on lui dresse
Des autels. . . .
Les Parques se disoient: Charles, qui doit venir
Au monde. . . .

Je veux, s'il est possible, atteindre la louange
De celle. . . .

Michael Drayton, who was twenty-two years of age when Ronsard died, seemed to think that the Alexandrine might be as pleasing to English as it was to French ears, and in this metre he wrote a long poem in twenty-four books called the *Polyolbion.* The metre, however, failed to catch the English ear. Our principal measure is a line of ten syllables, and we use the Alexandrine only occasionally to give it variety and weight. In our ordinary heroic verse it is but rarely introduced; but in the favourite narrative metre, known as the Spenserian, it comes in regularly as the concluding line of each stanza. In English usage, moreover, it is to be observed that there is no fixed rule as to the position of the pause, though it is true that most commonly the pause occurs at the end of the sixth syllable. Spenser is very free in shifting the pause about; and though the later poets who have used this stanza are not so free, yet, with the exception of Shenstone and of Byron, they do not scruple to obliterate all pause between the sixth and seventh syllables. Thus Thomson (*Castle of Indolence*, i. 42):—

"And music lent new gladness to the morning air."

The danger in the use of the Alexandrine is that, in attempting to give dignity to his line, the poet may only produce heaviness, incurring the sneer of Pope—

"A needless Alexandrine ends the song,
That, like a wounded snake, drags its slow length along."

(E. S. D.)

ALEXIS, an ancient comic poet, born about 394 B.C. at Thurii in Magna Græcia, the uncle and instructor of Menander. Plutarch says that he lived to the age of 106 years, and according to Suidas he wrote 245 plays, of which the titles of 113 are known. The fragments that have been preserved by Athenæus and Stobæus attest the wit and elegance of the author. The plays were frequently translated by the Latin comic writers. (See Meineke, *Fragm. Com. Græc.* vol. i.)

ALEXIUS I., the nephew of Isaac Comnenus, and the most distinguished member of the Comnenus family, was born in 1048, and died in 1118. In early life he signalised himself in the wars against the enemies of his country; but the mean jealousies of the ministers of the emperor Nicephorus (surnamed Botaniates) drove him to take up arms against a sovereign whose cause he had thrice gallantly defended against powerful insurgent leaders; and he ascended the throne of Constantinople in 1081. His character has been too partially drawn by his favourite daughter, Anna Comnena, who has, however, justly remarked that the disorders of the times were both the misfortune and glory of Alexius, and that he paid the penalty for the vices of his predecessors. In his reign the Turks extended their conquests from Persia to the Hellespont; on the north the empire was assailed by hordes of barbarians from the Danube, and on the west by the Normans; while Europe pressed on Asia by way of Constantinople, in the excitement of the first crusade. Amid these disturbances Alexius managed the affairs of the state with a dexterous and courageous hand, though his policy was ascribed by the Latins to cowardice or treachery. He was politic enough to derive solid advantages from the romantic valour of the crusaders. Alexius outlived the love of his subjects, and their patience was all but exhausted in the latter part of his long reign. The nobility were irritated by the extravagance of his relations; the people by his severity and exactions; and the clergy murmured at his appropriation of the church funds to the defence of the state.

ALFANI, Domenico, an Italian painter, born at Perugia towards the close of the fifteenth century. The precise date is uncertain, but he was a contemporary of Raphael, with whom he studied in the school of Perugino. The two artists lived on terms of intimate friendship, and the influence of the more distinguished of the two is so clearly traceable in the works of the other, that these have frequently been attributed to Raphael. Towards the close of his life Alfani gradually changed his style, and approximated to that of the later Florentine school. The date of his death, according to some, was 1540, while others say he was alive in 1553. Pictures by Alfani may be seen in collections at Florence, and in several churches in Perugia.

AL-FARABI, Abu Nasr Muhammad Ibn Tarkhan, one of the earliest Arabian philosophers, flourished during the former half of the 10th century. Philosophy, among the Arabs, was originally an extension of the related sciences of astronomy and medicine, and the first philosophers were physicians. The more eminent of them were court physicians, and to this they doubtless owed their protection against the jealous suspicions of the Mahometan sects. Al-Farabi is supposed (for the detailed accounts of his life are legendary) to have concerned himself more with the theory than the practice of medicine; but he is known to have been a physician at the court of Seif-Eddaula, and died when it was at Damascus in 950. Unlike some of his successors, notably Avicenna, he was an ascetic, and his philosophy, which has a slight Platonic infusion, bears traces of the contrast. He was unsystematic, and the sketches and aphorisms of his which have come down to us (many of his treatises are still in MS.) only partially enable us to reconstruct his philosophy. In his opusculum *De Scientiis* he enumerates six orders of sciences:—(1.) Language, by which he means little more than grammar. (2.) Logic, which he names as an art, conceives generally as a science, and confounds in its details with the corresponding art, with rhetoric, and with criticism. (3.) The mathematical sciences, embracing geometry, arithmetic, optics, the science of the stars, music, and the sciences of weights and of capacities (*ingenia*). Arithmetic is abstract and concrete; geometry is active, passive, and speculative; and the science of the stars includes astronomy, astrology, the science of climates, and of dreams and auguries. (4.) The natural sciences, ten in number. (5.) Civil science, including judicial science and rhetoric. (6.) Divine science, or metaphysics. This hierarchy has striking approximations to the most modern classifications. Logic and mathematics, the most abstract sciences, are near the beginning, if not quite first; what stands for social science follows the physical concrete sciences; and the distinction between abstract and concrete, which Comte made one of the bases of his classification, and which has been more accurately discriminated by Spencer, is on the whole clearly seized. But art is throughout confounded with science; superstitions are mixed up with facts; physical and mental phenomena are not always separated; the subjective and the objective (learning and science) are confused, as they afterwards were by Bacon; and there is no science of man—man was not yet conceived, metaphysically, as an individual. This agrees with Al-Farabi's science of politics as expounded in another work, in which he follows his master, Aristotle, in denying the permanence of the individual soul, and anticipates the Averrhoistic doctrine of the unity of souls. For his metaphysics is Peripatetic, as Peripateticism was interpreted by the Neo-Platonist commentators on Aristotle. Starting with the distinction between the possible and the necessary, he assumes that there must be some supreme necessary existence which accounts for all actual existence. This supreme existence has infinite life, wisdom, power, beauty, goodness, &c., but it is an absolute unity, and is without distinguishable attributes. How does the world, with its infinite

multiplicity and diversity, issue from this absolutely one and identical being? Here Al-Farabi neo-platonises. It proceeds by emanation. The absolute Being knows itself, and in virtue of this knowledge the first intelligence exists. He does not explain how self-consciousness comes to be inseparable from necessary existence, but his dynamic, at this and all the lower stages, is self-knowledge; and indeed the act of knowing and the resultant existence appear at this height of abstraction to be all but identical. The first intelligence, intrinsically a unity, contains multiplicity, because it is no longer devoid of attributes. In so far as it necessarily exists, it evolves the second intelligence; in so far as it is merely potential being, and knows itself, it evolves the world-soul and the uppermost world-circle, which is moved by that soul. Similarly descending intelligences, ever-wider world-circles and the corresponding souls, are evolved by the same process of emanation, down to the active reason, which is most nearly related to the earthly elements and human souls. The active reason, by its contact with matter, impresses on it forms, of which the human soul is one, with greater or less permanence according to the degree in which it is immersed in, or rises above, matter. The forms decline in permanence the further we descend below the active reason, and the matter which has least form is the limit of emanation. There is here nothing like what is now called evolution: the conception of the universe is, as in all theories of emanation, really statical, not dynamical, for the ideas of cause and perpetual causation do not yet exist; and of course the process is the reverse of that implied in the modern development theory. (For information on Al-Farabi, see Munk, *Melanges*, pp. 341–52; and Steinschneider, *Memoires de l'Académie de St Petersbourg*, vii. série, tom. xiii. Two of his opuscula have been translated by Schmölders, *Documenta Philosophiæ Arabum*, and two are contained in *Alpharabii Opera Omnia*, Parisiis, 1638.)

ALFIERI, Vittorio, chiefly celebrated as the author who raised the Italian tragic drama from its previous state of degradation, was born on the 17th January 1749, at the town of Asti, in Piedmont. He lost his father in early infancy; but he continued to reside with his mother, who married a second time, till his tenth year, when he was placed at the academy of Turin. After he had passed a twelvemonth at the academy, he went on a short visit to a relation who dwelt at Coni; and during his stay there he made his first poetical attempt, in a sonnet chiefly borrowed from lines in Ariosto and Metastasio, the only poets he had at that time read. When thirteen years of age he was induced to commence the study of civil and canonical law; but the attempt only served to disgust him with every species of application, and to increase his relish for the perusal of French romances. By the death of his uncle, who had hitherto taken some charge of his education and conduct, he was left, at the age of fourteen, to enjoy without control his vast paternal inheritance, augmented by the recent accession of his uncle's fortune. He now began to attend the riding-school, where he acquired that rage for horses and equestrian exercise which continued to be one of his strongest passions till the close of his existence.

After some time spent in alternate fits of extravagant dissipation and ill-directed study, he was seized with a desire of travelling; and having obtained permission from the king, he departed in 1766, under the care of an English preceptor. Restless and unquiet, he posted with the utmost rapidity through the towns of Italy; and his improvement was such as was to be expected from his mode of travelling and his previous habits. Hoping to find in foreign countries some relief from the tedium and *ennui* with which he was oppressed, and being anxious to become acquainted with the French theatre, he proceeded to Paris. But he appears to have been completely dissatisfied with everything he witnessed in France, and contracted a dislike to its people, which his intercourse in future years rather contributed to augment than diminish. In Holland he became deeply enamoured of a married lady, who returned his attachment, but who was soon obliged to accompany her husband to Switzerland. Alfieri, whose feelings were of the most impetuous description, was in despair at this separation, and returned to his own country in the utmost anguish and despondency of mind. While under this depression of spirits he was induced to seek alleviation from works of literature; and the perusal of Plutarch's *Lives*, which he read with profound emotion, inspired him with an enthusiastic passion for freedom and independence. Under the influence of this rage for liberty he recommenced his travels; and his only gratification, in the absence of freedom among the Continental states, appears to have been derived from contemplating the wild and sterile regions of the north of Sweden, where gloomy forests, lakes, and precipices conspired to excite those sublime and melancholy ideas which were congenial to his disposition. Everywhere his soul felt as if confined by the bonds of society; he panted for something more free in government, more elevated in sentiment, more devoted in love, and more perfect in friendship. In search of this ideal world he posted through various countries, more with the rapidity of a courier than of one who travels for amusement or instruction. During a journey to London, he engaged in an intrigue with a married lady of high rank; and having been detected, the publicity of a rencounter with the injured husband, and of a divorce which followed, rendered it expedient and desirable for him to quit England. He then visited Spain and Portugal, where he became acquainted with the Abbé Caluso, who remained through life the most attached and estimable friend he ever possessed. In 1772 Alfieri returned to Turin, where he again became enamoured of a lady, whom he loved with his usual ardour, and who seems to have been as undeserving of a sincere attachment as those he had hitherto adored. In the course of a long attendance on his mistress, during a malady with which she was afflicted, he one day wrote a dialogue or scene of a drama, which he left at her house. On a difference taking place between them, the piece was returned to him, and being retouched and extended to five acts, it was performed at Turin in 1775, under the title of *Cleopatra*.

From this moment Alfieri was seized with an insatiable thirst for theatrical fame, and the remainder of his life was devoted to its attainment. His first two tragedies, *Filippo* and *Polinice*, were originally written in French prose; and when he came to versify them in Italian, he found that, from his Lombard origin, and long intercourse with foreigners, he expressed himself with feebleness and inaccuracy. Accordingly, with the view of improving his Italian style, he went to Tuscany, and, during an alternate residence at Florence and Siena, he completed his *Filippo* and *Polinice*, and conceived the plan of various other dramas. While thus employed, he became acquainted with the Countess of Albany, who then resided with her husband at Florence. For her he formed an attachment which, if less violent than his former loves, appears to have been more permanent. With this motive to remain at Florence, he could not endure the chains by which his vast possessions bound him to Piedmont. He therefore resigned his whole property to his sister, the Countess Cumiana, reserving an annuity which scarcely amounted to a half of his original revenues. At this period the Countess of Albany, urged by the ill-treatment she received from her husband, sought refuge in Rome, where she at length received permission from the pope to live apart from her tormentor.

Alfieri followed the countess to that capital, where he completed fourteen tragedies, four of which were now for the first time printed at Sienna.

At length, however, it was thought proper that, by leaving Rome, he should remove the aspersions which had been thrown on the object of his affections. During the year 1783 he therefore travelled through different states of Italy, and published six additional tragedies. The interests of his love and literary glory had not diminished his rage for horses, which seems to have been at least the third passion of his soul. He came to England solely for the purpose of purchasing a number of these animals, which he carried with him to Italy. On his return he learned that the Countess of Albany had gone to Colmar in Alsace, where he joined her, and resided with her under the same roof during the rest of his life. They chiefly passed their time between Alsace and Paris, but at length took up their abode entirely in that metropolis. While here, Alfieri made arrangements with Didot for an edition of his tragedies; but was soon after forced to quit Paris by the storms of the Revolution. He recrossed the Alps with the countess, and finally settled at Florence. The last ten years of his life, which he spent in that city, seem to have been the happiest of his existence. During that long period his tranquillity was only interrupted by the entrance of the Revolutionary armies into Florence in 1799. Though an enemy of kings, the aristocratic feelings of Alfieri rendered him also a decided foe to the principles and leaders of the French Revolution; and he rejected with the utmost contempt those advances which were made with a view to bring him over to their cause. The concluding years of his life were laudably employed in the study of the Greek literature, and in perfecting a series of comedies. His assiduous labour on this subject, which he pursued with his characteristic impetuosity, exhausted his strength, and brought on a malady for which he would not adopt the prescriptions of his physicians, but obstinately persisted in employing remedies of his own. His disorder rapidly increased, and at length terminated his life on the 8th October 1803, in the fifty-fifth year of his age.

The character of Alfieri may be best appreciated from the portrait which he has drawn of himself in his own *Memoirs of his Life*. He was evidently of an irritable, impetuous, and almost ungovernable temper. Pride, which seems to have been a ruling sentiment, may account for many apparent inconsistencies of his character. But his less amiable qualities were greatly softened by the cultivation of literature. His application to study gradually tranquillised his temper and softened his manners, leaving him at the same time in perfect possession of those good qualities which he had inherited from nature,—a warm and disinterested attachment to his family and friends, united to a generosity, vigour, and elevation of character, which rendered him not unworthy to embody in his dramas the actions and sentiments of Grecian heroes.

It is to his dramas that Alfieri is chiefly indebted for the high reputation he has attained. Before his time the Italian language, so harmonious in the *Sonnets* of Petrarch, and so energetic in the *Commedia* of Dante, had been invariably languid and prosaic in dramatic dialogue. The pedantic and inanimate tragedies of the 16th century were followed, during the iron age of Italian literature, by dramas of which extravagance in the sentiments and improbability in the action were the chief characteristics. The prodigious success of the *Merope* of Maffei, which appeared in the commencement of the last century, may be attributed more to a comparison with such productions than to intrinsic merit. In this degradation of tragic taste the appearance of the tragedies of Alfieri was perhaps the most important literary event that had occurred in Italy during the 18th century. On these tragedies it is difficult to pronounce a judgment, as the taste and system of the author underwent considerable change and modification during the intervals which elapsed between the three periods of their publication. An excessive harshness of style, an asperity of sentiment, and total want of poetical ornament, are the characteristics of his first four tragedies, *Filippo, Polinice, Antigone*, and *Virginia*. These faults were in some measure corrected in the six tragedies which he gave to the world some years after, and in those which he published along with *Saul*, the drama which enjoyed the greatest success of all his productions; a popularity which may be partly attributed to the severe and unadorned manner of Alfieri being well adapted to the patriarchal simplicity of the age in which the scene of the tragedy is placed. But though there be a considerable difference in his dramas, there are certain observations applicable to them all. None of the plots are of his own invention. They are founded either on mythological fable or history; most of them had been previously treated by the Greek dramatists, or by Seneca. *Rosmunda*, the only one which could be supposed of his own contrivance, and which is certainly the least happy effusion of his genius, is partly founded on the eighteenth novel of the third part of Bandello, and partly on Prevost's *Mémoires d'un Homme de Qualité*. But whatever subject he chooses, his dramas are always formed on the Grecian model, and breathe a freedom and independence worthy of an Athenian poet. Indeed, his *Agide* and *Bruto* may rather be considered oratorical declamations and dialogues on liberty than tragedies. The unities of time and place are not so scrupulously observed in his as in the ancient dramas; but he has rigidly adhered to a unity of action and interest. He occupies his scene with one great action and one ruling passion, and removes from it every accessary event or feeling. In this excessive zeal for the observance of unity he seems to have forgotten that its charm consists in producing a common relation between multiplied feelings, and not in the bare exhibition of one, divested of those various accompaniments which give harmony to the whole. Consistently with that austere and simple manner which he considered the chief excellence of dramatic composition, he excluded from his scene all *coups de théâtre*, all philosophical reflections, and that highly ornamented versification which had been so assiduously cultivated by his predecessors. In his anxiety, however, to avoid all superfluous ornament, he has stripped his dramas of the embellishments of imagination; and for the harmony and flow of poetical language he has substituted, even in his best performances, a style which, though correct and pure, is generally harsh, elaborate, and abrupt; often strained into unnatural energy, or condensed into factitious conciseness. The chief excellence of Alfieri consists in powerful delineation of dramatic character. In his *Filippo* he has represented, almost with the masterly touches of Tacitus, the sombre character, the dark mysterious counsels, the *suspensa semper et obscura verba*, of the modern Tiberius. In *Polinice*, the characters of the rival brothers are beautifully contrasted; in *Maria Stuarda*, that unfortunate queen is represented unsuspicious, impatient of contradiction, and violent in her attachments. In *Mirra*, the character of Ciniro is perfect as a father and king, and Cecri is a model of a wife and mother. In the representation of that species of mental alienation where the judgment has perished, but traces of character still remain, he is peculiarly happy. The insanity of Saul is skilfully managed; and the horrid joy of Orestes in killing Ægisthus rises finely and naturally to madness, in finding that, at the same time, he had inadvertently slain his mother.

Whatever may be the merits or defects of Alfieri, he may be considered as the founder of a new school in the Italian drama. His country hailed him as her sole tragic poet; and his successors in the same path of literature have regarded his bold, austere, and rapid manner, as the genuine model of tragic composition.

Besides his tragedies, Alfieri published during his life many sonnets, five odes on American independence, and the poem of *Etruria*, founded on the assassination of Alexander I., duke of Florence. Of his prose works the most distinguished for animation and eloquence is the *Panegyric on Trajan*, composed in a transport of indignation at the supposed feebleness of Pliny's eulogium. The two books entitled *La Tirannide* and the *Essays on Literature and Government*, are remarkable for elegance and vigour of style, but are too evidently imitations of the manner of Machiavel. His *Antigallican*, which was written at the same time with his *Defence of Louis XVI.*, comprehends an historical and satirical view of the French Revolution. The posthumous works of Alfieri consist of satires, six political comedies, and the *Memoirs of his Life*—a work which will always be read with interest, in spite of the cold and languid gravity with which he delineates the most interesting adventures and the strongest passions of his agitated life. See *Mem. di. Vit. Alfieri*; Sismondi *De la Lit. du Midi de l'Europe*; Walker's *Memoir on Italian Tragedy*; *Giorn. de Pisa*. tom. lviii.; *Life of Alfieri*, by Centofanti (Florence, 1842); and *Vita, Giornali, Lettere di Alfieri*, by Teza (Florence, 1861).

ALFORD, HENRY, D.D., Dean of Canterbury, one of the most variously-accomplished churchmen of his day—poet, preacher, painter, musician, biblical scholar, critic, and philologist—was born at 25 Alfred Place, Bedford Row, London, October 7th, 1810 (died 1871) He came

of a Somersetshire family, five generations of which, in direct succession, contributed clergymen of some distinction to the English Church. The earliest of these, his great-great-grandfather, Thomas Alford, who died in 1708, was for many years the vicar of Curry Rivell, near Taunton—a living that passed from one to another of his descendants. The father of Dean Alford studied for the bar, but after practising for a short time, followed the course of his predecessors by taking holy orders; and, until his death at a venerable age in 1852, had long been familiarly known and revered in his part of the country as the rector of Aston Sandford in Buckinghamshire. His first wife, the dean's mother, whose maiden name was Sarah Eliza Paget, was the younger daughter of a well-to-do banker of Tamworth in Staffordshire. A twelvemonth after their marriage, her husband, then practising as a special pleader, was by her premature death in childbed left a widower. The newly-born infant, who remained to the last the bereaved parent's only child, was confided in the first instance to the affectionate care of the home-circle in the house of his maternal grandfather. Towards the close of 1813 he was taken back to the lonely hearth of his father, who had now entered upon his clerical duties as curate of Steeple Ashton, near Trowbridge in Wiltshire. Being the only son of a secluded scholar, the boy's education was from an unusually early period sedulously cared for; his father being his first instructor, and at the outset his constant companion. So exceptional was his precocity that at six he had already written a little MS. volume entitled (in round hand) the *Travels of St Paul*. Before he was eight he had penned a collection of Latin odes in miniature. When he was scarcely nine he had compiled, in the straggling characters of a schoolboy, a compendious *History of the Jews;* besides drawing out a chronological scheme in which were tabulated the events of the Old Testament. Prior to the completion of his tenth year he actually produced a series of terse sermons or laconically outlined homilies, the significant title of which was *Looking unto Jesus*. During the absence of his father, who had gone abroad as the travelling chaplain of Lord Calthorpe, Henry, at seven years of age, began the round of three academies, at Charmouth and Hammersmith; the happiest time of all for him as a schoolboy being three years and upwards passed in the grammar-school at Ilminster. His character was already displaying a marked individuality. He could repeat not only readily but appreciatively an astonishing number of lines in Greek, Latin, and English, selected from what were then and always afterwards his favourite classic authors. He indulged, too, in those early days, in the luxury of original versification. Then it was also that he first began to manifest that singular capacity for ingenious contrivance and that surprising neatness and dexterity of manipulation for which he was afterwards remarkable. It was said of him later in life, that he could construct an organ and then play upon it; and when his reputation for profound scholarship had been long established, his constructiveness was curiously manifested by his adaptation to the purposes of utility of the seemingly ordinary walking-stick he carried when ravelling on the Continent. In its upper joint he secreted his surplus money and his drawing materials; in its lower joint, pens, ink, wax, and pencils. Strangely contrasting with this ineradicable passion for nicety and precision was his delight at all times in giving himself up to the most diversified occupations, and in yielding, often at an instant's notice, as he sometimes notes with regret, to the temptation of mere discursiveness.

It was in the October of 1827 that the university life of Alford commenced. At seventeen he went up to Cambridge, having won his scholarship, and had his name entered at Trinity College. During the midsummer of his fourth year at Cambridge, in the June of 1831, he had obtained the second prize essay. As the autumn deepened into winter he was nervously preparing to go in for honours at the examinations. In the possibility of his success he had not the slightest confidence, yet on the 21st January 1832 he appears as thirty-fourth wrangler; while on the 25th February his name comes out eighth on the first-class list of the classical tripos. He now began to take pupils, and within the interval which elapsed between his taking his degree and giving himself up more completely to the great work of his life—the elaboration of his edition of the Greek New Testament—it is believed that he had under his charge at least sixty. These included barristers, clergymen, peers, and members of parliament; many of whom afterwards attained positions of eminence, all of them having their characters moulded more or less under the inspiring influence of his. In his twenty-sixth year he was united in marriage to his cousin Fanny, a daughter of his uncle, the Rev. Samuel Alford, who was then, as his father and his great-grandfather had been before him, vicar of Curry Rivell. Surviving her husband after nearly thirty-five years of wedded life, during which she had seen the development of his intellectual powers and the realisation of some portions at least of his many-sided ambition, she brought out in 1872 his journals and correspondence, carefully edited by herself. A curiously characteristic side-light is thrown upon Alford's inner nature, both moral and intellectual, by the circumstance there recorded—that, with a view to enable his future wife to read the New Testament in Greek, he wrote with his own hand, in the interval between betrothal and marriage, an elementary Greek grammar of sixty folio pages. The incident is all the more interesting as affording the earliest glimpse of what soon proved to be his d minant aspiration. His researches in secular scholarship were at this time becoming every year more and more adventurous. He shrank not from proclaiming even then that he regarded Niebuhr as "one of the greatest men in this ignorant and obstinate world." Meanwhile, in the midst of his excursive inquiries as a student in the most opposite directions, he was indulging at every available opportunity in the lotos-delight of his own day-dreamings; and in February 1833, he published his maiden work as a lyrist, *Poems and Poetical Fragments*. Simply as an instructor he was working steadily seven hours a-day; but the time came when, in furtherance of his favourite researches, he was known to toil at the desk sometimes twelve or fourteen.

Resolved from childhood to tread the path of life in the footsteps of his orefathers, Alford was ordained deacon on the 26th October 1833, and at once began active professional work as curate of Ampton. So modest was his own estimate of his intellectual capabilities, that it was with unaffected surprise h found his name second on the list of the six Fellows of Trinity who were elected on the 1st of the following October. On the 6th November he was admitted to priest's orders, and four months afterwards, upon the 4th March 1835—scarcely a week before his marriage—entered upon his parochial labours of eighteen years' duration as vicar of Wymeswold in Leicestershire. Twice during the interval of his scholarly seclusion in that quiet vicarage he was vainly tempted with the offer of a colonial bishopric, first in 1841 as bishop of New Zealand, and again in 1844 as bishop of New Brunswick. He contentedly drudged on for years together in comparative obscurity among his pupils and parishioners. Although a ripe scholar, and remarkable for his splendid versatility, it was less by the brilliancy of his achievements than by the sheer force of the most diligent perseverance that he pushed his way eventually into the front rank, and commanded at last the recognition of his contemporaries.

Whatever he put his hand to he carried out with a zeal that at times looked almost like dogged determination. Thrown from his horse in the February of 1847 when going to deliver his first lecture, although very seriously shaken and disfigured, he nevertheless punctually appeared before his audience with his face and head covered with surgical bandages, and—resolutely lectured. His reputation as a lecturer of exceptional power was within a few years from that time thoroughly established. Several of his discourses, notably one on Saul of Tarsus, with others on themes as varied as astronomy, music, scenery, and Christianity, acquired in the end a certain amount of celebrity. For two years together, in 1841 and 1842, he held the chair at Cambridge of Hulsean lecturer. As the result of his labours in that capacity, two substantial volumes afterwards made their appearance. Meanwhile, in the midst of his more serious avocations, he was at uncertain intervals making good his claim to be regarded as one of the more subtle and tender of the minor religious poets of England. Adopting an old forgotten title of Quarles's, he brought out, on his arrival at Wymeswold (1835), in two volumes, his *School of the Heart*, coupled with a reissue of his minor poems and sonnets. In 1838, he edited, in six vols., the works of Donne, prefixing a luminous preface, at once critical and biographical. Throughout the year 1839 and part of 1840 he edited a monthly magazine called *Dearden's Miscellany*. In 1841 he published, with other new poems, his *Abbot of Muchelnaye*. A collection of *Psalms and Hymns* appeared from his hand in the spring of 1844. A couple of years before that, in 1842, he had first entered upon his duties at Somerset House, where he acted for many years as examiner in logic and moral and intellectual philosophy in the university of London. So youthful was his appearance at the date of his first receiving this appointment, that on his entering the apartment where he was awaited by the candidates, he was mistaken for one of themselves.

What eventually proved to be the noblest of all his literary undertakings, his new edition, with running commentary, of the *Greek Testament*, engrossed his attention for fully twenty years together, from 1841 to 1861. Originally designed for the use of students in the universities, the work, from its modest first projection, grew in his hands to enormous proportions. He fancied at starting that a single year might witness its completion, and that a couple of thin octavos might embrace both text and commentary. By the time the expanding scheme was actually realised twenty years had elapsed, and the work had swollen into four ponderous tomes, the contents of which were as weighty as they were comprehensive. The idea of the work was suggested to Alford's mind as he listened one day to a sermon at Cambridge. What he proposed to himself at the outset was simply to adopt the main text, and to combine with it the greater part of the readings of Philipp Buttmann and Karl Lachmann. This, however, led to a more extended plan of critical labour and research, including a comprehensive digest of the various readings founded on the latest collations of the principal manuscripts, the Codex Vaticanus, the Codex Sinaiticus, the Codex Alexandrinus, and others. With a view to illustrate more clearly than ever the verbal and idiomatic or constructional usages of the sacred text, an entirely new collection of marginal references was compiled. Added to this there was a copious abundance of English notes, both exegetical and philological. Conscious of the vast stores of learning that had been accumulating in Germany, Alford from an early date determined to render himself as thoroughly as possible a master of the German language and at home in German literature. This intention was fairly carried out at Bonn before the close of the summer of 1847. Then, but hardly till then, he felt himself at last duly qualified to edit the *Greek Testament*. From that time he prepared in earnest to open up systematically to the contemplation of English readers the wealth of German criticism, actually made plain for the first time in our language through his *Prolegomena* and subsequent incidental commentary. In November 1849 (the month the author took his B.D. degree at Cambridge), vol. i. of the *Greek Testament* was published, containing the four Gospels. Through it theological students in this country had placed within their reach in an epitomised form the latest results of the labours of continental critics on the Greek text, including portions even of those of Constantine Tischendorf. Issued from the press volume by volume, the work, as already remarked, was not completed till long afterwards. In January 1861 the fourth or final volume, beginning with the Epistle to the Hebrews and ending with the Book of Revelation, made its appearance. What is chiefly noticeable in regard to the work is its strictly critical character. It is the production of a philologist rather than of a theologian. Abbreviations, punctuations, elisions of orthography, systematic ellipses, the merest turns of the pen in this or that manuscript, are weighed against microscopic scruples in the balance of his judgment. There can be little question that the work appreciably increased the aggregate amount of the biblical knowledge of Alford's immediate contemporaries. So carefully matured were his researches in the regions of exegesis, already crossed and recrossed by the footprints of countless commentators, that the work is regarded as in many respects authoritative even among those who differ from him widely on many important questions.

Early in 1853 Alford first preached in Quebec chapel, London, the building in which his father had been ordained deacon forty years before. Before the year was out, on the 26th September, he had removed from his picturesque church in the wolds of Leicestershire to the plain conventicle in Tyburnia. There he remained for nearly four years, toiling assiduously, preaching twice every Sunday to a large and cultured congregation. Seven volumes, issued from the press at intervals, have, under the title of *The Quebec Chapel Sermons*, preserved 153 of the more remarkable of these discourses—those preached by him in the morning—all of which were carefully prepared beforehand. As a preacher his style was severe and earnest rather than eloquent or impassioned. Perhaps the finest discourse he ever delivered was the one on the text, "A great multitude which no man could number." It was preached from the cathedral pulpit shortly after his advancement by Lord Palmerston, in March 1857, to the deanery of Canterbury. Throughout his life, but especially towards its close, his chief delight intellectually appears to have been the rapid alternation of his pursuits. While he was yet in the midst of his biblical researches he was, simultaneously, at the beginning of 1851, translating the *Odyssey*, arranging his poems, with additions for their American republication, and preparing an article for the *Edinburgh Review* on the *St Paul* of Conybeare and Howson. A series of ingenious lectures, delivered by him in his capacity of philologist, on being compacted into a manual of idiom and usage, entitled *The Queen's English*, attained a high degree of popularity. Nevertheless, in spite of their wholly unpretentious and essentially humorous character, these mere casual notes on spelling and speaking drew down upon their author one of the sharpest criticisms he ever provoked, sarcastically entitled *The Dean's English*. The *Contemporary Review* was inaugurated under his editorship; and from January 1866 to August 1870 was conducted by him as a sort of neutral ground for religious criticism. Under the title of *The Year of Prayer*, Alford in 1866 published a

book of family devotion; and in 1867, a collection of original hymns called *The Year of Praise*, works of little pretension, but by which his name was widely popularised. His latest poetic effusion of any considerable length was *The Children of the Lord's Prayer*, which appeared in 1869 as the letterpress accompaniment to designs by F. R. Pickersgill, R.A. The miscellaneous papers he had contributed to periodicals were, the same year, collected under the name of *Essays and Addresses*. He brought out, in 1865, his *Letters from Abroad*, eminently characteristic records of travel, mainly descriptive of Italian cities and scenery; and in 1870, a collection of spirited pen and pencil sketches of *The Riviera*, the latter being reproduced from his water-colour drawings by the aid of chromo-lithography. The artist faculty, it has been observed, and not extravagantly, "would have made him a great landscape painter had he not, either from preference or necessity, become a great Greek scholar and a dean." Such were the pliancy and the resilience of his nature that he would turn with zest, after hours of severe study given to the collation of a Hebrew manuscript or to the examination of the exegetical subtleties of a German commentator on the Greek Testament, to doctoring the hall clock and making it strike the half-hours, to tuning the piano in the drawing-room, or to playing games with his children in the nursery. The wooden front of the organ (which instrument he could play with the hand of a master) was carved according to his own ingenious design and by his own dexterous chiselling. A *Masque of the Seasons*, performed as a holiday pastime on New Year's Day 1861, in the deanery, owed to him both the words and the music—he himself, besides, enacting in it the part of "Father Christmas." A couple of years before his death he appeared as a novelist, conjointly with his niece producing the story of *Netherton on Sea*. The last work of any magnitude upon which he adventured as a biblical scholar was his *Commentary on the Old Testament*. In the diversity of his avocations, and the thoroughness with which they were, one and all, carried to a successful issue, he was his own severest taskmaster. Throughout life, until he was stretched upon his deathbed, he never seemed to indulge in the luxury of inaction. The end came at length to him calmly, on the 12th January 1871, and five days afterwards his remains were interred under a yew tree in St Martin's churchyard, within view of the towers of Canterbury Cathedral. It is significant of the tender poetical quaintness of his whole character, that there is inscribed above his tomb, in obedience to his own directions, "Diversorium Viatoris Hierosolymam Proficiscentis." A statue of the dean, by Pfyffers, was unveiled, before the year of his demise had run out, in a niche on the west front of the most ancient of our cathedrals. Dean Alford was a man as variously accomplished as any of his generation; and he would unquestionably have risen to far greater eminence than he ever achieved in poetry, in oratory, in music, in painting, in theology, or in general literature, if he had aimed at excelling in one or two alone of those arts or sciences, instead of endeavouring to shine in all of them alike. (C. K.)

ALFRED, or ÆLFRED, THE GREAT, the youngest son of Æthelwulf, king of the West Saxons, was born at Wantage in Berkshire in 849 A.D. At an early age he was summoned to the assistance of his brother Æthelred against the Danes. These formidable enemies, whose object hitherto had been mere plunder, were now aiming at a permanent settlement in the country, and after ravaging and subduing Northumbria, East Anglia, and the greater part of Mercia, they fell with their united forces on Wessex itself. A series of encounters took place, in which Alfred greatly distinguished himself, especially at Ashdown, where the Danes were routed with great slaughter, and left several of their most famous leaders dead on the field of battle. Æthelred dying in the midst of the struggle, Alfred was unanimously elected king (871), in the twenty-second year of his age. About a month after his accession he met the enemy at Wilton, where, after a long and doubtful struggle, he was defeated. Both parties were now becoming tired of the war. Immense loss had been suffered on both sides, and although the Danes on the whole had been victorious, their victories had brought them no substantial results. A treaty of peace was concluded, and the Danes withdrew to London.

On the cessation of hostilities, Alfred was enabled to turn his attention to naval affairs. The sea was swarming with pirates, and their descents on the coast kept the country in a state of perpetual alarm. To cope with them successfully Alfred resolved to meet them on their own element, and a naval victory which he gained over seven Danish rovers in 875 is the first on record won by Englishmen. In the following year the peace of 871 was broken. An army of Danes from East Anglia, under their king, Guthrum, sailing along the south coast, landed in Wessex, seized upon Wareham, and afterwards upon Exeter, then the centre of a disaffected Celtic population, and it was not till 877 that the country was once more free from the invader.

The year 878 was the most eventful in the course of Alfred's reign. At mid-winter, without any warning, the Danes came pouring into Wessex from the north, seized Chippenham, and making it the centre of their operations, quickly overran the country. Many of the inhabitants, in despair, fled into foreign lands, and Alfred, totally unprepared to meet the storm, retired to the marshes of Somerset. Never at any other period, either before or after, were his fortunes so low, and the national existence itself was at stake. Had Alfred, like his kinsman Burhed of Mercia, left his people in their hour of need, the heathen Dane in all probability would have acted like the heathen Englishmen before him—a new race would have possessed the land, and the names of England and Englishmen would have disappeared from the page of history. Alfred's misfortunes only roused him to fresh exertions, and his military skill and valour enabled him to carry his people in safety through this momentous crisis. Fortifying himself at Athelney about Easter, he secretly matured his plans for meeting the enemy, and seven weeks after, having collected his forces at Brixton near Selwood, he rapidly advanced in a north-easterly direction, and was close upon the Danes before they had any intelligence of his approach. A fierce conflict ensued at Ethandun, now Edington, in which the Danes were entirely defeated; and about fourteen days after this they were compelled to sue for peace. By the treaty of Wedmore, Watling Street (the old road running across the island from London to Chester and the Irish Channel) was to be the boundary between Alfred and the Danes, the latter were to be vassals to the kings of Wessex, and their chiefs to receive baptism. This treaty was observed by the Danes with much greater fidelity than those of an earlier date had been. Guthrum their king and about thirty of their chiefs were baptised at Wedmore, and Alfred, who stood sponsor for Guthrum, gave him the name of Æthelstan. The Danish army after this slowly withdrew, and eventually settled down peaceably in East Anglia. The acceptance of Christianity by their chiefs seems indeed to have broken for a time the fierce crusading energy which gave a special animus to the piratical expeditions of the heathen Danes.

As soon as peace had been concluded Alfred turned his attention to the internal affairs of his kingdom. He vigorously set to work to put the country in a complete state of defence. Old fortifications were repaired and new

ones raised in suitable localities. The fleet was brought into a state of greater efficiency, and it was Alfred indeed that laid the foundation of England's naval greatness. He cleared the land of the bands of robbers that infested it, and took care that justice was impartially administered to all his subjects, severely punishing any wilful perversion of it on the part of the judges. In his code of laws, which is a compilation from those of his predecessors, he wisely abstained from introducing much of his own, giving as his reason that he was afraid it might not be accepted by posterity. He greatly encouraged commerce, and took a lively interest in geographical discovery. We have from his pen a minute account of two voyages of Ohthere, especially of the one round the North Cape into the White Sea, and also of a voyage of Wulfstan to the Baltic. And it is to Alfred that we are indebted for the best account that has reached us of the Germany of the 9th century.

Alfred's devotion to learning, and his exertions in the cause of education are among the most remarkable features of his reign. So deep was the popular ignorance when Alfred ascended the throne that, according to his own testimony, hardly any one south of the Thames could understand the ritual of the church or translate a Latin letter. It was one of the strongest and most cherished of his purposes that this state of matters should be entirely changed, and that every free-born English youth who had the means should qualify himself to read English correctly. In order to accomplish this, he rebuilt the monasteries which had been cast down in the late wars, and which were the great centres of education in those days, invited learned men from all quarters to his court, and by their assistance completed a number of works for the diffusion of knowledge throughout his dominions. These were not original compositions but free translations of Latin authors that were held in much esteem at the time, and the fact that Orosius and Bede are two of the works he selected, shows the high value he set upon an acquaintance with history and geography. A copy of his version of Gregory's *Pastoral Care* was sent to every diocese for the benefit of the clergy. It is in the preface to that work that Alfred gives his touching account of the decay of learning, and expresses his desire for its revival. But the work which seems to have had the greatest attraction for him was *The Consolations of Philosophy* by Boethius. In his translation of this work Alfred gives us more of his own original composition, and a deeper insight into his thoughts and feelings, than in any other of his works. His Manual or Handbook, which is known to have been in existence in the 12th century, is lost, and this is the more to be regretted since, besides the extracts from Latin authors which it contained, it is believed that he had inserted in it not a few compositions of his own.

In occupations such as these fifteen years of comparative tranquillity, disturbed now and then by troubles with the Danes, passed away. A fresh swarm from abroad had landed in Kent in 885 and besieged Rochester, but on the king's approach they raised the siege and returned to their ships. The next eight years were years of uninterrupted peace; but the Danes, suffering a severe defeat at the hands of Arnulf, king of the East Franks, sailed for England in two divisions in 893. One of these divisions was under the command of the terrible Hastings. Their arrival was a signal to the Danes of Northumbria and East Anglia, who rose in great numbers to aid their kinsmen. Alfred, however, was better prepared to meet the danger than he had formerly been. His towns were so strong that the Danes seem studiously to have avoided them. A body of the enemy was routed by Alfred at Farnham in Surrey. Another great host, moving to the west in the line of the Thames, was followed by three of Alfred's aldermen to Buttington in Montgomeryshire and completely defeated. Those who escaped made their way to Essex. Leaving their wives and children there, and receiving considerable additions to their numbers, they crossed the country once more and established themselves within the fortifications of the old Roman town of Chester, which was then uninhabited. There they remained for the winter, when, provisions failing them, they removed to Wales, and with the harvest of plunder they gathered there they retreated into Essex by way of the friendly districts of Northumbria and East Anglia. So rapid had their movements been that Alfred's army was unable to keep up with them. The same year (895), before winter set in, the Danes sailed up the Thames into the Lea, and selecting an advantageous position on the banks of the latter stream, constructed a fortress about 20 miles above London. As this proved a considerable annoyance to the citizens, they attacked it the following summer, but were repulsed with great loss. During harvest the king was obliged to encamp in the neighbourhood of the city to protect the reapers while gathering in their crops. He afterwards raised two forts on each side of the Lea, and so effectually blocked up the passage of the river that the enemy abandoned their vessels and proceeded to Bridgenorth on the Severn. In the summer of 897 the great Danish host broke up, and part of them returned to the continent. The rest dispersed through Northumbria and East Anglia, and for some time gave Alfred no little trouble by their piratical excursions. By means of vessels formed after a model of his own, of unusual length and speed, he succeeded at last in curbing his Danish foes, but not till after a desperate encounter with them on the south coast, in which the advantage was not all on his side. The war was, as usual, accompanied by pestilence, and great numbers perished, many being persons of the highest rank in the state. The rest of Alfred's reign, about which we know almost nothing, seems to have been passed in peace. He died in the year 901, at the age of fifty-two, and was buried at Winchester.

The memory of Alfred has ever been gratefully cherished by his countrymen. There never perhaps was a monarch so highly esteemed; and traditional stories of the most fascinating description cluster around his name, in which he appears almost to as much advantage as in real history. Institutions that existed long before his time, but whose origin it is impossible to trace, have erroneously been attributed to him; and in the times of Norman oppression, when the people were groaning under the burden of slavery, they fondly called to mind the "Darling of the English," to whom they ascribed all those rights and privileges which they so highly valued, and of which they had been unjustly deprived. Time but adds to Alfred's praises. With one consent our historians agree in characterising him as the wisest, best, and greatest king that ever reigned in England.

The following is a list of Alfred's works:—

1. *Manual* or *Handbook*, of which no copy is known to exist. 2. *Laws* (see Wilkin's *Leges Anglo-Saxonicæ*, 1721, and Thorpe's *Ancient Laws and Institutes of England*, London, 1840). Translations into Old English (Anglo-Saxon) of the following:—3. Bede's *Ecclesiastical History*, edited by Wheloc, Cambridge, 1643–4, and by Smith, Cambridge, 1722. 4. *The Universal History of Orosius*, edited by Thorpe, London, 1857. 5. *The Consolations of Philosophy*, by Boethius, edited by Fox, London, 1864. 6. Gregory's *Pastoral Care*, edited by Sweet for the Early English Text Society, London, 1871–2.

For further information about Alfred see Pauli's *Life of Alfred* and Freeman's *Old English History* and *History of the Norman Conquest*.

ALGÆ, or Hydrophyta, a large order of cellular, flowerless, cryptogamic plants, found in the sea (seaweeds), in rivers, lakes, marshes, hot springs, and moist places, all over the world. They consist of a brown, red, or green,

flattened, cellular, leaf-like expansion, called a *thallus*, sometimes stalked, which bears the organs of reproduction. Some have root-like processes by which they are attached to rocks. These do not act like the nourishing roots of flowering plants; they simply fix the plants and enable them to sway about in the water. This is markedly the case with the Laminarias, or large tangles of our coasts. The leafy appendages of seaweeds are called fronds. They vary in size, colour, and consistence. Some of the red and green delicate fronds form beautiful objects when carefully dried and laid out on drawing-paper. In order to dry seaweeds they must be first washed carefully in fresh water to separate saline matters, and then placed within drying-paper and subjected to pressure. Very delicate seaweeds should be floated out in water, drawing-paper being placed under them, and their fronds being carefully arranged on the paper before they are raised out of the water. They must then be dried partially in the air, and afterwards under pressure between sheets of drying-paper.

Seaweeds are composed entirely of cells, which in some instances become elongated so as to have the appearance of tubes. Some Algæ are uni-cellular, that is, are composed of a single cell, as occurs in some Desmidieæ, as Closterium. At other times they are composed of numerous cells, which are kept together by a gelatinous matter, but separating easily from each other so as to have an independent existence. This is observed in the red snow plant (*Protococcus* or *Palmella nivalis*). The cells of seaweeds are sometimes joined together so as to form a linear series, and to give them a thread-like appearance; and in such a case, when the divisions between the cells are marked, the whole appears like a beaded necklace of cells. When the cells are united both lengthwise and laterally they then form an expanded flat frond. In some instances the frond is gelatinous.

The germinating bodies or spores of seaweeds are cells often contained in cavities (Fig. 2). They vary in colour, and the fronds have frequently the same colour as the spores. In reference to their colour, Algæ have been divided into three sub-orders: 1. Melanospermeæ, brown coloured seaweeds (Fig. 1), with olive-brown spores; 2. Rhodospermeæ, rose-coloured seaweeds, with red spores; 3. Chlorospermeæ, green-coloured seaweeds, with green spores.

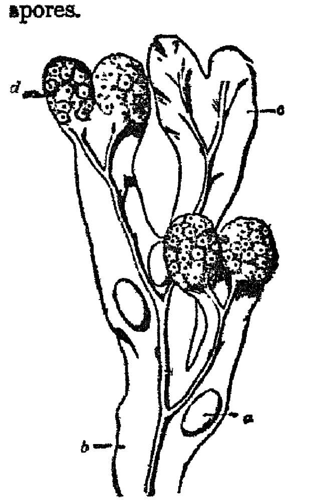


Fig. 1.

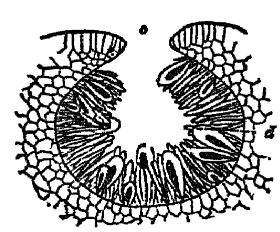


Fig. 2.

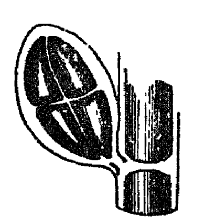


Fig. 3.

Fig. 1.—Thallus, *tt*, of *Fucus vesiculosus*, the common Bladder Seaweed, with air-vesicle, *v*, and masses of conceptacles constituting the fructification, *fr*, *fr*, which is sometimes called gleba. Fig. 2.—Fructification of a Seaweed, containing spores, which are ultimately discharged at an opening, *o*. Fig. 3.—Tetraspore of one of the rose-coloured Seaweeds.

Algæ are multiplied by the division of cells and by spores. By cell-division there is a multiplication of cells, and by separation from the parent plant these cells may bear buds. True fertilisation is effected by means of union of cells, or what is called conjugation. In this process two kinds of cells unite by means of a tube, and the contents of the one passes into the other, thus giving rise to germinating spores. This is seen in Confervæ, such as the green matter often seen in ponds, and called *silk-weed*. There are also observed in Algæ two kinds of fertilising bodies, one set called Antheridia, containing moving filaments or spermatozoids; and the other called Archegonia, containing a rudimentary cell, which, after contact with the spermatozoids, becomes a spore forming a new plant. The spores produced by some Algæ move about in water, and have been called Zoospores. Their spontaneous movements are effected by means of vibratile slender threads called cilia. These zoospores are contained in a cell, which ultimately bursts and scatters them. The process is well seen in a green Alga called Vaucheria. The zoospores move about for a certain time, and ultimately the spores get fixed to a rock or the wood of a pier, and then the cilia disappear. Cilia sometimes occur in pairs at one end of a spore, numbering two or three; at other times they are placed round the whole circumference of the spore.

Spores have a tendency to divide into four; such compound spores are called tetraspores (Fig. 3). They are common in the sub-order Rhodospermeæ. They seem to differ from ordinary spores, and to be more of the nature of buds. In some Algæ, such as Corallines, there is a coating of calcareous matter which conceals their tissue. This can be removed by means of hydrochloric acid. Diatoms, a subdivision of Algæ, are so called from two Greek words signifying to cut through, in allusion to the mode of division into two valves. They are microscopic one-celled bodies, covered externally by a siliceous or flinty coat. They are on the confines of the animal and vegetable kingdoms, and have been referred sometimes to the one and sometimes to the other. Their mode of reproduction by conjugation and spores seems to indicate their alliance with Algæ, although some still place them among infusorial animalcules. The siliceous markings of Diatoms are very beautiful microscopic objects. After exposure to the action of fire or nitric acid, the silex remains unaltered, and in that state the streaks of the covering are easily observed.

Many of the Algæ supply nutritious food. *Rhodymenia palmata*, one of the red seaweeds, is the *dulse* of the Scotch, the *dillesk* of the Irish. *Chondrus* (*Sphærococcus*) *crispus* and *C. mammillosus*, two Rhodosperms, receive the name of *carrageen* or Irish moss. Their fronds consist in part of a substance allied to starch, which is extracted by putting them in water, and on cooling it forms a jelly. Species of Ulva, one of the Chlorosperms, supply the green laver. Species of Caulerpa furnish food to turtles. *Laminaria digitata*, and *Laminaria saccharina*, under the name of *tangle*, are eaten in the north of Europe. Dulse and tangle was formerly a common cry in the streets of Edinburgh. *D'Urvillæa utilis* is used as food in Chili. *Alaria esculenta*, a British species, is also edible. *Gigartina speciosa* is used for jelly in the Swan River settlement. *Gracilaria lichenoides*, under the name of Ceylon moss, is used for soups and jellies. *Gracilaria spinosa* supplies the Agar-Agar in China. *Nostoc edule* is a Chinese article of diet. The edible nests of China are supposed to be formed from seaweeds. *Plocaria tenax* is used in China to furnish glue. *Iridæa edulis* is edible. *Laurencia pinnatifida* is called pepper-dulse on account of having pungent qualities. Seaweeds form an excellent manure. They are used on many farms situated near the sea-shore. Seaweeds after burning yield barilla, an impure carbonate of soda. Kelp was for many years prepared from seaweeds in Scotland, more especially in the Western and Northern Islands.

As regards the distribution of seaweeds, some are cosmopolitan or pelagic, as species of Ulva and Enteromorpha, which are equally abundant in high northern and southern latitudes, as they are under the equator and in temperate regions. Many Diatomaceæ are distributed from pole to pole. In general, however, seaweeds are more or less limited in their distribution, so that different marine floras exist in various parts of the ocean. The marine species have been estimated at about 6000, and they are distributed in various regions. The Northern Ocean, from the pole to the 40th degree, the sea of the Antilles, the eastern coasts of South America, those of New Holland, the Indian Archipelago, the Mediterranean, the Red Sea, the Chinese and Japanese seas, all present very large marine regions, each of which possesses a peculiar vegetation. The degree of exposure to light, and the greater or less motion of the waves, are important in the distribution of Algæ. The intervention of great depths of the ocean has an influence on sea plants similar to that of high mountains on land plants. Melanospermeæ increase as we approach the tropics, where the maximum of the species is found. Rhodospermeæ chiefly abound in the temperate zone; while Chlorospermeæ form the chief marine vegetation of the polar zone, and abound in the colder temperate zone. The green colour is characteristic of those Algæ which grow either in fresh water or in the shallower parts of the sea; the olive-coloured Algæ are abundant between the tide-marks; while the red-coloured species occur chiefly in the deeper and the darker parts of the sea.

Some seaweeds are worthy of note on account of the mode of their growth and distribution. *Chorda Filum*, a long cord-like seaweed, lies in beds of 15 to 20 miles in length, and only about 600 feet in breadth, in the North Sea and the British Channel. *Sargassum bacciferum* constitutes the Gulf-weed, which has been noticed by all who have crossed the Atlantic. The Gulf-weed has never been seen attached, but always floating. From the abundance of this seaweed its locality is called the Sargasso Sea. The most remarkable of the seaweeds, as regards size and the extent of range, are *Macrocystis pyrifera* and *Laminaria radiata*. Masses of Macrocystis, like green meadows, are found in every latitude. Many specimens have been seen about 300 feet long; some even extend to 700 feet or upwards. A tree seaweed, *Lessonia fuscescens*, with a stem 10 feet long, 12 inches in circumference, and its fronds 2–3 feet long and 3 inches broad, is found in immense masses off the Patagonian regions. *D'Urvillæa utilis* is another large Antarctic seaweed, which, along with Lessoniæ, occurs at the Falkland Islands, formed by the surf into enormous vegetable cables, several hundred feet long, and thicker than the human body. In Britain we have a marked distribution of seaweeds as regards depth. There is a littoral zone lying between high and low water marks, divided into sub-regions characterised by the following seaweeds:—1. *Fucus canaliculatus*; 2. *Fucus vesiculosus*; 3. *Fucus nodosus*; 4. *Fucus serratus*. Secondly, there is a laminarian zone, commencing at low-water mark, and extending for a depth of 7 to 15 fathoms. Here we meet with the great tangle seaweeds, such as *Laminaria digitata* and *L. saccharina*, along with deep-water Fuci. (J. H. B.)

ALGARDI, Alessandro, one of the most celebrated sculptors of Italy, was born at Bologna in 1602, and died in 1654. While he was attending the school of the Caracci his preference for the plastic art became evident, and he placed himself under the instruction of the sculptor Conventi. At the age of twenty he was brought under the notice of Duke Ferdinand of Mantua, who gave him several commissions. He was also much employed about the same period by jewellers and others in modelling in gold, silver, and ivory. After a short residence in Venice, he went to Rome in 1625 with an introduction from the Duke of Mantua to the pope's nephew, Cardinal Ludovisi, who employed him for a time in the restoration of ancient statues. The death of the Duke of Mantua left him to his own resources, and for several years he earned a precarious maintenance from these restorations and the commissions of goldsmiths and jewellers. In 1640 he executed for Pietro Buoncompagni his first work in marble, a colossal statue of San Filippo Neri, with kneeling angels. Immediately after, he produced a similar group, representing the execution of St Paul, for the church of the Barnabite Fathers in Bologna. These works, displaying great technical skill, though with considerable exaggeration of expression and attitude, at once established Algardi's reputation, and other commissions followed in rapid succession. The turning-point in Algardi's fortune was the accession of Innocent X., of the Bolognese house of Panfili, to the papal throne in 1644. He was employed by Camillo Panfili, nephew of the pontiff, to design the Villa Doria Panfili outside the San Pancrazio gate. The most important of Algardi's other works were the monument of Leo XI., a bronze statue of Innocent X. for the Capitol, and, above all, *La Fuega d'Attila*, the largest alto-rilievo in the world, the two principal figures being about 10 feet high. The great technical excellence of these works is considerably marred by an exaggeration of expression resulting from the vain endeavour to produce in marble effects which can only be legitimately brought out on canvas. From an artistic point of view, he is most successful in his portrait-statues and groups of children, where he is obliged to follow nature most closely. In his later years he became very avaricious, and amassed a great fortune.

ALGAROTTI, Francesco, Count, was born at Venice on the 11th December 1712. He went abroad in his youth, and in 1733 visited Paris, where he issued his Newtonian Philosophy for the Ladies, in the work entitled *The Plurality of Worlds*. He was much honoured by Frederick the Great, who, when crowned at Königsberg in 1740, created him a count of Prussia. He died at Pisa on the 23d of May 1764, and, by his own direction, the following inscription was placed upon his tomb:—*Hic jacet Algarottus, sed non omnis*. He is allowed to have been a great connoisseur in painting, sculpture, and architecture; and he contributed much to the reformation of the Italian opera. His works (6 vols., Leghorn, 1764; 17 vols., Venice, 1791–4) are numerous, and on a variety of subjects, abounding with vivacity, elegance, and wit.

ALGARVE, the most southerly province of Portugal, is bounded on the E. by the Spanish province of Seville, from which it is separated by the river Guadiana; on the N. by Alemtejo; and on the W. and S. by the Atlantic Ocean. Its length from east to west is 85 miles, the average width is 22 miles, and the area, according to the most recent measurement, 1865 square miles. In 1868 the population was 177,342, giving the small proportion of 95 to the square mile.

The Sierra de Caldeiraon and the Sierra de Monchique extend across the northern part of the province, and, sweeping to the south-west, terminate in the lofty promontory of Cape St Vincent, the south-west extremity of Europe. Between the mountainous tracts in the north and the southern coast stretches a narrow plain, watered by numerous rivers flowing southward from the hills. In the hilly districts the roads are bad, the soil unsuited for cultivation, and the inhabitants few. Flocks of goats are reared on the mountain sides. The level country along the southern coast is more fertile, and produces in abun-

dance grapes, figs, oranges, lemons, olives, almonds, and aloes, and even the plantain and the date. The land is, however, not well suited for the production of cereals; little wheat or other corn is grown in the province, and its grain supplies are chiefly derived from Spain. On the coast the people derive their subsistence in great measure from the fisheries, tunny and sardines being caught in considerable quantities. Salt is also made from sea-water. There is no manufacturing or mining industry of any importance. The harbours are bad, and the whole foreign trade is carried on by ships of other nations, although the inhabitants of Algarve are reputed to be the best seamen and fishermen of Portugal. The chief exports are dried fruit, wine, salt, tunny, sardines, and anchovies.

The name of Algarve is derived from the Arabic, and signifies a land lying to the west. The province was taken from the Moors in 1253 by Alphonso III., king of Portugal, who then assumed the additional title of king of Algarve. It is sometimes designated the district of Faro, and is subdivided into fifteen communes and sixty-two parishes. The chief town is Faro, and among the other towns are Castro Marino, Tavira, Portimao, Lagos, and Sagres, all on the coast or on the estuaries of the rivers, and Silves, on the river Portimao, the ancient Moorish capital of Algarve.

ALGAU, or ALLGAU, the name now given to a comparatively small district forming the south-western corner of Bavaria, and belonging to the province of Swabia and Neuburg, but formerly applied to a much larger territory, which extended as far as the Danube on the north, the Inn on the south, and the Lech on the west. The Algau Alps contain several lofty peaks, the highest of which is Mädele-Gabel, 8611 feet above the sea. The district is celebrated for the cattle, milk, butter, and cheese that it produces.

AL-GAZALI, ABU HAMED MUHAMMAD, usually described as an Arabian philosopher, was really a Moslem theologian who met the heretical philosophers on their own ground. He was born in 1058, and belonged to the sect of the Ascharites, or extreme right of the Motecallemin, who (and not the philosophers) were the real Arabian schoolmen. At thirty-three he became the head of a theological college at Baghdad, where his professor's chair was surrounded by eager crowds, including all the imams of the country. It was a time of keen speculation, when philosophic scepticism was encouraged in high places; and the premature convictions of Al-Gazali gave way under a violent reaction against the orthodox creed. Driven by mental inquietude, he escaped from Baghdad on the plea of making a pilgrimage to Mecca, but went to Syria, and (after visiting, though a Mahometan, the Holy Sepulchre at Jerusalem) settled at Damascus, where he spent ten years in seclusion and meditation. Recalled by his private affairs as he was on his way to Egypt, he returned to Baghdad, reluctantly resumed teaching (which he continued for fifteen years), then retired to Tous, his native town, and devoted his remaining years to the contemplative life of the Sufis, who had been his earliest instructors. He died in 1111. His outer life, so restless and unquiet, was the reflex of a mental history disturbed by prolonged agitation. Revolting, in the height of his success, against the current creed, he began to examine the foundations of knowledge. Where could certainty be found? In the perceptions of the senses? But these are contradicted by one another, and disproved by reason. In the notions of reason? Reason, indeed, professes to furnish us with necessary truths; but what assurance have we that the verdicts of reason may not be reversed by some higher authority? Al-Gazali then interrogated all the sects in succession to learn their criterion of truth. He first applied to the theological schoolmen, who grounded their religion on reason; but their aim was only to preserve the faith from heresy. He turned to the philosophers, and examined the accepted Aristotelianism in a treatise which has come down to us—*The Destruction of the Philosophers*. He assails them on twenty points of their mixed physical and metaphysical peripateticism, from the statement of which, in spite of his pretended scepticism, we can deduce some very positive metaphysical opinions of his own. He claims to have shown that the dogmas of the eternity of matter and the permanence of the world are false; that their description of the Deity as the demiurgos is unspiritual; that they fail to prove the existence, the unity, the simplicity, the incorporeality, or the knowledge (both of species and accidents) of God; that their ascription of souls to the celestial spheres is unproved; that their theory of causation, which attributes effects to the very natures of the causes, is false, for that all actions and events are to be ascribed to the Deity; and, finally, that they cannot establish the spirituality of the soul, nor prove its mortality. These criticisms disclose nothing like a sceptical state of mind, but rather a reversion from the metaphysical to the theological stage of thought. He denies the intrinsic tendencies, or souls, by which the Aristotelians explained the motion of the spheres, because he ascribes their motion to God. The sceptic would have denied both. Mr Lewes rightly censures M. Renan for asserting of Al-Gazali's theory of causation—"*Hume n'a rien dit plus.*" It is true that Al-Gazali maintains that the natural law according to which effects proceed inevitably from their causes is only custom, and that there is no *necessary* connection between them. So far the Eastern and the European sceptic are on the same ground. But while Hume absolutely denies the necessity, Al-Gazali merely removes it one stage further back, and plants it in the mind of the Deity. This, of course, is not metaphysics, but theology. Having, as he believed, refuted the opinions of the philosophers, he next investigated the pretensions of the Allegorists, who derived their doctrines from an imam. These Arabian ultramontanes had no word for the doubter. Did he ask for the proof of their doctrine, they could only answer that "thus it was written." They could not, he says, even understand the problems they sought to resolve by the assumption of infallibility, and he turned again, in his despair, to the instructors of his youth—the Sufis. In their mystical intuition of the laws of life, and absorption in the immanent Deity, he at last found peace. This pathetic close of his stormy career negatives the idea that he ever wrote the philosophical work he once contemplated on *The Bases of Belief*, and at the same time shows the true character of the treatise which, alike in mediæval and modern times, has been quoted as containing an exposition of his opinions. The work called *The Tendencies of the Philosophers*, and which was translated in 1506, with the title *Logica et Philosophia Algazelis Arabis*, contains neither the logic nor the philosophy of Al-Gazali. It is a mere abstract or statement of the Peripatetic systems, and was made preliminary to that *Destruction* of which we have already spoken. With this work Arabian philosophy in the East came to an end; but it revived in the new Arabia which had been planted in the West—in Mahometan Spain. If, therefore, Al-Gazali was the Oriental Descartes in being the first destructive sceptic of the old, he was its Descartes no less in being the initiator of the new philosophy.

For direct knowledge of Al-Gazali, see his *Destructio*, &c., in the ninth vol. of Averrhoës's works, but especially his spiritual autobiography, translated by Schmölders in his *Essai sur les Ecoles Philosophiques chez les Arabes*. See also Von Hammer, introduction to *O Kind*; Munk, *Mélanges*; and Gosche in *Abhandlungen der König. Akad. der Wissenschaften zu Berlin*, 1858.

ALGEBRA

Definition. ALGEBRA is that branch of the mathematical sciences which has for its object the carrying on of operations either in an order different from that which exists in arithmetic, or of a nature not contemplated in fixing the boundaries of that science. The circumstance that algebra has its origin in arithmetic, however widely it may in the end differ from that science, led Sir Isaac Newton to designate it "Universal Arithmetic," a designation which, vague as it is, indicates its character better than any other by which it has been attempted to express its functions—better certainly, to ordinary minds, than the designation which has been applied to it by Sir William Rowan Hamilton, one of the greatest mathematicians the world has seen since the days of Newton—"the Science of Pure Time;" or even than the title by which De Morgan would paraphrase Hamilton's words—"the Calculus of Succession."

To express in few words what it is which effects the transition from the science of arithmetic into a new field is not easy. It will serve, probably, to convey some notion of the position of the boundary line, when it is stated that the operations of arithmetic are all capable of direct interpretation *per se*, whilst those of algebra are in many cases interpretable only by comparison with the assumptions on which they are based. For example, multiplication of fractions—which the older writers on arithmetic, Lucas de Burgo in Italy, and Robert Recorde in England, clearly perceived to be a new application of the term multiplication, scarcely at first sight reconcilable with its original definition as the exponent of equal additions,—multiplication of fractions becomes interpretable by the introduction of the idea of multiplication into the definition of the fraction itself. On the other hand, the independent use of the sign *minus*, on which Diophantus, in the 4th century, laid the foundation of the science of algebra in the West, by placing in the forefront of his treatise, as one of his earliest definitions, the rule of the sign minus, "that *minus* multiplied by *minus* produces *plus*"—this independent use of the sign has no originating operation of the same character as itself, and might, if assumed in all its generality as existing side by side with the laws of arithmetic, more especially with the commutative law, have led to erroneous conclusions. As it is, the unlimited applicability of this definition, in connection with all the laws of arithmetic standing in their integrity, pushes the dominion of algebra into a field on which the oldest of the Greek arithmeticians, Euclid, in his unbending march, could never have advanced a step without doing violence to his convictions.

In asserting that the independent existence of the sign *minus*, side by side with the laws of arithmetic, might have led to anomalous results, had not the operations been subject to some limitation, we are introducing no imaginary hypothesis, but are referring to a fact actually existing. The most recent advance beyond the boundaries of algebra, as it existed fifty years ago, is that beautiful extension to which Sir W. R. Hamilton has given the designation of Quaternions, the very foundation of which requires the removal of one of the ancient axioms of arithmetic, "that operations may be performed in any order."

HISTORY.

At what period and in what country algebra was invented? is a question that has been much discussed. Who were the earliest writers on the subject? What was the progress of its improvement? And lastly, by what means and at what period was the science diffused over Europe? It was a common opinion in the 17th century that the ancient Greek mathematicians must have possessed an analysis of the nature of modern algebra, by which they discovered the theorems and solutions of the problems which we so much admire in their writings; but that they carefully concealed their instruments of investigation, and gave only the results, with synthetic demonstrations.

This opinion is, however, now exploded. A more intimate acquaintance with the writings of the ancient geometers has shown that they had an analysis, but that it was purely geometrical, and essentially different from our algebra.

Although there is no reason to suppose that the great geometers of antiquity derived any aid in their discoveries from the algebraic analysis, yet we find that at a considerably later period it was known to a certain extent among the Greeks.

About the middle of the 4th century of the Christian era, a period when the mathematical sciences were on the decline, and their cultivators, instead of producing original works of genius, contented themselves with commentaries on the works of their more illustrious predecessors, there was a valuable addition made to the fabric of ancient learning.

This was the treatise of Diophantus on arithmetic, consisting originally of thirteen books, of which only the first six, and an incomplete book on polygonal numbers, supposed to be the thirteenth, have descended to our times. Diophantus.

This precious fragment does not exhibit anything like a complete treatise on algebra. It lays, however, an excellent foundation of the science, and the author, after applying his method to the solution of simple and quadratic equations, such as to "find two numbers of which the sum and the sum or difference of the squares are given," proceeds to a peculiar class of arithmetical questions, which belong to what is now called the indeterminate analysis.

Diophantus may have been the inventor of the Greek algebra, but it is more likely that its principles were not unknown before his time; and that, taking the science in the state in which he found it as the basis of his labours, he enriched it with new applications. The elegant solutions of Diophantus show that he possessed great address in the particular branch of which he treated, and that he was able to resolve determinate equations of the second degree. Probably this was the greatest extent to which the science had been carried among the Greeks. Indeed, in no country did it pass this limit, until it had been transplanted into Italy on the revival of learning.

The celebrated Hypatia, the daughter of Theon, composed a commentary on the work of Diophantus. This, however, is now lost, as well as a similar treatise, on the *Conics* of Apollonius, by this illustrious and ill-fated lady, who, as is commonly known, fell a sacrifice to the fury of a fanatical mob about the beginning of the 5th century.

About the middle of the 16th century, the work of Diophantus above referred to, written in the Greek language, was discovered at Rome in the Vatican library, having probably been brought there from Greece when the Turks possessed themselves of Constantinople. A Latin translation, without the original text, was given to the world by Xylander in 1575; and a more complete translation, by Bachet de Mezeriac (one of the earliest members of the French Academy), accompanied by a commentary, appeared in 1621. Bachet was eminently skilful in the indeterminate analysis, and therefore well qualified for the work he had undertaken; but the text of Diophantus was so much in-

jured, that he was frequently obliged to guess the meaning of the author, or supply the deficiency. At a later period, the celebrated French mathematician Fermat supplemented the commentary of Bachet by notes of his own on the writings of the Greek algebraist. These are extremely valuable, on account of Fermat's profound knowledge of this particular branch of analysis. This edition, the best which exists, appeared in 1670.

Arabian writers.

Although the revival of the writings of Diophantus was an important event in the history of mathematics, yet it was not from them that algebra became first known in Europe. This important invention, as well as the numeral characters and decimal arithmetic, was received from the Arabians. That ingenious people fully appreciated the value of the sciences; for at a period when all Europe was enveloped in the darkness of ignorance, they preserved from extinction the lamp of knowledge. They carefully collected the writings of the Greek mathematicians; they translated them into their language, and illustrated them with commentaries. It was through the medium of the Arabic tongue that the elements of Euclid were first introduced into Europe; and a part of the writings of Apollonius are only known at the present day by a translation from the Arabic, the Greek original being lost.

The Arabians ascribe the invention of their algebra to one of their mathematicians, Mahommed-ben-Musa, or Moses, called also Mahommed of Buziana, who flourished about the middle of the 9th century, in the reign of the Caliph Almamoun.

It is certain that this person composed a treatise on this subject, because an Italian translation was known at one time to have existed in Europe, although it is now lost. Fortunately, however, a copy of the Arabic original is preserved in the Bodleian Library at Oxford, bearing a date of transcription corresponding to the year 1342. The title-page identifies its author with the ancient Arabian. A marginal note concurs in this testimony, and further declares the work to be the first treatise composed on algebra among the faithful; and the preface, besides indicating the author, intimates that he was encouraged by Almamoun, commander of the faithful, to compile a compendious treatise of calculation by algebra.

The circumstance of this treatise professing to be only a compilation, and, moreover, the first Arabian work of the kind, has led to an opinion that it was collected from books in some other language. As the author was intimately acquainted with the astronomy and computations of the Hindoos, he may have derived his knowledge of algebra from the same quarter. The Hindoos, as we shall presently see, had a science of Algebra, and knew how to solve indeterminate problems. Hence we may conclude, with some probability, that the Arabian algebra was originally derived from India.

The algebraic analysis, having been once introduced among the Arabians, was cultivated by their own writers. One of these, Mahommed Abulwafa, who flourished in the last forty years of the 10th century, composed commentaries on the writers who had preceded him. He also translated the writings of Diophantus.

It is remarkable, that although the mathematical sciences were received with avidity, and sedulously cultivated during a long period by the Arabians, yet in their hands they received hardly any improvement. It might have been expected that an acquaintance with the writings of Diophantus would have produced some change in their algebra. This, however, did not happen: their algebra continued nearly in the same state, from their earliest writer on the subject, to one of their latest, Behaudin, who lived between the years 953 and 1031.

Writers on the history of algebra were long under a mistake as to the time and manner of its introduction into Europe. It has now, however, been ascertained that the science was brought into Italy by Leonardo, a merchant of Pisa. This ingenious man resided in his youth in Barbary, and there learned the Indian method of counting by the nine numeral characters. Commercial affairs led him to travel into Egypt, Syria, Greece, and Sicily, where we may suppose he made himself acquainted with everything known respecting numbers. The Indian mode of computation appeared to him to be by far the best. He accordingly studied it carefully; and, with this knowledge, and some additions of his own, and also taking some things from Euclid's Geometry, he composed a treatise on arithmetic. At that period algebra was regarded only as a part of arithmetic. It was indeed the sublime doctrine of that science; and under this view the two branches were handled in Leonardo's treatise, which was originally written in 1202, and again brought forward under a revised form in 1228. When it is considered that this work was composed two centuries before the invention of printing, and that the subject was not such as generally to interest mankind, we need not wonder that it was but little known; hence it has always remained in manuscript, as well as some other works by the same author. Indeed it was not known to exist from an early period until the middle of the last century, when it was discovered in the Magliabecchian library at Florence.

Introduction into Europe by Leonardo

The extent of Leonardo's knowledge was pretty much the same as that of the preceding Arabian writers. He could resolve equations of the first and second degrees, and he was particularly skilful in the Diophantine analysis. He was well acquainted with geometry, and he employed its doctrines in demonstrating his algebraic rules. Like the Arabian writers, his reasoning was expressed in words at length; a mode highly unfavourable to the progress of the art. The use of symbols, and the method of combining them so as to convey to the mind at a single glance a long process of reasoning, was a much later invention.

Considerable attention was given to the cultivation of algebra between the time of Leonardo and the invention of printing. It was publicly taught by professors. Treatises were composed on the subject; and two works of the oriental algebraists were translated from the Arabian language into Italian. One was entitled *the Rule of Algebra*, and the other was the oldest of all the Arabian treatises, that of Mahommed-ben-Musa of Corasan.

The earliest printed book on algebra was composed by Lucas Paciolus, or Lucas de Burgo, a minorite friar. It was first printed in 1494, and again in 1523. The title is *Summa de Arithmetica, Geometria, Proportioni, et Proportionalita.*

Lucas de Burgo.

This is a very complete treatise on arithmetic, algebra, and geometry, for the time in which it appeared. The author followed close on the steps of Leonardo; and, indeed, it is from this work that one of his lost treatises has been restored.

Lucas de Burgo's work is interesting, inasmuch as it shows the state of algebra in Europe about the year 1500: probably the state of the science was nearly the same in Arabia and Africa, from which it had been received.

The power of algebra as an instrument of research is in a very great degree derived from its notation, by which all the quantities under consideration are kept constantly in view; but in respect of convenience and brevity of expression, the algebraic analysis in the days of Lucas de Burgo was very imperfect: the only symbols employed were a few abbreviations of the words or names which occurred in the processes of calculation, a kind of short-hand, which formed a very imperfect substitute for that compactness of expression which has been attained by the modern notation.

The application of algebra was also at this period very limited; it was confined almost entirely to the resolution of certain questions of no great interest about numbers. No idea was then entertained of that extensive application which it has received in modern times.

The knowledge which the early algebraists had of their science was also circumscribed: it extended only to the resolution of equations of the first and second degrees; and they divided the last into cases, each of which was resolved by its own particular rule. The important analytical fact, that the resolution of all the cases of a problem may be comprehended in a single formula, which may be obtained from the solution of one of its cases, merely by a change of the signs, was not then known: indeed, it was long before this principle was fully comprehended. Dr Halley expresses surprise, that a formula in optics which he had found, should by a mere change of the signs give the focus of both converging and diverging rays, whether reflected or refracted by convex or concave specula or lenses; and Molyneux speaks of the universality of Halley's formula as something that resembled magic.

The rules of algebra may be investigated by its own principles, without any aid from geometry; and although in some cases the two sciences may serve to illustrate each other, there is not now the least necessity in the more elementary parts to call in the aid of the latter in expounding the former. It was otherwise in former times. Lucas de Burgo found it to be convenient, after the example of Leonardo, to employ geometrical constructions to prove the truth of his rules for resolving quadratic equations, the nature of which he did not completely comprehend; and he was induced by the imperfect nature of his notation to express his rules in Latin verses, which will not now be read with the kind of satisfaction we receive from the perusal of the well-known poem, "the Loves of the Triangles."

As Italy was the first European country where algebra became known, it was there that it received its earliest improvements. The science had been nearly stationary from the days of Leonardo to the time of Paciolus, a period of three centuries; but the invention of printing soon excited a spirit of improvement in all the mathematical sciences. Hitherto an imperfect theory of quadratic equations was the limit to which it had been carried. At last this boundary was passed, and about the year 1505 a particular case of equations of the third degree was resolved by Scipio Ferreus, a professor of mathematics in Bononia. This was an important step, because it showed that the difficulty of resolving equations of the higher orders, at least in the case of the third degree, was not insurmountable, and a new field was opened for discovery. It was then the practice among the cultivators of algebra, when they advanced a step, to conceal it carefully from their contemporaries, and to challenge them to resolve arithmetical questions, so framed as to require for their solution a knowledge of their own new-found rules. In this spirit did Ferreus make a secret of his discovery: he communicated it, however, to a favourite scholar, a Venetian named Florido. About the year 1535 this person, having taken up his residence at Venice, challenged Tartalea of Brescia, a man of great ingenuity, to a trial of skill in the resolution of problems by algebra. Florido framed his questions so as to require for their solution a knowledge of the rule which he had learned from his preceptor Ferreus; but Tartalea had, five years before this time, advanced further than Ferreus, and was more than a match for Florido. He therefore accepted the challenge, and a day was appointed when each was to propose to the other thirty questions. Before the time came, Tartalea had resumed the study of cubic equations, and had discovered the solution of two cases in addition to two which he knew before. Florido's questions were such as could be resolved by the single rule of Ferreus; while, on the contrary, those of Tartalea could only be resolved by one or other of three rules, which he himself had found, but which could not be resolved by the remaining rule, which was also that known to Florido. The issue of the contest is easily anticipated; Tartalea resolved all his adversary's questions in two hours, without receiving one answer from him in return.

Ferreus.

Tartalea.

The celebrated Cardan was a contemporary of Tartalea. This remarkable person was a professor of mathematics at Milan, and a physician. He had studied algebra with great assiduity, and had nearly finished the printing of a book on arithmetic, algebra, and geometry; but being desirous of enriching his work with the discoveries of Tartalea, which at that period must have been the object of considerable attention among literary men in Italy, he endeavoured to draw from him a disclosure of his rules. Tartalea resisted for a time Cardan's entreaties. At last, overcome by his importunity, and his offer to swear on the holy Evangelists, and by the honour of a gentleman, never to publish them, and on his promising on the faith of a Christian to commit them to cypher, so that even after his death they would not be intelligible to any one, he ventured with much hesitation to reveal to him his practical rules, which were expressed by some very bad Italian verses, themselves in no small degree enigmatical. He reserved, however, the demonstrations. Cardan was not long in discovering the reason of the rules, and he even greatly improved them, so as to make them in a manner his own. From the imperfect essays of Tartalea he deduced an ingenious and systematic method of resolving all cubic equations whatsoever; but with a remarkable disregard for the principles of honour, and the oath he had taken, he published in 1545 Tartalea's discoveries, combined with his own, as a supplement to a treatise on arithmetic and algebra, which he had published six years before. This work is remarkable for being the second printed book on algebra known to have existed. Cardan.

In the following year Tartalea also published a work on algebra, which he dedicated to Henry VIII., king of England.

It is to be regretted that in many instances the authors of important discoveries have been overlooked, while the honours due to them have been transferred to others having only secondary pretensions. The formulæ for the resolution of cubic equations are now called Cardan's rules, notwithstanding the prior claim of Tartalea. It must be confessed, however, that he evinced considerable selfishness in concealing his discovery; and although Cardan cannot be absolved from the charge of bad faith, yet it must be recollected that by his improvements in what Tartalea communicated to him, he made the discovery in some measure his own; and he had moreover the high merit of being the first to publish this important improvement in algebra to the world.

The next step in the progress of algebra was the discovery of a method of resolving equations of the fourth order. An Italian algebraist had proposed a question which could not be resolved by the newly invented rules, because it produced a biquadratic equation. Some supposed that it could not be resolved at all; but Cardan was of a different opinion. He had a pupil named Lewis Ferrari, a young man of great genius, and an ardent student in the algebraic analysis: to him Cardan committed the solution of this difficult question, and he was not disappointed. Ferrari not only resolved the question, but he also found a general method of resolving equations of the fourth degree, by making them depend on the solution of equations of the third degree. Ferrari.

This was another great improvement; and although the precise nature of an equation was not then fully understood, nor was it indeed until half a century later, yet, in the general resolution of equations, a point of progress was then reached which the utmost efforts of modern analysis have never been able to pass.

Bombelli. There was another Italian mathematician of that period who did something for the improvement of algebra. This was Bombelli. He published a valuable work on the subject in 1572, in which he brought into one view what had been done by his predecessors. He explained the nature of the *irreducible case* of cubic equations, which had greatly perplexed Cardan, who could not resolve it by his rule; he showed that the rule would apply sometimes to particular examples, and that all equations of this case admitted of a real solution; and he made the important remark, that the algebraic problem to be resolved in this case corresponds to the ancient problem of the trisection of an angle.

There were two German mathematicians contemporary with Cardan and Tartalea, viz., Stifelius and Scheubelius. Their writings appeared about the middle of the 16th century, before they knew what had been done by the Italians. Their improvements were chiefly in the notation. Stifelius, in particular, introduced for the first time the characters which indicate addition and subtraction, and the symbol for the square root.

First English treatise by Recorde of Cambridge. The first treatise on algebra in the English language was written by Robert Recorde, teacher of mathematics and practitioner in physic at Cambridge. At this period it was common for physicians to unite with the healing art the studies of mathematics, astrology, alchemy, and chemistry. This custom was derived from the Moors, who were equally celebrated for their skill in medicine and calculation. In Spain, where algebra was early known, the title of physician and algebraist were nearly synonymous. Accordingly, in the romance of Don Quixote, when the bachelor Samson Carasco was grievously wounded in his rencounter with the knight, an *algebrista* was called in to heal his bruises.

Recorde published a treatise on arithmetic, which was dedicated to Edward VI.; and another on algebra, with the title, *The Whetstone of Wit*, &c. Here, for the first time, the modern sign for equality was introduced.

By such gradual steps did algebra advance in improvement from its first introduction by Leonardo, each succeeding writer making some change for the better; but with the exception of Tartalea, Cardan, and Ferrari, hardly any one rose to the rank of an inventor. At length came Vieta, to whom this branch of mathematical learning, as well as others, is highly indebted. His improvements in algebra were very considerable; and some of his inventions, although not then fully developed, have yet been the germs of later discoveries. He was the first that employed general characters to represent known as well as unknown quantities. Simple as this step may appear, it has yet led to important consequences. He must also be regarded as the first that applied algebra to the improvement of geometry. The older algebraists had indeed resolved geometrical problems, but each solution was particular; whereas Vieta, by introducing general symbols, produced general formulæ, which were applicable to all problems of the same kind, without the trouble of going over the same process of analysis for each.

Vieta.

This happy application of algebra to geometry produced great improvements: it led Vieta to the doctrine of angular sections, one of the most important of his discoveries, which is now expanded into the arithmetic of sines or analytical trigonometry. He also improved the theory of algebraic equations, and he was the first that gave a general method of resolving them by approximation. As he lived between the years 1540 and 1603, his writings belong to the latter half of the 16th century. He printed them at his own expense, and liberally bestowed them on men of science.

Girard. The Flemish mathematician Albert Girard was one of the improvers of algebra. He extended the theory of equations somewhat further than Vieta, but he did not completely unfold their composition; he was the first that showed the use of the negative sign in the resolution of geometrical problems, and the first to speak of *imaginary quantities*. He also inferred by induction that every equation has precisely as many roots as there are units in the number that expresses its degree. His algebra appeared in 1629.

Harriot. The next great improver of algebra was Thomas Harriot, an Englishman. As an inventor he has been the boast of this country. The French mathematicians have accused the British of giving discoveries to him which were really due to Vieta. It is probable that some of these may be justly claimed for both, because each may have made the discovery for himself, without knowing what had been done by the other. Harriot's principal discovery, and indeed the most important ever made in algebra, was, that every equation may be regarded as formed by the product of as many simple equations as there are units in the number expressing its order. This important doctrine, now familiar to every student of algebra, developed itself slowly. It was quite within the reach of Vieta, who unfolded it in part, but left its complete discovery to Harriot.

We have seen the very inartificial form in which algebra first appeared in Europe. The improvements of almost 400 years had not given its notation that compactness and elegance of which it is susceptible. Harriot made several changes in the notation, and added some new signs: he thus gave to algebra greater symmetry of form. Indeed, as it came from his hands, it differed but little from its state at the present time.

Oughtreed. Oughtreed, another early English algebraist, was a contemporary with Harriot, but lived long after him. He wrote a treatise on the subject, which was long taught in the universities.

In tracing the history of algebra, we have seen, that in the form under which it was received from the Arabs, it was hardly distinguishable as a peculiar mode of reasoning, because of the want of a suitable notation; and that, poor in its resources, its applicability was limited to the resolution of a small number of uninteresting numeral questions. We have followed it through different stages of improvement, and we are now arrived at a period when it was to acquire additional power as an instrument of analysis, and to admit of new and more extended applications. Vieta saw the great advantage that might be derived from the application of algebra to geometry. The essay he made in his theory of angular sections, and the rich mine of discovery thus opened, proved the importance of his labours. He did not fully explore it, but it has seldom happened that one man began and completed a discovery. He had, however, an able and illustrious successor in Descartes, who, employing in the study of algebra that high power of intellect with which he was endowed, not only improved it as an abstract science, but, more especially by its application to geometry, laid the foundation of the great discoveries which have since so much engaged mathematicians, and have made the last two centuries ever memorable in the history of the progress of the human mind.

Descartes.

Descartes' grand improvement was the application of algebra to the doctrine of curve lines. As in geography we refer every place on the earth's surface to the equator, and

to a determinate meridian, so he referred every point of a curve to some line given by position. For example, in a circle, every point in the circumference might be referred to the diameter. The perpendicular from any point in the curve, and the distance of that perpendicular from the centre or from the extremity of a diameter, were lines which, although varying with every change of position in the point from which the perpendicular was drawn, yet had a determinate relation to each other, which was the same for all points in the curve depending on its nature, and which, therefore, served as a characteristic to distinguish it from all other curves.

The relations of lines drawn in this way could be readily expressed in algebraic symbols; and the expression of this relation in general terms constituted what is called the *equation* of the curve.

This might serve as its definition; and from the equation by the processes of algebra, all the properties of the curve could be investigated.

Descartes' *Geometry* (or, as it might have been named, the application of algebra to geometry) appeared first in 1637. This was six years after the publication of Harriot's discoveries, which was a posthumous work. Descartes availed himself of some of Harriot's views, particularly the manner of generating an equation, without acknowledgment; and on this account Dr Wallis, in his algebra, has reflected with considerable severity on the French algebraist. This spirit has engendered a corresponding eagerness in the French mathematicians to defend him. Montucla, in his history of the mathematics, has evinced a strong national prejudice in his favour; and, as usually happens, in order to exalt him, he hardly does justice to Harriot, the idol of his adversaries.

The new views which the labours of Vieta, Harriot, and Descartes opened in geometry and algebra were seized with avidity by the powerful minds of men eager in the pursuit of real knowledge. Accordingly, we find in the 17th century a whole host of writers on algebra, or algebra combined with geometry.

Our limits will not allow us to enter minutely into the claims which each has on the gratitude of posterity. Indeed, in pure algebra the new inventions were not so conspicuous as the discoveries made by its applications to geometry, and the new theories which were suggested by their union. The curious speculations of Kepler concerning the solids formed by the revolutions of curvilinear figures, the Geometry of Indivisibles by Cavalerius, the Arithmetic of Infinites of Wallis, and, above all, the Method of Fluxions of Newton, and the Differential and Integral Calculus of Leibnitz, are fruits of the happy union. All these were agitated incessantly by their inventors and contemporaries; by such men as Barrow, James Gregory, Wren, Cotes, Taylor, Halley, De Moivre, Maclaurin, Stirling, and others, in this country; and abroad by Roberval, Fermat, Huyghens, the two Bernoullis, Pascal, and many others.

The first half of the 18th century produced little in the way of addition either to pure algebra or to its applications. Men were employed rather in elaborating and working out what Newton, Leibnitz, and Descartes had originated, than in exercising themselves in independent investigations. There are, indeed, to be found some names of eminence associated with the science of algebra, such as Maclaurin, but their eminence will be found to depend on their connection with the extensions of the science, rather than with the science itself. It was reserved for Lagrange, in the latter part of the century, to give a new impulse to extension in pure algebra, in a direction which has led to most important results. Not only did he, in his *Traité de la Resolution des Equations Numériques*, lay the foundation on which Budan, Fourier, Sturm, and others, have built a goodly fabric after the pattern of the *Universal Arithmetic* of Newton, but in his *Théorie des fonctions analytiques*, and *Calcul des fonctions*, he endeavoured, and with a large amount of success, to reduce the higher analysis (the Fluxions of Newton), to the domain of pure algebra. Nor must the labours of a fellow-workman, Euler, be forgotten. In his voluminous and somewhat ponderous writings will be found a perfect storehouse of investigations on every branch of algebraical and mechanical science. Especially pertinent to our present subject is his demonstration of the Binomial Theorem in the *Novi Commentarii*, vol. xix., which is probably the original of the development that Lagrange makes the basis of his analysis (*Calcul des fonctions*, leçon seconde), and which for simplicity and generality leaves nothing to be desired.

Lagrange.

Euler.

This brings the history down to the close of the last century. We have been as copious as our limits would permit on the early history, because it presents the interesting spectacle of the progress of a science from an almost imperceptible beginning, until it has attained a magnitude too great to be fully grasped by the human mind.

It will be seen from what precedes, that we have not limited "algebra" to the pure science, but have retained the name when it has encroached on the territories of geometry, trigonometry, and the higher analysis. To continue to trace its course through all these branches during the present century, when it has extended into new directions within its own borders, would far exceed the limits of an introductory sketch like the present. We must, therefore, necessarily limit ourselves to what has been done in the Theory of Equations (which may be termed algebra proper), and in Determinants.

Theory of Equations.

Theory of Equations.—That every numerical equation has a root—that is, some quantity in a numerical form, real or imaginary, which, when substituted for the unknown quantity in the equation, shall render the equation a numerical identity—appears to have been taken for granted by all writers down to the time of Lagrange. It is by no means self-evident, nor is it easy to afford evidence for it which shall be at the same time convincing and free from limitations. The demonstrations of Lagrange, Gauss, and Ivory, have for simplicity and completeness given way to that of Cauchy, published first in the *Journal de l'École Polytechnique*, and subsequently in his *Cours d'Analyse Algébrique*.

Cauchy.

The demonstration of Cauchy (which had previously been given by Argand, though in an imperfect form, in *Gergonne's Annales des Mathématiques*, vol. v.) consists in showing that the quantity which it is wished to prove capable of being reduced to zero, can be exhibited as the product of two factors, one of which is incapable of assuming a minimum value, or, in other words, that a less value than one assigned can always be found, and therefore that it is capable of acquiring the value zero. This argument, if not absolutely free from objection, is less objectionable than any of the others. The reader may consult papers by Airy and De Morgan, in the tenth volume of the *Transactions of the Cambridge Philosophical Society*.

General solution of equations of the fifth and higher orders, still a desideratum.

Admitting, then, that every equation has a root, it becomes a question to what extent are we in possession of an analysis by which the root can be ascertained. If the question be put absolutely, we fear, the answer must be, that in this matter we are in the same position that we have held for the last three centuries. Cubic and biquadratic equations can be solved, whatever they may be; but equations of higher orders, in which there exists no relation amongst the several coefficients, and no known or assumed connection between the different roots, have baffled all

attempts at their solution. Much skill and ingenuity have been displayed by writers of more or less eminence in the attempt to elaborate a method of solution applicable to equations of the fifth degree, but they have failed; whether it be that, like the ancient problems of the quadrature of the circle, and the duplication of the cube, an absolute solution is an impossibility, or whether it is reserved for future mathematicians to start in the research in some new path, and reach the goal by avoiding the old tracks which appear to have been thoroughly traversed in vain.

It is scarcely necessary to refer to such writers as Hoene de Wronski, who, in 1811, announced a general method of solving all equations, giving formulæ without demonstration. In 1817, the Academy of Sciences of Lisbon proposed as the subject of a prize, the *demonstration* of Wronski's formulæ. The prize was in the following year awarded to M. Torriani for the refutation of them.

The reader will find in the fifth volume of the *Reports of the British Association*, an elaborate report by Sir W. R. Hamilton on a Method of Decomposition, proposed by Mr G. B. Jerrard in his *Mathematical Researches*, published at Bristol in a work of great beauty and originality, but which Hamilton is compelled to conclude fails to effect the desired object. In fact, the method which is valid when the proposed equation is itself of a sufficiently elevated degree, fails to reduce the solution of the equation of the fifth degree to that of the fourth.

But although the absolute solution of equations of higher orders than the fourth remains amongst the things uneffected, and rather to be hoped for than expected, a very great deal has been done towards preparing the way for approximate, if not for absolute solutions.

In the first place, equations of the higher orders, when they assume certain forms, have been shown to be capable of solution. An equation of this kind, to all appearance of a very general and comprehensive form, had been solved by De Moivre in the *Philosophical Transactions* for 1737. Binomial equations had advanced under the skilful hands of Gauss, who, in his *Disquisitiones Arithmeticae*, which appeared in 1801, added largely to what had been done by Vandermonde in the classification and solution of such equations; and subsequently, Abel, a mathematician of Norwegian birth, who died too early for science, completed and extended what Gauss had left imperfect. The collected writings of Abel published at Christiania in 1839, contain original and valuable contributions to this and many other branches of mathematics.

Gauss.

Abel.

But it is not in the solution of equations of certain forms that the greatest advance has been made during the present century. The basis of all methods of solution must evidently be found in the previous separation of the roots, and the efforts of mathematicians have been directed to the discovery of methods of effecting this. The object is not so much to classify the roots into positive and negative, real and imaginary, as to determine the situation and number of the real roots of the equation. The first writer on the subject whose methods appeared in print is Budan, whose treatise, entitled *Nouvelle méthode pour la résolution des équations numériques*, appeared in 1807. But there is evidence that Fourier had delivered lectures on the subject prior to the publication of Budan's work, and consequently, without detriment to the claims of Budan, we may admit that the most valuable and original contribution to the science is to be found in Fourier's posthumous work, published by Navier in 1831, entitled *Analyse des équations déterminées*. The theorem which Fourier gave for the discovery of the position, within narrow limits, of a root of an equation, is one of two theorems, each of which is known by mathematicians as "Fourier's Theorem." The other is a theorem of integration, and occurs in the author's magnificent work *Théorie de la Chaleur*. During the interval between the publication of Budan's work and that of Fourier, there appeared a paper in the *Philosophical Transactions of the Royal Society* for 1819, by W. G. Horner, upon a new method of solving arithmetical equations. From its being somewhat obscurely expressed, the great originality of the memoir did not at once appear. Gradually, however, Mr Horner's method came to be appreciated, and it now ranks as one of the best processes, approaching, in some points, to Fourier's. In the *Mémoires des savans étrangers* for 1835, appears a memoir, which, if it does not absolutely supersede all that had been previously done in assigning the positions of the real roots of equations, yet in simplicity, completeness, and universality of application, surpasses them all. The author, M. Sturm, of French extraction, but born at Geneva, has in this memoir linked his name to a theorem which is likely to retain its place amongst the permanent extensions of the domain of analysis as long as the study of algebra shall last. It was presented to the Academy in 1829.

Budan.

Fourier.

Horner.

Sturm.

Determinants.—The solution of simultaneous equations of the first degree may be presented under the form of a set of fractions, the numerators and denominators of which are symmetric products of the coefficients of the unknown quantities in the equations. These products were originally known as *resultants*, a name applied to them by Laplace, and retained as late as 1841 by Cauchy in his *Exercices d'analyse et de physique mathématique*, vol. ii. p. 161, but now replaced by the title *determinants*, a name first applied to certain forms of them by Gauss. In his *Cours d'analyse algébrique*, Cauchy terms them *alternate* functions. The germ of the theory of determinants is to be found in the writings of Leibnitz, who, indeed, was far-seeing enough to anticipate for it some of the power which, about a century after his time, it began to attain. More than half that period had indeed elapsed before any trace of its existence can be found in the writings of the mathematicians who succeeded Leibnitz. The revival of the method is due to Cramer, who, in a note to his *Analyse des lignes courbes algébriques*, published at Geneva in 1750, gave the rule which establishes the sign of a product as *plus* or *minus*, according as the number of displacements from the typical form has been even or odd. Cramer was followed in the last century by Bézout, Laplace, Lagrange, and Vandermonde. In 1801 appeared the *Disquisitiones Arithmeticae* of Gauss, of which a French translation by M. Poullet-Delisle was given in 1807. Notwithstanding the somewhat obscure form in which this work was presented, its originality gave a new impetus to investigations on this and kindred subjects. To Gauss is due the establishment of the important theorem, that the product of two determinants both of the second and third orders is a determinant. Binet, Cauchy, and others followed, and applied the results to geometrical problems. In 1826, Jacobi commenced a series of papers on the subject in *Crelle's Journal*. In these papers, which extended over a space of nearly twenty years, the subject was recast and made available for ordinary readers; and at the same time it was enriched by new and important theorems, through which the name of Jacobi is indissolubly associated with this branch of science. Following the steps of Jacobi, a number of mathematicians of no mean power have entered the field. Pre-eminent above all others are two British names, those of Sylvester and Cayley. By their originality, by their fecundity, by their grasp of all the resources of analysis, these two powerful mathematicians have enriched the *Transactions of the Royal Society*, *Crelle's Journal*, the *Cambridge and Dublin Mathematical Journal*, and the *Quarterly Journal of Mathematics*, with papers on this and on kindred branches of science of such value as

Determinants.

Leibnitz.

Cramer.

Gauss.

Jacobi.

Sylvester.

Cayley.

to have placed their authors at the head of living mathematicians. The reader will find the subject admirably treated in Baltzer's *Theorie und Anwendung der Determinenten;* and more briefly in Salmon's *Higher Algebra.* Elementary treatises have also been published by Spottiswoode in 1851, by Brioschi in 1854, by Todhunter in his *Theory of Equations* in 1861, and by Dodgson in 1867.

Indian Algebra.

The attention of the learned has, during the present century, been called to a branch of the history of algebra, in no small degree interesting; we mean the cultivation of the science to a considerable extent, and at a remote period, in India.

We are indebted, we believe, to Mr Reuben Burrow for some of the earliest notices which reached Europe on this very curious subject. His eagerness to illustrate the history of the mathematical sciences led him to collect oriental manuscripts, some of which, in the Persian language, with partial translations, were bequeathed to his friend Mr Dalby of the Royal Military College, who communicated them to such as took an interest in the subject, about the year 1800.

In the year 1813, Mr Edward Strachey published in this country a translation from the Persian of the *Bija Ganita* (or *Vija Ganita*), a Hindoo treatise on algebra; and in 1816 Dr John Taylor published at Bombay a translation of *Lelawati* (or *Lilavati*), from the Sanscrit original. This last is a treatise on arithmetic and geometry, and both are the production of an oriental algebraist, Bhascara Acharya. Lastly, in 1817, there came out a work entitled *Algebra, Arithmetic, and Mensuration, from the Sanscrit of Brahmegupta and Bhascara,* translated by Henry Thomas Colebrooke, Esq. This contains four different treatises, originally written in Sanscrit verse, viz., the *Vija Ganita* and *Lilavati* of Bhascara Acharya, and the *Ganitad'haya* and *Cuttacad'hyaya* of Brahmegupta. The first two form the preliminary portion of Bhascara's Course of Astronomy, entitled *Sidd'hanta Siromani,* and the last two are the twelfth and eighteenth chapters of a similar course of astronomy, entitled *Brahma-sidd'hanta.*

The time when Bhascara wrote is fixed with great precision, by his own testimony and other circumstances, to a date that answers to about the year 1150 of the Christian era. The works of Brahmegupta are extremely rare, and the age in which he lived is less certain. Mr Davis, an oriental scholar, who first gave the public a correct view of the astronomical computations of the Hindoos, is of opinion that he lived in the 7th century; and Dr William Hunter, another diligent inquirer into Indian science, assigns the year 628 of the Christian era as about the time he flourished. From various arguments, Mr Colebrooke concludes that the age of Brahmegupta was antecedent to the earliest dawn of the culture of the sciences among the Arabians, so that the Hindoos must have possessed algebra before it was known to that nation.

Brahmegupta's treatise is not, however, the earliest work known to have been written on this subject. Ganessa, a distinguished astronomer and mathematician, and the most eminent scholiast of Bhascara, quotes a passage from a much older writer, Arya-Bhatta, specifying algebra under the designation of *Vija,* and making separate mention of *Cuttaca,* a problem subservient to the resolution of indeterminate problems of the first degree. He is understood by another of Bhascara's commentators to be at the head of the older writers. They appear to have been able to resolve quadratic equations by the process of completing the square; and hence Mr Colebrooke presumes that the treatise of Arya-Bhatta then extant extended to quadratic equations in the determinate analysis, and to indeterminate equations of the first degree, and probably to those of the second.

The exact period when Arya-Bhatta lived cannot be determined with certainty; but Mr Colebrooke thinks it probable that this earliest of known Hindoo algebraists wrote as far back as the fifth century of the Christian era, and perhaps earlier. He lived therefore nearly as early as the Grecian algebraist Diophantus, who is reckoned to have flourished in the time of the emperor Julian, or about A.D. 360.

Mr Colebrooke has instituted a comparison between the Indian algebraist and Diophantus, and found reason to conclude that in the whole science the latter is very far behind the former. He says the points in which the Hindoo algebra appears particularly distinguished from the Greek are, besides a better and more convenient algorithm, 1*st*, the management of equations of more than one unknown quantity; 2*d*, the resolution of equations of a higher order, in which, if they achieved little, they had at least the merit of the attempt, and anticipated a modern discovery in the resolution of biquadratics; 3*d*, general methods for the resolution of indeterminate problems of the first and second degrees, in which they went far indeed beyond Diophantus, and anticipated discoveries of modern algebraists; and 4*th*, the application of algebra to astronomical investigations and geometrical demonstration, in which also they hit upon some matters which have been re-invented in modern times.

When we consider that algebra made little or no progress among the Arabians, a most ingenious people, and particularly devoted to the study of the sciences, and that centuries elapsed from its first introduction into Europe until it reached any considerable degree of perfection, we may reasonably conjecture that it may have existed in one shape or other in India long before the time of Arya-Bhatta; indeed, from its close connection with their doctrines of astronomy, it may be supposed to have descended from a very remote period along with that science. Professor Playfair, adopting the opinion of Bailly, the eloquent author of the *Astronomie Indienne,* with great ingenuity attempted to prove, in a *Memoir on the Astronomy of the Brahmins,* that the observations on which the Indian astronomy is founded were of great antiquity, indeed more than 3000 years before the Christian era. The very remote origin of the Indian astronomy had been strongly questioned by many in this country, and also on the Continent; particularly by Laplace, and by Delambre in his *Histoire de l'Astronomie Ancienne,* tome i. p. 400, &c., and again in *Histoire de l'Astronomie du Moyen Age, Discours Préliminaire,* p. 18, &c., where he speaks slightingly of their algebra; and in this country, Professor Leslie, in his *Philosophy of Arithmetic,* pp. 225 and 226, calls the *Lilavati* "a very poor performance, containing merely a few scanty precepts couched in obscure memorial verses." We are disposed to agree with Professor Leslie as to the value, and with Professor Playfair as to the antiquity of this Hindoo algebra. That it should have remained in a state of infancy for so many centuries is accounted for by the latter author in the following passage:—"In India everything [as well as algebra] seems equally insurmountable, and truth and error are equally assured of permanence in the stations they have once occupied. The politics, the laws, the religion, the science, and the manners, seem all nearly the same as at the remotest period to which history extends. Is it because the power which brought about a certain degree of civilisation, and advanced science to a certain height, has either ceased to act, or has met with such a resistance as it is barely able to overcome? or is it because the discoveries which the Hindoos are in possession of are an inheritance from some more inventive and more ancient

people, of whom no memorial remains but some of their attainments in science?"

Writers on Algebra.

Diophantus, *Arithmeticorum Libri sex*, about A.D. 360 (First edition of his writings, 1575; the best, 1670.)
Leonardo Bonacci (his works described in Cossali) 1202
Lucas Paciolus, or De Burgo, *Summa de Arithmetica*, &c. 1494
Rudolff, *Algebra*..........1522
Stifelius, *Arithmetica Integra*, &c. 1544
Cardan, *Ars Magna quam vulgo Cossam vocant* 1545
Ferreus 1545
Ferrari (first resolved biquadratic equations) 1545
Tartalea, *Quesiti ed Inventioni diverse* 1546
Scheubelius, *Algebra Compendiosa* 1551
Recorde, *Whetstone of Wit* 1557
Peletarius, *De Occulta parte Numerorum* 1558
Buteo, *De Logistica* 1559
Ramus, *Arithmeticae Libri duo et totidem Algebrae*...1560
Pedro Nugnez or Nonnius, *Libro de Algebra*, &c. ...1567
Jossalin, *De Occulta parte Mathematicorum* 1576
Bombelli 1579
Clavius 1580
Bernard Solignac, *Arith. Libri ii. et Algebrae totidem* 1580
Stevinus, *Arithmétique, &c. aussi l'Algèbre* 1585
Vieta, *Opera Mathematica*, 1600
Folinus, *Algebra, sive Liber de Rebus Occultis* 1619
Van Ceulen..........1619
Bachet, *Diophantus cum Commentariis*..........1621
Albert Girard, *Invention Nouvelle en Algèbre* 1629
Ghetaldus, *De Resolutione et Compositione Mathematica* 1630
Harriot, *Artis Analyticae Praxis* 1631
Oughtreed, *Clavis Mathematica* 1631
Herigonius, *Cursus Mathematicus* 1634
Cavalerius, *Geometria Indivisibilibus Continuorum, &c.* 1635
Descartes, *Geometria*.........1637
Franciscus à Schooten, Florimond de Beaune, Erasmus Bertholinus, Joh. Hudde, F. Rabuel, James Bernoulli, John de Witt, &c.—*Commentators on Descartes.*
Roberval, *De Recognitione Aequationum*, &c. 1640
De Billy, *Nova Geometricae Clavis Algebra* 1643
Renaldinus, *Opus Algebraicum* 1644
Pascal 1654
Wallis, *Arithmetica Infinitorum*, 1655; *Algebra*, 1685
Slusius, *Mesolabum* 1659
Rhonius, *Algebra* (translated into English).........1659
Kinckhausen, used as a text-book by Sir I. Newton...1661
Sir Isaac Newton, *The Binomial Theorem*..........1666
Frenicle, Various papers in *Mem. of French Acad.* ...1666
Pell (translated and improved Rhonius' Algebra) 1668
James Gregory, *Exercitationes Geometricae* 1668
Mercator, *Logarithmotechnia* 1668
Barrow, in *Lectiones Geometricae* 1669
Kersey, *Elements of Algebra* 1673
Prescot, *Nouveaux Elémens de Mathématiques* 1675
Leibnitz, in *Leipsic Acts*, &c. 1677
Fermat, in *Varia Opera Mathematica* 1679
Bulliald, *Opus Novum ad Arithmeticam Infinitorum* 1682
Tschirnhausen, in the *Leipsic Acts*..........1683
Baker, *Geometrical Key*, &c. 1684
Dr Halley, in *Philosophical Transactions* ...1687 and 1694
Rolle, *Une Méthode pour la Résolution des Equations Indéterminées* 1690
Raphson, *Analysis Aequationum Universalis* 1690
Dechales, *Cursus seu Mundus Mathematicus* 1690
De Lagny, various pieces on Equations 1692
Alexander, *Synopsis Algebraica* 1693
Ward, *Compendium of Algebra*, 1695; *Young Mathematician's Guide* 1706
De Moivre, various Memoirs in *Phil. Trans.* ...1697–1730
Sault, *New Treatise of Algebra* 1698
Christopher, *De Constructione Aequationum*.........
Ozanam, *Nouveaux Elémens d'Algèbre*..........1702
Harris, *Lexicon Technicum* 1704
Guisnée, *Application de l'Algèbre à la Géométrie*..1705
Jones, *Synopsis Palmariorum Matheseos* 1706
Newton, *Arithmetica Universalis* 1707
L'Hôpital, *Traité Analytique des Sections Coniques* 1707
Reyneau, *Analyse Démontrée* 1708
Brooke Taylor, *Methodus Incrementorum* 1715
Stirling, *Lineae Tertii Ordinis*, 1717; *Methodus Differentialis* 1730
Nicole, On Cubic Equations, in *Mém. Acad. des Sciences* 1717
S'Gravesande, *Algebra* 1727
Wolfius, *Algebra: Cursus Mathematicus*..........1732
Kirby, *Arithmetic and Algebra* 1735
James Gregory 1736
Simpson, *Algebra*, and various works 1740, 1742
Saunderson, *Algebra*, 2 vols. 4to 1740
La Caille, *Algebra* in *Leçons de Mathématiques* 1741
De Gua, On the Roots of Equations, in *Mém. Acad. des Sciences*..........1741
Clairaut, *Elémens d'Algèbre* 1746
Maclaurin, *Algebra* 1747
Fontaine, *L'Art de Résoudre les Equations* 1747
Donna Maria Gaetana Agnesi, *Instituzioni Analitichi* 1748
Boscovich, in *Elementa Universae Matheseos* 1754
Segner, *Berlin Mem.*..........1756
Castillon, *Arithmetica Universalis Newtoni cum Commentario* 1761
Emerson, *Algebra, &c.* ...1763
Landen, *Residual Analysis*, &c. 1764
Lagrange, *Traité de la Résolution des Equations Numériques*, *Recueil des Mém. de l'Acad. de Berlin*..........1767
Do. republished with Notes, Paris 1797
Euler, *Algebra* 1770
Waring, *Meditationes Algebraicae, &c.* 1770, 1776
Soladini, *Compendio d'Analisi* 1775
Paoli, *Elementi d'Algebra* ..1794
Ruffini, *Teoria delle Equazione Algeb.* 1799
Budan, *Nouvelle Méthode pour la Résolution des Equations Numériques* ...1807
Gompertz, *Principles and Application of Imaginary Quantities* .....1817 and 1818
Biot, *Gergonne's Annales*, vol. vi.
Horner, *Philos. Trans.* 1819
Dandelin, *Mém. de l'Acad. Roy. de Bruxelles* 1826
Swinburne and Tylecote, *on the Binomial Theorem* 1827
Warren, *on the Geometric Representation of the Square Roots of Negative Quantities* 1828
Abel, *Mémoire sur les Equations Algébriques*, Christiania ....1829 and in *Crelle*, vol. i. 4.
Fourier, *Analyse des Equations Déterminées* (posthumous), with preface by Navier.. 1831
Malfatti, *Mem. della Soc. Ital.*, vol. xi.
Davies Gilbert, *Philos. Trans.*..........1831
Sturm, *Mém. présentés par les Savans Etrangers*......1835
Lockhart, *Resolution of Equations* 1837

To the preceding list of writers, which contains almost all of an early date, the following are to be added:—

Arbogast, *Calcul des Dérivations.*
The Bernoullis, Begnalt, Bertrand, Bezout (*Cours des Mathématiques*), Bossuet, Burja, Brunacci, Babbage, Bridges, Bland, Budan, Bonnycastle, Bourdon, Barlow (on the *Theory of Numbers*), Baltzer (on *Determinants*).
Cousin, Cauchy, Coignet, Carnot, Cayley, Cockle.
Degraave, Ditton, Dodgson (on *Determinants*).
Frisius, Francœur, Frend.
Gauss, *Disquisitiones Arithmeticae*, 1801.
Hemischius, Hales, Hirsch, Hutton, Holdred, Horner, Hargreaves.
Kuhnius, Kramp, Kaestner.
Laloubre, Lorgna, Le Blonde, Lee, Lacroix, Ludlam, Legendre (on the *Theory of Numbers*), L'Huillier, Leroy.
Mescher, Malebranche, Manfredi, Maseres, Murphy.
Nicholson, Nieuwentijdt, (*Analysis Infinitorum*).
Polleti, Poignard (on *Magic Squares*), Playfair.
Rowning, Reimer.
Suremain-Missery (on *Impossible Quantities*), Schonerus, Salignut, Sturm, Serret, Salmon, Sylvester.
Trail, Tedenat, Thacker.
Vilent, Vandermonde.
Warren, Wells, Wilson, Wood, Woodhouse.
Young.
Elementary Treatises of Bryce, Colenso, De Morgan, Hind, Kelland, Peacock, Todhunter.

Writers on the History of Algebra.

Wallis, in his *Algebra;* Maseres, *Scriptores Logarithmici*, 1791, Montucla, in *Histoire des Mathématiques;* Bossuet, *Histoire des Mathématiques;* Cossali, *Origine, Trasporto in Italia, e Primi Progressi in Essa dell' Algebra*, 2 vols. printed in 1797; Hutton, in his *Dictionary*, and more diffusely in his *Tracts*, vol. ii.; *Libri Histoire des Sciences Mathématiques en Italie*, Paris 1838.
Terquem, *Bulletin de Bibliographie.*
Peacock, *Report of British Association*, 1833.

For the titles of works on Algebra, consult Murhard, *Bibliotheca Mathematica;* and for Memoirs on Algebra, in Academical Collections, see Reuss, *Repertorium Commentationum*, tom. vii.; Smith (on the *Theory of Numbers*), Brit. Assoc. 1859–60, 1862–63.

NOTATION AND FIRST PRINCIPLES.

1. In arithmetic there are ten characters, which being variously combined, according to certain rules, serve to denote all numerical magnitudes whatever. But this method of expressing *quantities* (a phrase used to designate

something more than mere numbers), is found to be inadequate, taken by itself, to the more difficult cases of mathematical investigation; and it is therefore necessary, in many inquiries concerning the relations of magnitude, to have recourse to that more general mode of notation, and more extensive system of operations, which constitute the science of algebra.

In algebra quantities of every kind may be denoted by any characters whatever, but those commonly used are the letters of the alphabet; and as in the simplest mathematical problems there are certain magnitudes given, in order to determine other magnitudes which are unknown, the first letters of the alphabet, a, b, c, &c., are used to denote known quantities, while those to be found are represented by v, x, y, &c., the last letters of the alphabet.

Definitions of signs.

2. The sign + (*plus*) denotes, in arithmetic, that the quantity before which it is placed is to be added to some other quantity. Thus, $a+b$ denotes the sum of a and b; $3+5$ denotes the sum of 3 and 5, or 8.

The sign − (*minus*) signifies that the quantity before which it is placed is to be subtracted. Thus, $a-b$ denotes the excess of a above b; $6-2$ is the excess of 6 above 2, or 4.

Quantities which have the sign + prefixed to them are called *positive*, and such as have the sign − are called *negative*.

When no sign is prefixed to a quantity, + is always understood, or the quantity is to be considered as positive.

Quantities which have the same sign, either + or −, are said to have like signs. Thus, $+a$ and $+b$ have like signs, but $+a$ and $-c$ have unlike signs.

3. A quantity which consists of one *term* is said to be *simple;* but if it consist of several terms, connected by the signs + or −, it is then said to be compound. Thus, $+a$ and $-c$ are simple quantities; and $b+c$, and $a+b-d$, are compound quantities.

4. To denote the product arising from the multiplication of quantities, they are either joined together, as if intended to form a word, or else they are connected together, with the sign × or . interposed between every two of them. Thus, ab, or $a \times b$, or $a \,.\, b$, denotes the product of a and b; also abc, or $a \times b \times c$, or $a \,.\, b \,.\, c$, denotes the product of a, b, and c. If some of the quantities to be multiplied be compound, each of these has a line drawn over it called a vinculum, and the sign × is interposed, as before. Thus, $a \times \overline{c+d} \times \overline{e-f}$ denotes that a is to be considered as one quantity, the sum of c and d as a second, and the difference between e and f as a third; and that these three quantities are to be multiplied into one another. Instead of placing a line over such compound quantities as enter a product, we may enclose each of them between two parentheses, so that the last product may be otherwise expressed thus, $a(c+d)(e-f)$; or thus, $a \times (c+d) \times (e-f)$.

A number prefixed to a letter is called a *numerical coefficient*, and denotes how often that quantity is to be taken. Thus, $3a$ signifies that a is to be taken three times. When no number is prefixed, the coefficient is understood to be unity.

5. The quotient arising from the division of one quantity by another is often expressed by placing the *dividend* above a line, and the *divisor* below it. Thus, $\frac{12}{3}$ denotes the quotient arising from the division of 12 by 3, or 4; $\frac{b}{a}$ denotes the quotient arising from the division of b by a.

6. The equality of two quantities is expressed by putting the sign = between them. Thus, $a+b=c-d$ denotes that the sum of a and b is equal to the excess of c above d.

7. Simple quantities, or the terms of compound quantities, are said to be *like*, which consist of the same letter or letters taken together in the same way. Thus, $+ab$ and $-5ab$ are like quantities, but $+ab$ and $+abb$ are unlike.

There are some other characters, such as > for *greater than*, < for *less than*, ∴ for *therefore*, which will be explained when we have occasion to use them; and in what follows we shall suppose that the operations and notation of common arithmetic are sufficiently understood.

Extension of definitions.

8. As the science extends itself beyond its original boundaries, it begins gradually to appear that the limits imposed by these definitions have been transgressed, so that almost insensibly the symbols have acquired for themselves significations much more comprehensive than those originally attached to them. Thus, were $+a$ to signify a *gain* of £a, $-a$ would signify a *loss* of the same sum; were $+a$ to signify motion *forwards* through a feet, $-a$ would signify motion *backwards* through the same space. The extended definitions of + and − may now be such as the following: + and − are *collective* symbols of operations the reverse of each other. From similar considerations to those by which the signification of + and − has been extended, we extend that of × and ÷ to something like the following: × and ÷ are *cumulative* symbols of operations the inverse of each other. We may now exhibit the most general definition of the four symbols in the following form: + and − are symbols of operations prefixed to algebraical symbols of quantity, and are such that $+a-a=+0$ or -0, where $+0$ means simply or very nearly *increased* by 0; -0, *diminished* by 0. × and ÷ are symbols of operations prefixed to algebraical symbols of quantity, and are such that $\times a \div a = \times 1$ or $\div 1$, where $\times 1$ means simply or very nearly *multiplied* by 1; $\div 1$, *divided* by 1.

Laws of combination.

9. The laws by which the symbols are combined are the same as in arithmetic. It is desirable, however, to exhibit them. They are three,—

LAW I. Quantities affected by the signs + and − are in no way influenced by the quantities to which they are united by these signs.

LAW II. *The Distributive Law.*—Additions and subtractions may be performed in any order.

LAW III. *The Commutative Law.*—Multiplications and divisions may be performed in any order.

We may remark that these laws are *assumed* for algebra, so that the science is limited by their applicability. Algebra has been extended into the science of quaternions by freeing it from part of the limitation imposed by the third of these laws. In this new science ab is *not* the same thing as ba.

Examples.

We add a few examples of the substitution of numbers for letters. (*Ex.* 3 and 4 involve processes that will be explained later.)

Ex. 1. If $a=1$, $b=2$, $c=3$, find the value of $(a+b+c) \,.\, (a+2b-c) \,.\, (b+2c-a)$.

It is $(1+2+3) \,.\, (1+4-3) \,.\, (2+6-1)=84$.

Ex. 2. If $a=\frac{1}{2}$, $b=\frac{1}{3}$, $c=\frac{1}{4}$, $x=0$ find the value of $\frac{a}{b}+\frac{b}{c}+\frac{c}{a}+x^2$

It is $\frac{3}{2}+\frac{4}{3}+\frac{1}{2}+0=3\frac{1}{3}$

Ex. 3. With the same data as in example 2, find the value of $\frac{a^2-b^2}{x}-\frac{b^2-c^2}{x^2}$

The first term is infinite, and the second is infinitely greater than the first, because $x^2=x \times x$ ∴ the answer is $-\infty$.

Ex. 4. If $x=\frac{1}{y}=\frac{1}{z}=0$; find the value of

$$2xy-\frac{z}{2x}+\frac{x}{z}+\frac{2y}{x}-\frac{3}{2}\left(\frac{x}{z}+y\right)\left(\frac{x}{y}+z\right).$$

Write down the expression in x by putting $\frac{1}{x}$ for y, &c.

It becomes

$$2-\frac{1}{2x^3}+x^2+\frac{2}{x^3}-\frac{3}{2}\left(x^2+\frac{1}{x}\right)\left(x^2+\frac{1}{x}\right)$$
$$=2+\frac{3}{2}\frac{1}{x^3}+x^2-\frac{3}{2}\frac{1}{x^3}+\text{ \&c.}$$
$$=2\cdot\text{ because } x=0.$$

Sect. I.—Fundamental Operations.

The primary operations in algebra are the same as in common arithmetic—namely, addition, subtraction, multiplication, and division; and from the various combinations of these four, all the others are derived.

I. *Addition.*

10. In addition there may be three cases: the quantities to be added may be like, and have like signs; or they may be like, and have unlike signs; or, lastly, they may be unlike.

Case 1. To add quantities which are like, and have like signs.

Rule. Add together the coefficients of the quantities, prefix the common sign to the sum, and annex the letter or letters common to each term.

Examples.

$$\text{Add together}\begin{cases}+\ 7a\\+\ 3a\\+\ \ a\\+\ 2a\end{cases}\qquad\text{Add together}\begin{cases}-\ 2ax\\-\ \ ax\\-\ 5ax\\-12ax\end{cases}$$
$$\text{Sum, } +13a\qquad\qquad \text{Sum, } -20ax$$

Case 2. To add quantities which are like, but have unlike signs.

Rule. Add the positive coefficients into one sum, and the negative ones into another; then subtract the less of these sums from the greater, prefix the sign of the greater to the remainder and annex the common letter or letters as before

Examples.

$$\text{Add together}\begin{cases}+\ 2ax\\-\ \ ax\\-\ 3ax\\+\ 9ax\end{cases}\qquad\text{Add together}\begin{cases}+\ 6ab+\ 7\\-\ 4ab+\ 9\\+\ \ ab-\ 5\\+\ 7ab-13\end{cases}$$

Sum of the pos.	$+11ax$	Sum of the pos.	$+14ab+16$
Sum of the neg.	$-\ 4ax$	Sum of the neg.	$-\ 4ab-18$
Sum required,	$+\ 7ax$	Sum required,	$+10ab-\ 2$

Case 3. To add unlike quantities.

Rule. Put down the quantities, one after another, in any order, with their signs and coefficients prefixed.

Examples.

$$\begin{array}{l}2a\\3b\\-4c\\\hline \text{Sum, } 2a+3b-4c\end{array}\qquad\qquad\begin{array}{l}ax+2ay\\bb-3bz\\\hline \text{Sum, } ax+2ay+bb-3bz\end{array}$$

II. *Subtraction.*

11. *General Rule.*—Change the signs of the quantities to be subtracted, or suppose them changed, and then add them to the other quantities, agreeably to the rules of addition.

Examples

$$\begin{array}{lr}\text{From} & 5a-12b\\ \text{Subtract} & 2a-\ 5b\\\hline \text{Remainder} & 3a-\ 7b\end{array}\qquad\begin{array}{lr}\text{From} & 6x-\ 8y+3\\ \text{Subtract} & 2x+\ 9y-2\\\hline \text{Remainder} & 4x-17y+5\end{array}$$

$$\begin{array}{l}5xy-2+\ 8x-\ \ y\\3xy-8-\ 8x-\ 3y\\\hline 2xy+6+16x+\ 2y\end{array}\qquad\begin{array}{l}aa-ax-yy\\bb\ -by+zz\\\hline aa-ax-yy-bb+by-zz\end{array}$$

The reason of the rule for subtraction may be explained thus. Let it be required to subtract $2p-3q$ from $m+n$. If we subtract $2p$ from $m+n$, there will remain $m+n-2p$, but if we are to subtract $2p-3q$, which is less than $2p$, it is evident that the remainder will be greater by a quantity equal to $3q$; that is, the remainder will be $m+n-2p+3q$, hence the reason of the rule is evident.

III. *Multiplication.*

12. *General Rule for the Signs.*—If the quantities to be multiplied have like signs, the sign of the product is $+$; but if they have unlike signs, the sign of the product is $-$. Rule of signs.

This rule, which is given by Diophantus[1] as the *definition* of $+$ and $-$, may be said to constitute the basis of algebra as distinct from arithmetic.

If we admit the definitions given above, the rule may be demonstrated in the following way:—

(1.) $+a\times+b=+ab$ is assumed.

(2.) $+a\times-b$ will have the same value, whatever $-b$ may be connected with, as it has when $-b$ is connected with $+b$ (Law 1).

Now $+a\times(+b-b)=+a\times+0=0$ (Def.)

But $+a\times(+b-b)=+a\times+b$, and $+a\times-b$ (Law 2).

$\therefore\ +a\ \times+b$ and $+a\times-b$ make up $0\cdot$

i.e., $+ab$ and $+a\times-b$ make up 0.

Now $+ab-ab=0$, $\therefore +a\times-b=-ab$.

(3.) Similarly $-a\times-b=+ab$.

The examples of multiplication may be referred to two cases; the first is when both the quantities are simple, and the second when one or both of them are compound.

Case 1. To multiply simple quantities.

Rule. Find the sign of the product by the general rule, and annex to it the product of the numeral coefficients, then set down all the letters, one after another, as in one word.

Examples.

$$1.\begin{cases}\text{Multiply} & +a\\ \text{By} & +c\\ \hline \text{Product} & +ac\end{cases}\qquad 2.\begin{cases}+\ 5b\\-\ 4a\\\hline -20ab\end{cases}\qquad 3.\begin{cases}-\ 3ax\\+\ 7ab\\\hline -21aabx\end{cases}$$

Case 2. To multiply compound quantities.

Rule. Multiply every term of the multiplicand by all the terms of the multiplier, one after another, according to the preceding rule, and collect their products into one sum, which will be the product required.

Examples.

$$1.\ \begin{array}{ll}\text{Mult.} & 2x\ +y\\ \text{By} & x\ \ -2y\\\hline \text{Prod.} & 2xx+xy\\ & \quad -4xy-2yy\\\hline & 2xx-3xy-2yy\end{array}\qquad 2.\ \begin{array}{l}a\ -b\ +c\\a\ +b\ -c\\\hline aa-ab+ac\\ \quad +ab\quad -bb+bc\\ \qquad -ac\quad +bc\ -cc\\\hline aa\quad *\quad *-bb+2bc-cc\end{array}$$

[1] Λεῖψις ἐπὶ λεῖψιν πολλαπλασιασθεῖσα, ποιεῖ ὕπαρξιν· λεῖψις δὲ ἐπὶ ὕπαρξιν ποιεῖ λεῖψιν.—Diophantus, *Ed. Fermat*, *Tolosæ*, 1670, p. 7, Def. 9.

When several quantities are multiplied together so as to constitute a product, each of them is called a *factor* of that product: thus a, b, and c are factors of the product abc; also, $a+x$ and $b-x$ are factors of the product $(a+x).(b-x)$.

The products arising from the continual multiplication of the same quantity are called *powers* of that quantity, which is called the *root*. Thus aa, aaa, $aaaa$, &c., are powers of the root a. These powers are commonly expressed by placing above the root, towards the right hand, a figure, denoting how often the root is repeated. This figure serves to denominate the power, and is called its *index* or *exponent*. Thus, the quantity a being considered as the root, or as the first power of a, we have aa or a^2 for its second power, aaa or a^3 for its third power, $aaaa$ or a^4 for its fourth power, and so on.

The second and third powers of a quantity are generally called its *square* and *cube*.

By considering the notation of powers, and the rules for multiplication, it appears that powers of the same root are multiplied by adding their exponents. Thus $a \times a^3 = a^4$, also $x^3 \times x^4 = x^7$; and in general $a^m \times a^n = a^{m+n}$.

Shorter processes

When the quantities to be multiplied appear under a symmetrical form, the operation of multiplying them may sometimes be shortened by *detached coefficients*, by *symmetry*, and by *general considerations* suggested by the particular examples under consideration.

13. *Detached Coefficients.*

Ex. 1. Multiply $x^4 - 3x^3 + 2x^2 - 7x + 3$ by $x^2 - 5x + 4$. Here the powers of x occur in regular order, so that we need only write down the coefficients of the several terms during the operation, having it in our power to supply the x's whenever we require them; we write, therefore,—

$$\begin{array}{l}
1-3+\ 2-\ 7+\ 3 \\
\underline{1-5+\ 4\qquad\qquad\quad} \\
1-3+\ 2-\ 7+\ 3 \\
\quad -5+15-10+35-15 \\
\underline{\qquad\ \ +\ 4-12+\ 8-28+12} \\
1-8+21-29+46-43+12
\end{array}$$

The last line (for which the result might have been written down in full at once) is equivalent to

$$x^6 - 8x^5 + 21x^4 - 29x^3 + 46x^2 - 43x + 12.$$

When any terms are wanting, they may be supplied by zeros; thus,

Ex. 2. Multiply $x^4 - 7x^3 + x - 1$ by $x^3 - x + 2$.

We write

$$\begin{array}{l}
1\ -7\quad +0+\ 1\quad -\ 1 \\
\underline{1\ +0\quad -1+\ 2\qquad\quad} \\
1\ -7\quad +0+\ 1\quad -\ 1 \\
\qquad\quad\ \ -1+\ 7\quad -\ 0\quad -1\ +1 \\
\underline{\qquad\qquad\quad +\ 2\quad -14\quad +0\ +2\ -2} \\
x^7 - 7x^6 - x^5 + 10x^4 - 15x^3 - x^2 + 3x - 2
\end{array}$$

the product required.

14. *Symmetry.*

We may take advantage of symmetry by two considerations either separately or combined.

(1.) *Symmetry of a Symbol.*

Ex. Find the sum of $(a+b-2c)^2 + (a+c-2b)^2 + (b+c-2a)^2$.

Here a^2 occurs with 1 as a multiplier in the first square, with 1 as a multiplier in the second square, and with 4 as a multiplier in the third square,

$$\therefore\ 6a^2 \text{ is part of the result:}$$

ab occurs with 2 as a multiplier in the first square, with -4 in the second, and with -4 in the third

$$\therefore\ -6ab \text{ is part of the result.}$$

But a^2, b^2, c^2, are similarly circumstanced, as also ab, ac, bc; hence the whole result must be $6(a^2+b^2+c^2-ab-ac-bc)$.

(2.) *Symmetry of an Expression.*

Ex. Find the sum of $(a+b+c)(x+y+z)+(a+b-c)(x+y-z)+(a-b+c)(x-y+z)+(-a+b+c)(-x+y+z)$.

First, the product of $(a+b+c)$ by $x+y+z$ is to be found by multiplying out term by term.

It is $ax+ay+az+bx+by+bz+cx+cy+cz$.

The product of $(a+b-c)\ (x+y-z)$ is now simply *written down* from the above, by changing the sign of every term which contains *one only* of the two quantities affected with a $-$ sign, *i.e.*, in this case c and z.

Lastly, the four products may be arranged below each other, the signs alone being written down; thus,

$$\begin{array}{ccccccccc}
ax & +\,ay & +\,az & +\,bx & +\,by & +\,bz & +\,cx & +\,cy & +\,cz \\
+ & + & - & + & + & - & - & - & + \\
+ & - & + & - & + & - & + & - & + \\
+ & - & - & - & + & + & - & + & +
\end{array}$$

and the sum required is therefore $4ax+4by+4cz$.

15. *General Considerations.*

Ex. Find $(a+b+c)^3$.

By multiplying out we get

$$(a+b)^3 = a^3 + 3a^2b + \ .\ .\ .\ .\ .$$

Now a, b, c are similarly involved in $(a+b+c)^3$; $\therefore$ b^3 and c^3 must appear along with a^3, $3a^2c$, $3b^2a$, &c., along with $3a^2b$, and hence we can at once write down all the terms except that which contains abc. To obtain the coefficient of abc, we observe that if a, b, and c, are each equal to 1, $(a+b+c)^3$ is reduced to 3^3 or 27. In other words, there are 27 terms, if we consider $3a^2b$ and every similar expression as three terms; and as the terms preceding abc are in this way found to be 21 in number, we require $6abc$ to make up the full number 27;

$$\therefore\ (a+b+c)^3 = a^3+b^3+c^3+3a^2b+3a^2c+3b^2a+3b^2c+3c^2a+3c^2b+6abc.$$

It is desirable to introduce here some examples of the application of the process of the substitution of a letter for any number or fraction to the properties of numbers, inequalities, &c.

16. *Properties of Numbers.*

Ex. 1. If unity is divided into any two parts, the difference of their squares is equal to the difference of the parts themselves.

Let x stand for one part; $1-x$ for the other.

Now $(1-x)^2 - x^2 = 1 - 2x + x^2 - x^2 = 1 - 2x = (1-x) - x$.

i.e., the difference of the squares of the parts is equal to the difference of the parts.

Ex. 2. The product of three consecutive even numbers is divisible by 48.

Let $2n$, $2n+2$, $2n+4$, be the three numbers $\therefore$ their product is $8n(n+1)(n+2)$. Now, of three consecutive numbers, n, $n+1$, $n+2$, one must be divisible by 2, and one by 3, $\therefore$ $n(n+1)(n+2)$ is divisible by 6, whence the proposition.

Ex. 3. The sum of the squares of three consecutive odd numbers, when increased by 1, is divisible by 12, but never by 24.

Let $2n-1$, $2n+1$, $2n+3$, be the three odd numbers.

The sum of their squares when increased by 1 is $12n^2+12n+12=12(n^2+n+1)=12(n.\overline{n+1}+1)$.

Now, either n or $n+1$ is even, $\therefore n(n+1)+1$ is odd; hence the sum under consideration is 12 times an odd number, whence the proposition.

Additional Examples in Symmetry, &c.

Ex. 1. $(a+b+c)^2+(a+b-c)^2+(a+c-b)^2+(b+c-a)^2 = 4(a^2+b^2+c^2)$.

This is written down at once, from observing that a^2 occurs in each of the four expressions, and that $2ab$ occurs with a $+$ sign in two, and with a $-$ sign in the other two. There is no other form.

Ex. 2. $(a+b+c)^3+(a+b-c)^3+(a+c-b)^3+(b+c-a)^3 = 2(a^3+b^3+c^3)+6(a^2b+a^2c+b^2a+b^2c+c^2a+c^2b)-12abc$.

1*st*, a^3 occurs $+$ in three, and $-$ in one term.

2*d*, $3a^2b$ occurs $+$ in three, and $-$ in one term.

3*d*, When a, b, c are all units, the number resulting is 30; $\therefore$ there are 30 terms, and as (1*st*) and (2*d*) make up 42, there fall to be subtracted 12, *i.e.*, the coefficient of abc is -12.

Ex. 3. $(ax+by+cz)^2+(ax+cy+bz)^2+(bx+ay+cz)^2+(bx+cy+az)^2+(cx+ay+bz)^2+(cx+by+az)^2=2(a^2+b^2+c^2)(x^2+y^2+z^2)+4(ab+ac+bc)(xy+xz+yz)$.

Ex. 4. The difference of the squares of two consecutive numbers is equal to the sum of the numbers.

Ex. 5. The sum of the cubes of three consecutive numbers is divisible by the sum of the numbers.

Ex. 6. If x is an odd number, x^5-x is divisible by 24, and $(x^2+3)(x^2+7)$ by 32.

Ex. 7. If $(pq-r)^2+4(p^2-q)(pr-q)^2=0$, then will

$$4(p^2-q)^3=(2p^3-3pq+r)^2,$$

and
$$4(q^2-pr)^3=(2q^3-3pqr+r^2)^2.$$

Ex. 8. Given $x+y+z=0$, $X+Y+Z=0$, to prove that

$$(x^2+X^2)yz+(y^2+Y^2)zx+(z^2+Z^2)xy=(x^2+X^2)YZ+(y^2+Y^2)ZX+(z^2+Z^2)XY.$$

Let the left hand side equal the right $+u$; then multiplying out,

$$xyz(x+y+z)+X^2yz+Y^2zx+Z^2xy= XYZ(X+Y+Z)+x^2YZ+y^2ZX+z^2XY+u,$$

i.e.,
$$X^2yz+Y^2zx+(X+Y)^2xy= x^2YZ+y^2ZX+(x+y)^2XY+u,$$

or,
$$X^2y(z+x)+Y^2x(z+y)= x^2Y(Z+X)+y^2X(Z+Y)+u,$$

or,
$$-X^2y^2-Y^2x^2=-x^2Y^2-y^2X^2+u$$
$$\therefore u=0.$$

Ex. 9. If $4a^2b^2c^2(x^2+y^2+z^2)(a^2x^2+b^2y^2+c^2z^2)= \{(b^2+c^2)a^2x^2+(c^2+a^2)b^2y^2+(a^2+b^2)c^2z\}^2$,

when a is greater than b, and b greater than c; then is $y=0$. As the argument concerns y, multiply out, and arrange in order of powers of y. After reduction this results in

$$(a^2-c^2)b^4y^4+2\{(a^2-c^2)(b^2-c^2)a^2x^2+(a^2-c^2)(a^2-b^2)c^2z^2\}b^2y^2 +\{(b^2-c^2)a^2x^2-(a^2-b^2)c^2z^2\}^2=0.$$

Now each of these three terms is a *positive* quantity, if it be not zero, and as the sum of three positive quantities cannot be equal to zero, it follows that each term must be separately equal to zero,

$$\textit{i.e.},\ y=0,\ \text{and}\ (b^2-c^2)a^2x^2=(a^2-b^2)c^2z^2.$$

17. *Inequalities.*

The demonstrations of inequalities are of so simple and instructive a character, that a somewhat lengthened exhibition of them forms a valuable introduction to the higher processes of the science. In all that follows under this head, the symbols x, y, z stand for *positive* numbers or fractions, usually *unequal*.

Ex. 1. $x^2+y^2>2xy$.

Because $(x-y)^2$ is $+$, whether x be greater or less than y, it follows that $x^2-2xy+y^2$ is $+$, *i.e.*, is some positive number or fraction,

$$\therefore x^2+y^2>2xy.$$

It will be remarked that when x and y are equal, the inequality rises into an equality, and this is common to all inequalities of the character under discussion.

Cor. $\frac{x}{y}+\frac{y}{x}>2$; *i.e.*, the sum of a fraction and its reciprocal is greater than 2.

Ex. 2. $x^2+y^2+z^2>xy+xz+yz$.

For $x^2+y^2>2xy$, $x^2+z^2>2xz$, $y^2+z^2>2yz$; which being added and divided by 2, gives the result required.

Ex. 3. $x^{m+n}+y^{m+n}>x^my^n+x^ny^m$.

For $(x^m-y^m)(x^n-y^n)$ is $+$, whether x be greater or less than y.

As a particular case $x^3+y^3>x^2y+xy^2$.

Ex. 4. $x^{2n}+1>x^{2n-2r}+x^{2r}$.

For $(x^{2n-2r}-1)(x^{2r}-1)$ is positive.

Cor. 1. $x^n+\frac{1}{x^n}>x^{n-2r}+\frac{1}{x^{n-2r}}$.

Cor. 2. Similarly, $x^n+\frac{1}{x^n}>x^{n-1}+\frac{1}{x^{n-1}}$,

i.e., as n increases $x^n+\frac{1}{x^n}$ increases, $\therefore$ as a particular case

$$x^n+\frac{1}{x^n}>x+\frac{1}{x}.$$

Ex. 5. If a, b, c are the sides of a triangle, $a^2+b^2+c^2>ab+ac+bc<2(ab+ac+bc)$. The former inequality is proved in example 2. For the latter we have

(*Euclid*, I. 20), $a<b+c\ \therefore\ a^2<ab+ac$.

Similarly, $b^2<ab+bc$, $c^2<ac+bc$.

$$\therefore a^2+b^2+c^2<2(ab+ac+bc).$$

Ex. 6. The arithmetic mean of any number of quantities (all positive) is greater than the geometric.

(The arithmetic mean is the sum of the quantities divided by their number; the geometric is that root of their product which is represented by their number.) Let the quantities be denoted by x_1, x_2, x_3, ... x_n, the numbers 1, 2, 3, placed under the x, indicating order only, so that x_1 may be read *the first* x, x_2 the *second* x, &c. Example 1 gives $\frac{x_1+x_2}{2}>\sqrt{x_1x_2}$, if we suppose the x and y of that example to be $\sqrt{x_1}$, $\sqrt{x_2}$ of the present.

It also gives
$$\frac{\frac{x_1+x_2}{2}+\frac{x_3+x_4}{2}}{2}>\sqrt{\frac{x_1+x_2}{2}\ \frac{x_3+x_4}{2}}$$
$$>\sqrt{\sqrt{x_1x_2}\sqrt{x_3x_4}}$$
$$>\sqrt[4]{x_1x_2x_3x_4}$$

In the same way we prove the proposition for 8, 16, or any number of quantities which is a power of 2.

For any other number, such, for instance, as 5, the following process is employed:—The number is made up to 8 by the insertion of three quantities, each equal to the arithmetic mean of the other five, viz., $\frac{x_1+x_2+x_3+x_4+x_5}{5}$,

Call this quantity y; then

$$\frac{x_1+x_2+\ldots x_5+3y}{8}>\sqrt[8]{x_1x_2\ldots x_5yyy}$$

$$\textit{i.e.},\ \frac{8y}{8}>\sqrt[8]{x_1x_2\ldots x_5y^3}$$

$$\text{or, } y^5>x_1x_2\ldots x_5y^3$$

$$\therefore y^5 > x_1 x_2 \ldots x_5$$
$$\therefore y \text{ or } \frac{x_1 + x_2 + \ldots x_5}{5} > \sqrt[5]{x_1 x_2 x_3 x_4 x_5}.$$

Cor. As a particular case, $x^3 + y^3 + z^3 > 3xyz$.

Ex. 7. Given $x_1 x_2 \ldots x_n = y^n$, to prove that $(1+x_1)(1+x_2) \ldots (1+x_n) > (1+y)^n$.

The demonstration will be perfectly general in fact, though limited in form, if we suppose the number of quantities to be 5; in which case,

$$x_1 x_2 \ldots x_5 = y^5.$$

Make the number up to 8 by introducing three y's; then

$$(1+x_1)(1+x_2) > (1+\sqrt{x_1 x_2})^2 \text{ by example 1.}$$
$$(1+x_3)(1+x_4) > (1+\sqrt{x_3 x_4})^2$$
$$(1+x_5)(1+y) > (1+\sqrt{x_5 y})^2$$
$$(1+y)(1+y) = (1+\sqrt{yy})^2$$

$\therefore$ Multiplying these products together, and combining the right hand factors two and two,

$$(1+x_1)(1+x_2) \ldots \ldots (1+x_5)(1+y)^3$$
$$> \{(1+\sqrt{x_1 x_2})(1+\sqrt{x_3 x_4})(1+\sqrt{x_5 y})(1+y)\}^2$$
$$> \{(1+\sqrt[4]{x_1 x_2 x_3 x_4})(1+\sqrt[4]{x_5 y^3})\}^4$$
$$> (1+\sqrt[8]{x_1 x_2 x_3 x_4 x_5 y^3})^8$$
$$> (1+y)^8$$
$$\therefore (1+x_1)(1+x_2) \ldots (1+x_5) > (1+y)^5.$$

Ex. 8. If the sum of n fractions makes up 1, the sum of their reciprocals is greater than the square of their number.

Let $x_1 + x_2 + \ldots x_n = 1$,

then, $\dfrac{1}{x_1} + \dfrac{1}{x_2} + \ldots + \dfrac{1}{x_n} > n\sqrt[n]{\dfrac{1}{x_1 x_2 \ldots x_n}}$ (example 6).

But $\sqrt[n]{x_1 x_2 \ldots x_n} < \dfrac{x_1 + x_2 + \ldots x_n}{n}$ (example 6) $< \dfrac{1}{n}$

$$\therefore \sqrt[n]{\frac{1}{x_1 x_2 \ldots x_n}} > n,$$

whence $\dfrac{1}{x_1} + \dfrac{1}{x_2} + \ldots + \dfrac{1}{x_n} > n^2$.

Ex. 9. $\dfrac{1+x^2+x^4+\ldots x^{2n}}{x+x^3+\ldots x^{2n-1}} < \dfrac{n+1}{2n}\left(x^n + \dfrac{1}{x^n}\right) > \dfrac{n+1}{2n}\left(x + \dfrac{1}{x}\right)$.

Let the numerator and denominator of this fraction be designated by N and D. N may be divided into pairs of terms, at the same distance from either end, viz., $1 + x^{2n}$, $x^2 + x^{2n-2}$, &c., with or without a middle term, each of which (after $1 + x^{2n}$) is, by example 4, less than that quantity; the middle term, if there be one, being less than

$$\tfrac{1}{2}(1+x^{2n}),$$

$$\therefore \text{ in either case } N < \frac{n+1}{2}(1+x^{2n}) \quad . \quad . \quad . \quad (1.)$$

$$\text{Again (example 6), } \quad D > n\sqrt[n]{xx^3 \ldots x^{2n-1}} > nx^n \quad . \quad (2.)$$

$$\therefore \text{ the fraction } \frac{N}{D} < \frac{n+1}{2n}\left(x^n + \frac{1}{x^n}\right).$$

To prove the second proposition, that the fraction is greater than $\dfrac{n+1}{2n}\left(x + \dfrac{1}{x}\right)$, it is only necessary to multiply up and reduce the result; thus,

$$\frac{n+1}{2n}\left(x + \frac{1}{x}\right)(x + x^3 + \ldots x^{2n-})^1$$
$$= \frac{n+1}{2n}(2N - 1 - x^{2n})$$
$$< \frac{n+1}{n}N - \frac{N}{n} \text{ (by 1)}$$
$$< N.$$

Whence the proposition.

Additional Examples.

Ex. 1. $(x+y+z)^2 < 3(x^2+y^2+z^2)$, and generally, $(x+y+z)^n < 3^{n-1}(x^n+y^n+z^n)$. (See Induction.)

Ex. 2. $(x+y)(y+z)(z+x) > 8xyz < \dfrac{8}{3}(x^3+y^3+z^3)$.

Ex. 3. $(x^4+y^4+z^4) > xyz(x+y+z)$.

Ex. 4. $(a^2+b^2+c^2)(x^2+y^2+z^2) > (ax+by+cz)^2$.

Ex. 5. The arithmetic mean of the pth powers of n positive quantities is greater than the pth power of their mean, and also greater than the mean of their combinations p together.

Ex. 6. $(ax+by+cz)^2 + (ax+cy+bz)^2 + (bx+ay+cz)^2 + (bx+cy+az)^2 + (cx+ay+bz)^2 + (cx+by+az)^2$
$> 6(ab+ac+bc)(xy+xz+yz,$
$< 6(a^2+b^2+z^2)(x^2+y^2+z^2)$.

18. *Induction.*

It will be noted that the numerical multiplier of the second term of the powers of $a+x$ already obtained is the same as the index. It is easy to see that this law is general. To demonstrate the fact formally we employ the method of induction.

The argument may be divided into four distinct steps—1. Inference; 2. Hypothesis; 3. Comparison; 4. Conclusion.

The first step, *inference*, is the discovery of the probable existence of a law.

The second step, *hypothesis*, is the assumption that that law holds to a certain point, up to which the opponent to the argument may be presumed to admit it.

The third step consists in basing on this assumption the demonstration of the law to a stage beyond what the opponent was prepared to admit.

The fourth step argues that as the law starts fair, and advances beyond a point at which any opponent is prepared to admit its existence, it is necessarily true.

Ex. 1. To prove that $(a+x)^n = a^n + na^{n-1}x +$, &c.

I. By multiplication we get

$$(a+x)^4 = a^4 + 4a^3x +, \text{ \&c.}$$

II. Let it be granted that $(a+x)^m = a^m + ma^{m-1}x +$, &c., where m is the extreme limit to which the opponent will admit of its truth.

III. By multiplying the equals by $a+x$, we get

$$(a+x)^{m+1} = a^{m+1} + ma^m x +, \text{ \&c.},$$
$$+ a^m x +, \text{ \&c.},$$
$$= a^{m+1} + (m+1)a^m x +, \text{ \&c.},$$

i.e., if the law be *admitted* true for m it is *proved* true for $m+1$; in other words, at whatever point the opponent compels us to limit our assumption, we can advance one step higher by argument.

IV. Now, the law is true for 4, $\therefore$ it is proved true for 5; and being true for 5, it is proved true for 6, and so on, *ad infinitum.*

Ex. 2. The sum of the cubes of the natural numbers is the square of the sum of the numbers,

$$1^3 + 2^3 = 9 = (1+2)^2 = \left(\frac{2.3}{2}\right)^2.$$

I. Let us assume that

$$1^3 + 2^3 +, \text{ \&c.}, + x^3 = \left(\frac{x(x+1)}{2}\right)^2.$$

II. *If* this be so, then by adding $(x+1)^3$ we get

$$1^3 + 2^3 + \ldots + (x+1)^3 = \left(\frac{x(x+1)}{2}\right)^2 + (x+1)^3$$
$$= \left(\frac{(x+1)(x+2)}{2}\right)^2.$$

III. Hence, if the law be true for any one number x, it is also true for $x+1$.

IV. But it is true for 2, $\therefore$ for 3, $\therefore$ for 4, &c.

Ex. 3. To prove the inequality,

$$(x+y+z)^n < 3^{n-1}(x^n+y^n+z^n)\,.$$

From the second example of inequalities we get at once $(x+y+z)^2 < 3(x^2+y^2+z^2)$.

Let us assume that $(x+y+z)^m < 3^{m-1}(x^m+y^m+z^m)$, then by multiplication we get

$$(x+y+z)^{m+1} < 3^{m-1}(x^{m+1}+y^{m+1}+z^{m+1}+x^my+y^mx+x^mz+z^mx+y^mz+z^my).$$

Now, inequality, example 3, gives

$$x^my+y^mx < x^{m+1}+y^{m+1},\ \text{\&c.}$$

$$\therefore\ x^my+y^mx+x^mz+z^mx+y^mz+z^my < 2(x^{m+1}+y^{m+1}+z^{m+1}),$$

and $\qquad (x+y+z)^{m+1} < 3^m(x^{m+1}+y^{m+1}+z^{m+1}),$

i.e., the law is true for $m+1$, if true for m; but it is true for 2, $\therefore$ it is always true.

IV. *Division.*

19. *General Rule for the Signs.*—If the signs of the divisor and dividend be like, the sign of the quotient is $+$; but if they be unlike, the sign of the quotient is $-$.

This rule is derived from the general rule for the signs in multiplication, by considering that the quotient must be such a quantity as, when multiplied by the divisor, shall produce the dividend, with its proper sign.

This definition of division is the same as that of a fraction; hence the quotient arising from the division of one quantity by another may be expressed by placing the dividend above a line, and the divisor below it; but it may also be often reduced to a more simple form by the following rules.

Case 1. When the divisor is simple, and a factor of every term of the dividend.

Rule. Divide the coefficient of each term of the dividend by the coefficient of the divisor, and expunge out of each term the letter or letters in the divisor: the result is the quotient.

Ex. Divide $16a^3xy-28a^2xz^2+4a^2x^3$ by $4a^2x$.

The process requires no explanation. It is founded on Laws II. and III., together with the rule of signs.

The quotient is $4ay-7z^2+x^2$.

If the divisor and dividend be powers of the same quantity, the division will evidently be performed by subtracting the exponent of the divisor from that of the dividend. Thus a^5, divided by a^3, has for a quotient $a^{5-3}=a^2$.

Case 2. When the divisor is simple, but not a factor of the dividend.

Rule. The quotient is expressed by a fraction, of which the numerator is the dividend, and the denominator the divisor.

Thus the quotient of $3ab^2$, divided by $2mbc$, is the fraction $\dfrac{3ab^2}{2mbc}$.

It will sometimes happen that the quotient found thus may be reduced to a more simple form, as shall be explained when we come to treat of fractions.

Case 3. When the divisor is compound.

Rule. The terms of the dividend are to be arranged in the order of the powers of some one of its letters, and those of the divisor according to the powers of the same letter. The operation is then carried on precisely as for division of numbers.

To illustrate this rule, let it be required to divide $8a^2+2ab-15b^2$ by $2a+3b$, the operation will stand thus:

$$\begin{array}{l} 2a+3b)8a^2+\ 2ab-15b^2(4a-5b \\ \qquad\quad\ \ \underline{8a^2+12ab} \\ \qquad\qquad\quad -10ab-15b^2 \\ \qquad\qquad\quad \underline{-10ab-15b^2} \end{array}$$

Here the terms of the divisor and dividend are arranged according to the powers of the quantity a. We now divide $8a^2$, the first term of the dividend, by $2a$, the first term of the divisor; and thus get $4a$ for the first term of the quotient. We next multiply the divisor by $4a$, and subtract the product $8a^2+12ab$ from the dividend; we get $-10ab-15b^2$ for a new dividend.

By proceeding in all respects as before, we find $-5b$ for the second term of the quotient, and no remainder: the operation is therefore finished, and the whole quotient is $4a-5b$.

The following examples will also serve to illustrate the manner of applying the rule.

Ex. 1.

$$\begin{array}{l} 3a-b)3a^3-12a^2-a^2b+10ab-2b^2(a^2-4a+2b \\ \qquad\quad\ \underline{3a^3\qquad\quad\ -a^2b} \\ \qquad\qquad -12a^2\qquad +10ab \\ \qquad\qquad \underline{-12a^2\qquad +\ 4ab} \\ \qquad\qquad\qquad\qquad\ +\ 6ab-2b^2 \\ \qquad\qquad\qquad\qquad\ \underline{+\ 6ab-2b^2} \end{array}$$

Ex. 2.

$$\begin{array}{l} 1-x)1\qquad (1+x+x^2+\ \text{\&c.} \\ \qquad\ \ \underline{1-x} \\ \qquad\quad +x \\ \qquad\quad \underline{+x-x} \\ \qquad\qquad +x^2 \\ \qquad\qquad \underline{+x^2-x^3} \\ \qquad\qquad\qquad +x^3 \end{array}$$

Sometimes, as in this last example, the quotient will never terminate; in such a case it may either be considered as an infinite series, the law according to which the terms are formed being in general sufficiently obvious; or the quotient may be completed as in arithmetical division, by annexing to it a fraction (with its proper sign), the numerator of which is the remainder, and denominator the divisor. Thus the completed quotient, in last example, is—

$$1+x+x^2+\frac{x^3}{1-x}\,.$$

If x be small compared with unity, the remainders, as we advance, continually become smaller and smaller. If, on the other hand, x be large compared with unity, the remainders continually become larger and larger. In this case the quotient is worthless. To obtain a quotient which shall be of any practical value, we must reverse the order of arrangement, putting $-x+1$ in place of $1-x$. The division then becomes

$$\begin{array}{l} -x+1\Big)1\qquad \Big(-\frac{1}{x}-\frac{1}{x^2}-\ \text{\&c.} \\ \qquad\qquad \underline{1-\frac{1}{x}} \\ \qquad\qquad\quad +\frac{1}{x} \\ \qquad\qquad\quad \underline{+\frac{1}{x}-\frac{1}{x^2}} \\ \qquad\qquad\qquad\quad +\frac{1}{x^2} \end{array}$$

As it is generally the largest of the quantities that we desire to divide out, we observe that, in order to effect this, we have had to begin with that quantity. Hence the Rule—

The terms of the divisor and dividend are to be arranged according to the powers of that letter which it is wished (if possible) to divide out.

Ex. 3. Divide $a^4+b^4+b(a+b)^3$ by a^2+b^2-ab, where a is large compared with b.

We must arrange according to powers of a.

$$\begin{array}{l}
a^2-ab+b^2)a^4+a^3b+3a^2b^2+3ab^3+2b^4(a^2+2ab+4b^2\\
\qquad\qquad\underline{a^4-a^3b+a^2b^2}\\
\qquad\qquad\quad+2a^3b+2a^2b^2+3ab^3\\
\qquad\qquad\quad\underline{+2a^3b-2a^2b^2+2ab^3}\\
\qquad\qquad\qquad\qquad+4a^2b^2+\ \ ab^3+2b^4\\
\qquad\qquad\qquad\qquad\underline{+4a^2b^2-4ab^3+4b^4}\\
\qquad\qquad\qquad\qquad\qquad\quad+5ab^3-2b^4
\end{array}$$

We have spoken as if magnitude alone was the circumstance which should determine the precedence of the letters in a division. In the more advanced processes of algebra there are other circumstances which give precedence to certain letters, such, for example, as the fact that x may and often does stand for the *phrase* "quantity," whilst a stands for some determinate numerical quantity. This leads us to exhibit a proposition in division of the greatest value and most extensive application. It is as follows :—

Remainder after division.

20. PROPOSITION.—If any function of x, consisting of powers of that letter with numerical multipliers, is divided by $x-a$, the remainder, when all the x's are divided out, is the same function of a that the dividend is of x; in other words, the remainder is the dividend altered by writing a in place of x.

To prove this proposition we shall employ the following AXIOM :—If two expressions in x are identical in form and value, but one multiplied out farther than the other, we may write any numerical quantity we please in place of x in both, and the results will be equal.

For example, $(x-1)^2+(x-1)-3$ is identical with $x^2-2(x+1)+x-1$; and it is evident that if we write any number (say 1) for x, the results are the same in both.

We now proceed to prove the proposition.

Let the dividend be $x^n+px^{n-1}+qx^{n-2}$, &c., where n is a whole number, and p, q, &c., positive or negative numerical quantities.

Let the quotient, when this is divided by $x-a$, be Q, the remainder, which does not contain x, R; then

$$x^n+px^{n-1}+qx^{n-2}+, \text{ \&c. } =\mathrm{Q}(x-a)+\mathrm{R}$$

by the definition of Division.

Now this equality is in reality an identity in terms of the axiom. If then we write a in place of x, the results will be equal; this gives

$$\begin{aligned} a^n+pa^{n-1}+qa^{n-2}+ \text{ \&c. } &=\mathrm{Q}.0+\mathrm{R}\\ &=\mathrm{R},\end{aligned}$$

which is the proposition to be proved.

Examples.

Ex. 1. If n be any whole number, x^n-a^n is divisible by $x-a$ without remainder.

For the remainder, by the proposition, is $a^n-a^n=0$.

Ex. 2. If n be an even number, x^n-a^n is divisible by $x+a$ without remainder.

For the remainder is $(-a)^n-a^n=0$, since n is even.

Observe that the divisor here has to be changed to $x-(-a)$, so that $-a$ stands in place of the a of the proposition.

Ex. 3. If n be an odd number, x^n+a^n is divisible by $x+a$ without remainder.

For the remainder is $(-a)^n+a^n=0$, because n is odd.

Ex. 4. To prove that $4b^2c^2-(b^2+c^2-a^2)^2$ is divisible by $-a+b+c$; and hence to resolve it into simple factors. Here the $x-a$ of the proposition is replaced by $a-(b+c)$ (the negative sign of the whole divisor being of no consequence).

To determine the remainder, therefore, we write $b+c$ in place of a in the dividend, or thing to be divided; the result is,

$$4b^2c^2-(b^2+c^2-\overline{b+c}^{\,2})^2=0\,,$$

hence $4b^2c^2-(b^2+c^2-a^2)^2$ is divisible by $-a+b+c$.

Now, since the dividend contains only squares of a, and b, and c, any change in the sign of a, or b, or c, produces no change in the dividend. What we have just proved then becomes (putting $-a$ for a) the following :—

$$4b^2c^2-(b^2+c^2-a^2)^2 \text{ is divisible by } a+b+c.$$

This last becomes (putting $-b$ for b, and then $-c$ for c) :— $4b^2c^2-(b^2+c^2-a^2)$ is divisible by $a-b+c$, and by $a+b-c$.

Hence finally, $\quad 4b^2c^2-(b^2+c^2-a^2)^2=(a+b+c)$
$(-a+b+c)(a-b+c)(a+b-c)$.

The above example is a good exercise for the student. The result may be more simply arrived at by employing a proposition of very great value and frequent use—that *the difference of the squares of two quantities is the product of the sum and difference of the quantities.*

Ex. 5. To prove that $(1-a^2)(1-b^2)(1-c^2)-(c+ab)(b+ac)(a+bc)$ is divisible by $1+abc$.

It is simpler here to write a single letter x for abc, whereby the given quantity becomes

$$(1-a^2)(1-b^2)(1-c^2)-\frac{1}{x}(x+a^2)(x+b^2)(x+c^2),$$

which is obviously under the form $p-p$, when -1 is written for x, and $\therefore$ is divisible by $1+x$.

Ex. 6. Prove that $(x^2-x+1)(x^4-x^2+1)(x^8-x^4+1)(x^{16}-x^8+1)\ldots(x^{2n}-x^n+1)$ is the quotient of $x^{4n}+x^{2n}+1$ by x^2+x+1; n being any power of 2.

The divisor (x^2+x+1) being multiplied by x^2-x+1 gives x^4+x^2+1; which, being again multiplied by x^4-x^2+1, gives x^8+x^4+1; and so on to the end.

Additional Examples in Division.

Ex. 1. Divide $1-10x^3+15x^4-6x^5$ by $(1-x)^3$.

We must first multiply out $(1-x)^3$, and then divide the given expression by the product, $1-3x+3x^2-x^3$. The quotient is $1+3x+6x^2$.

Ex. 2. Divide $65x^2y^2-(x^4+64y^4)$ by $x^2-7xy-8y^2$.

We must arrange dividend and divisor in terms of powers of one of the letters, say x; the division will then assume the form

$$\begin{array}{c} x^2-7xy-8y^2)-x^4+65x^2y^2-64y^4(\\ \text{giving } -x^2-7xy+8y^2\,. \end{array}$$

Ex. 3. Divide $x^3+y^3+z^3-3xyz$ by $x+y+z$.

We must give exclusive attention to some one letter, say x, in dividing out; thus

$$\begin{array}{l}
x+y+z)x^3+y^3+z^3-3xyz\left(x^2-x(y+z)+(y^2+z^2-yz)\right.\\
\qquad\qquad\underline{x^3+x^2(y+z)}\\
\qquad\qquad\quad-x^2(y+z)\\
\qquad\qquad\quad\underline{-x^2(y+z)-x(y+z)^2}\\
\qquad\qquad\qquad\qquad\quad\underline{x(y^2-yz+z^2)+y^3+z^3}
\end{array}$$

the quotient being $x^2+y^2+z^2-xy-xz-yz$.

Ex. 4. Divide the product of

$$x^2+3x+2,\ x^2-5x+4,\ x^4+5x^2-14,$$

by the product of x^2-1, x^2-2. Here we observe that x^2-1 is the product of $x+1$, $x-1$.

Now (Art. 20), x^2+3x+2 is divisible by $x+1$, and x^2-5x+4 by $x-1$. Hence, if the product is divisible by x^2-1, x^2-2, without remainder, the third factor, x^4+5x^2-14 must be divisible by x^2-2, which is found to be the case. The quotient required is therefore the product of

$$(x+2)(x-4)(x^2+7)=x^4-2x^3-x^2-14x-56.$$

Ex. 5. Divide $12x^4-10x^3y-3x^2y^2+30xy^3-25y^4$ by $3x^2-4xy+5y^2$.

Horner's synthetic division.

We will employ this example to indicate Horner's method of synthetic division.

Let the dividend be represented by

$$Ax^4+Bx^3+Cx^2+Dx+E,$$

the divisor by ax^2+bx+c,
and the quotient by $\alpha x^2+\beta x+\gamma+$&c.

Then, multiplying the quotient by the divisor, we produce the dividend, which, exhibited by the method of detached coefficients, stands thus—

$$\begin{array}{l} a\alpha+a\beta+a\gamma+\&c.\\ \quad +b\alpha+b\beta+\&c.\\ \qquad +c\alpha+\&c.\\ \hline A+B+C+\&c.\end{array}$$

The last line being the sum column by column of the three preceding lines. Now, as the upper of these three lines contains term by term the quantities required, we convert this addition into subtraction; thus,

$$\begin{array}{r|l} & A+B+C+D+E\\ -b & \quad -b\alpha-b\beta-b\gamma-\&c.\\ -c & \qquad -c\alpha-c\beta-\&c.\\ \hline a & a\alpha+a\beta+a\gamma+a\delta+\&c.\end{array}$$

The first vertical column gives α; the second β, and so on.

In the example before us we write,—

$$\begin{array}{r|l} & 12-10-3\ +30-25\\ +4 & \quad +4\alpha+4\beta+4\gamma+\&c.\\ -5 & \qquad -5\alpha-5\beta-\&c.\\ \hline 3 & 3\alpha+3\beta+3\gamma+\&c.,\end{array}$$

whence $3\alpha=12$ gives $\alpha=4$; $3\beta=-10+4\alpha$ gives $\beta=2$; $3\gamma=-3+4\beta-5\alpha$ gives $\gamma=-5$.
Therefore the quotient required is $4x^2+2x-5$.

SECT. II.—INVOLUTION AND EVOLUTION.

21. In treating of multiplication, we have observed, that when a quantity is multiplied by itself any number of times, the product is called a *power* of that quantity, while the quantity itself, from which the powers are formed, is called the *root*. Thus, a, a^2, and a^3 are the first, second, and third powers of the root a; and in like manner $\frac{1}{a}$, $\frac{1}{a^2}$, and $\frac{1}{a^3}$ denote the same powers of the root $\frac{1}{a}$.

But before considering more particularly what relates to powers and roots, it will be proper to observe, that the quantities $\frac{1}{a}$, $\frac{1}{a^2}$, $\frac{1}{a^3}$, &c., admit of being expressed under a different form; for, just as the quantities a, a^2, a^3, &c., are expressed as *positive* powers of the root a, so the quantities $\frac{1}{a}$, $\frac{1}{a^2}$, $\frac{1}{a^3}$, &c., may be respectively expressed thus a^{-1}, a^{-2}, a^{-3}, &c., and considered as *negative* powers of the root a.

This method of expressing the fractions $\frac{1}{a}$, $\frac{1}{a^2}$, $\frac{1}{a^3}$, as powers of the root a, but with negative indices, is a consequence of the rule which has been given for the division of powers; for we consider $\frac{1}{a}$ as the quotient arising from the division of any power of a by the next higher power; for example, from the division of the 2d by the 3d, and so we have $\frac{1}{a}=\frac{a^2}{a^3}$; but since powers of the same quantity are divided by subtracting the exponent of the divisor from that of the dividend (Art. 19), it follows that $\frac{a^2}{a^3}=a^{2-3}=a^{-1}$; therefore the fraction $\frac{1}{a}$ may also be expressed thus, a^{-1}. By considering $\frac{1}{a^2}$ as equal to $\frac{a^2}{a^4}$, it will appear in the same manner that $\frac{1}{a^2}=\frac{a^2}{a^4}=a^{-2}$; and proceeding in this way, we get $\frac{1}{a^3}=\frac{a^2}{a^5}=a^{-3}$, $\frac{1}{a^4}=\frac{a^2}{a^6}=a^{-4}$, &c., and so on, as far as we please. It also appears that unity or 1 may be represented by a^0, where the exponent is a cypher, for $1=\frac{a^2}{a^2}=a^{2-2}=a^0$.

The rules which have been given for the multiplication and division of powers with positive integral exponents will apply in every case, whether the exponents be positive or negative, integral or fractional, provided we assume as the *definition* of the index in such cases, the law of combination $a^m\times a^n=a^{m+n}$. Definition of *index*.

Involution.

22. Involution is the method of finding any power of any assigned quantity, whether it be simple or compound: hence its rules are easily derived from the operation of multiplication.

Case 1. When the quantity is simple.

Rule. Multiply the exponents of the letters by the index of the power required, and raise the coefficient to the same power.

Note. If the sign of the quantity be +, all its powers will be positive; but if it be −, then all its powers whose exponents are even numbers are positive, and all its powers whose exponents are odd numbers are negative.

Ex. 1. Required the cube, or third power, of $2a^2x$.
$(2a^2x)^3=2\times2\times2a^{2\times3}x^{1\times3}=8a^6x^3$, the answer.

Ex. 2. Required the fifth power of $-3a^2x^3$.
$(-3a^2x^3)^5=-243a^{10}x^{15}$, the answer.

Ex. 3. Required the fourth power of $-\frac{2ax^2}{3b^2y}$.

$$\left(\frac{-2ax^2}{3b^2y}\right)^4=\frac{16a^4x^8}{81b^8y^4},\text{ the answer.}$$

Case 2. When the quantity is compound.

Rule. The powers must be found by a continual multiplication of the quantity by itself.

Ex. 4. Required the first four powers of the binomial quantity $a+x$.

$$\begin{array}{l} a+x \text{ the root, or first power.}\\ \underline{a+x}\\ a^2+ax\\ \quad \underline{+ax+x^2}\\ a^2+2ax+x^2 \text{ the square, or second power.}\\ \underline{a\ +x}\\ a^3+2a^2x+ax^2\\ \quad \underline{+\ a^2x+2ax^2+x^3}\\ a^3+3a^2x+3ax^2+x^3 \text{ the cube, or third power.}\\ a^4+3a^3x+3a^2x^2+ax^3\\ \quad \underline{+\ a^3x+3a^2x^2+3ax^3+x^4}\\ a^4+4a^3x+6a^2x^2+4ax^3+x^4 \text{ the fourth power.}\end{array}$$

If it be required to find the same powers of $a-x$, it will be found, writing $-x$ for x, that

$a-x$ being the root, or first power; then
$a^2-2ax+x^2$ is the square, or second power;
$a^3-3a^2x+3ax^2-x^3$, the cube, or third power;
$a^4-4a^3x+6a^2x^2-4ax^3+x^4$, the fourth power.

Hence it appears that the powers of $a+x$ differ from the powers of $a-x$ only in this respect, that in the former the signs of the terms are all positive, but in the latter they are positive and negative alternately.

Involution by the binomial theorem.

Besides the method of finding the powers of a compound quantity by multiplication, which we have just now explained, there is another more general, as well as more expeditious, by which a quantity may be raised to any power whatever without the trouble of finding any of the inferior powers, namely, by means of what is commonly called the *binomial theorem*, to be proved hereafter. This theorem may be expressed as follows:—Let $a+x$ be a binomial quantity, which is to be raised to any power denoted by the number n, then $(a+x)^n=$

$$a^n+\frac{n}{1}a^{n-1}x+\frac{n(n-1)}{1\,.\,2}a^{n-2}x^2+\frac{n(n-1)(n-2)}{1\,.\,2\,.\,3}a^{n-3}x^3$$
$$+\frac{n(n-1)(n-2)(n-3)}{1\,.\,2\,.\,3\,.\,4}a^{n-4}x^4$$
$$+\frac{n(n-1)(n-2)(n-3)(n-4)}{1\,.\,2\,.\,3\,.\,4\,.\,5}a^{n-5}x^5+\text{\&c.}$$

This series will always terminate when n is any whole positive number, by reason of some one of the factors $n-1$, $n-2$, &c., becoming $=0$; but if n be either a negative or fractional number, the series will consist of an infinite number of terms. As, however, we mean to treat in this section only of the powers of quantities when their exponents are whole positive numbers, we shall make no further remarks upon any other. The nth power of $a-x$ will not differ from the same power of $a+x$, except in the signs of the terms which compose it, for it will stand thus: $(a-x)^n=$

$$a^n-\frac{n}{1}a^{n-1}x+\frac{n(n-1)}{1\,.\,2}a^{n-2}x^2-\frac{n(n-1)(n-2)}{1\,.\,2\,.\,3}a^{n-3}x^3$$
$$+\frac{n(n-1)(n-2)(n-3)}{1\,.\,2\,.\,3\,.\,4}a^{n-4}x^4-\text{\&c.},$$ where the signs are $+$ and $-$ alternately.

Let it be required, for instance, to raise $a+x$ to the fifth power.

Here n, the exponent of the power, being 5, the first term a^n of the general theorem will be equal to a^5, the second $na^{n-1}x=5a^4x$, the third $\frac{n(n-1)}{1\,.\,2}a^{n-2}x^2=\frac{5\times4}{1\times2}a^3x^2=10a^3x^2$, the fourth $\frac{n(n-1)\,(n-2)}{1\,.\,2\,.\,3}a^{n-3}x^3=\frac{5\times4\times3}{1\times2\times3}\,a^2x^3=10a^2x^3$, the fifth $\frac{n(n-1)\,(n-2)\,(n-3)}{1\,.\,2\,.\,3\,.\,4}a^{n-4}x^4=\frac{5\times4\times3\times2}{1\times2\times3\times4}ax^4=5ax^4$, and the sixth and last $\frac{n(n-1)\,(n-2)\,(n-3)\,(n-4)}{1\,.\,2\,.\,3\,.\,4\,.\,5}a^{n-5}x^5=\frac{5\times4\times3\times2\times1}{1\times2\times3\times4\times5}a^0x^5=x^5$; the remaining terms of the general theorem all vanish, by reason of the factor $n-5=0$ by which each of them is multiplied, so that we get $(a+x)^5=a^5+5a^4x+10a^3x^2+10a^2x^3+5ax^4+x^5$.

If the quantity to be involved consists of more than two terms, as, if $p+q-r$ were to be raised to the second power, put $p=a$ and $q-r=b$, then $(p+q-r)^2=(a+b)^2=a^2+2ab+b^2=p^2+2p(q-r)+(q-r)^2$, but $2p(q-r)=2pq-2pr$, and by the general theorem $(q-r)^2=q^2-2qr+r^2$, therefore we get $(p+q-r)^2=p^2+2pq-2pr+q^2-2qr+r^2$; and by a similar method of proceeding a quantity consisting of four or more terms may be raised to any power.

Additional Examples.

Ex. 1. From the value of $(a+x)^4$ found in example 4, to find that of $(a+b+c)^4$. From example 4 we write at once, by symmetry,

$$\begin{aligned}(a+b+c)^4=a^4&+4a^3b+6a^2b^2+\mathrm{R}\\ +b^4&+4a^3c+6a^2c^2\\ +c^4&+4b^3a+6b^2c^2\\ &+4b^3c\\ &+4c^3a\\ &+4c^3b\end{aligned}$$

where R is the series of remaining terms denoting the three following forms, a^2bc, b^2ac, c^2ab. Now when a, b, c are each unity, there are 81 terms (viz. 3^4). But the number of terms already written down ($4a^3b$ being considered as 4 terms, &c.) is 45. The quantity R must consequently make up the other 36 terms, $\therefore$ it can be nothing else than $12a^2bc+12b^2ac+12c^2ab$.

Ex. 2. $(p+q+r)^2=p^2+q^2+r^2+2(pq+qr+rp)$.

Cor. If $p+q+r=0$; then $p^2+q^2+r^2+2(pq+qr+rp)=0$.

Case 1. $\overline{a-b}+\overline{b-c}+\overline{c-a}=0$, gives

$$(a-b)^2+(b-c)^2+(c-a)^2+2\{(a-b)(b-c)+(b-c)(c-a)+(c-a)(a-b)\}=0\,.$$

Case 2. $a(b-c)+b(c-a)+c(a-b)=0$, gives

$$a^2(b-c)^2+b^2(c-a)^2+c^2(a-b)^2+2\{ab(b-c)(c-a)+bc(c-a)(a-b)+ca(a-b)(b-c)\}=0\,.$$

Ex. 3. Prove that $(x^2-yz)^3+(y^2-xz)^3+(z^2-xy)^3-3(x^2-yz)(y^2-xz)(z^2-xy)$ is a complete square.

The expression will assume symmetry if $(x^2-yz)(y^2-xz)(z^2-xy)$, instead of being multiplied by 3, be repeated three times, each being connected with one of the cubes in turn; this gives—

$$\begin{aligned}&(x^2-yz)\{(x^2-yz)^2-(y^2-xz)(z^2-xy)\}\\ &+(y^2-xz)\{(y^2-xz)^2-(x^2-yz)(z^2-xy)\}\\ &+(z^2-xy)\{(z^2-xy)^2-(x^2-yz)(y^2-xz)\}\\ &=(x^2-yz)x\{x^3+y^3+z^3-3xyz\}\\ &\quad+\text{\&c., \&c.}\\ &=(x^3+y^3+z^3-3xyz)(x^3+y^3+z^3-3xyz)\,.\end{aligned}$$

Ex. 4. Prove that $(a^2+b^2+c^2)^3+2(ab+bc+ca)^3$
$$-3(a^2+b^2+c^2)(ab+bc+ca)^2=(a^3+b^3+c^3-3abc)^2\,.$$

Combine each of the cubes with each of the products in succession, and reduce, as in the last example.

Ex. 5. To find the condition that $px^2+2qxy+ry^2$ may be incapable of changing its sign through any change of sign or value of x and y. It is evident that p and r must have the same sign. Suppose it positive. By multiplying by p, the quantity may be thrown into the form $(px+qy)^2+(pr-q^2)y^2$, which is the sum of two positive quantities provided $pr>q^2$. The condition required is, therefore, $pr>q^2$; or as a particular case $pr=q^2$.

Ex. 6. To find the condition that $ax^2+by^2+cz^2+2\mathrm{P}yz+2\mathrm{Q}zx+2\mathrm{R}xy$ may be incapable of changing its sign through any change of sign or value of x, y, z.

We will suppose a, b, c to be all positive, in which case the whole result is also positive.

If we multiply the whole by a, we may write it under the form of a square and a supplement,

$$\text{viz., }(ax+\mathrm{Q}z+\mathrm{R}y)^2+(ac-\mathrm{Q}^2)z^2+(ab-\mathrm{R}^2)y^2+2(a\mathrm{P}-\mathrm{QR})yz.$$

Now as the first term of this expression is a square, it is essentially positive. Hence the required condition can be satisfied only by rendering the remainder positive.

It follows that $ac>\mathrm{Q}^2$, $ab>\mathrm{R}^2$, and

(Example 5) $\quad(ac-\mathrm{Q}^2)(ab-\mathrm{R}^2)>(a\mathrm{P}-\mathrm{QR})^2$,
i.e., $abc+2\mathrm{PQR}>a\mathrm{P}^2+b\mathrm{Q}^2+c\mathrm{R}^2$.

If we had begun by throwing the expression into the form of $(by+Pz+Rx)^2+$ &c., a resulting condition would have been $bc>P^2$. The four conditions are consequently

$$ab>R^2,\ ac>Q^2,\ bc>P^2,$$
$$abc+2PQR>aP^2+bQ^2+cR^2.$$

Results of this kind are of the utmost value in the higher analysis.

Evolution.

23. Evolution is the reverse of involution, or it is the method of finding the root of any quantity, whether simple or compound, which is considered as a power of that root: hence it follows that its operations, generally speaking, must be the reverse of those of involution.

To denote that the root of any quantity is to be taken, the sign $\surd$ (called the *radical sign*) is placed before it, and a small number placed over the sign to express the denomination of the root. Thus $\sqrt[2]{a}$ denotes the square root of a, $\sqrt[3]{a}$ its cube root, $\sqrt[4]{a}$ its fourth root, and in general, $\sqrt[n]{a}$ its nth root. The number placed over the radical sign is called the *index* or *exponent* of the root, and is usually omitted in expressing the square root: thus, either $\sqrt[2]{a}$ or $\sqrt{a}$ denotes the square root of a.

Case 1. When roots of simple quantities are to be found.

Rule. Divide the exponents of the letters by the index of the root required, and prefix the root of the numeral coefficient; the result will be the root required.

Note 1. The root of any positive quantity may be either positive or negative, if the index of the root be an even number; but if it be an odd number, the root can be positive only.

2. The root of a negative quantity is also negative when the index of the root is an odd number.

3. But if the quantity be negative, and the index of the root even, then no root can be assigned.

Ex. Required the cube root of $125a^6x^9$.

Here the index of the root is 3, and the root of the coefficient 5, therefore $\sqrt[3]{125a^6x^9}=5a^2x^3$, the root required; and in like manner the cube root of $-125a^6x^9$ is found to be $-5a^2x^3$.

The root of a fraction is found by extracting the root of both numerator and denominator. Thus the square root of $\frac{4a^2x^4}{9b^2y^6}$ is $\frac{2ax^2}{3by^3}$.

Case 2. When the quantity of which the root is to be extracted is compound.

Square root. I. To extract the square root.

Range the terms of the quantity according to the powers of one of the letters, as in division.

Find the square root of the first term for the first part of the root sought, subtract its square from the given quantity, and divide the remainder by double the part already found, and the quotient is the second term of the root.

Add the second part to double the first, and multiply their sum by the second part; subtract the product from the remainder, and if nothing remain, the square root is obtained. But if there is a remainder, it must be divided by the double of the parts already found, and the quotient will give the third term of the root, and so on.

Ex. Required the square root of $x^4-2x^3+\frac{3}{2}x^2-\frac{x}{2}+\frac{1}{16}$.

$$\begin{array}{rl}
 & x^4-2x^3+\frac{3}{2}x^2-\frac{x}{2}+\frac{1}{16}\left(x^2-x+\frac{1}{4}\right. \\
 & x^4 \\ \hline
2x^2-x\,) & -2x^3+\frac{3}{2}x^2 \\
\times\ -x\,) & -2x^3+x^2 \\ \hline
2x^2-2x+\frac{1}{4}\,) & \frac{x^2}{2}-\frac{x}{2}+\frac{1}{16} \\
\times\ \frac{1}{4} & \frac{x^2}{2}-\frac{x}{2}+\frac{1}{16} \\ \hline
 & * \quad * \quad *
\end{array}$$

To understand the reason of the rule for finding the square root of a compound quantity, it is only necessary to involve any quantity, as $a+b+c$, to the second power, and observe the composition of its square; for we have $(a+b+c)^2=a^2+2ab+b^2+2ac+2bc+c^2$; but $2ab+b^2=(2a+b)b$ and $2ac+2bc+c^2=(2a+2b+c)c$, therefore,

$$(a+b+c)^2=a^2+(2a+b)b+(2a+2b+c)c;$$

and from this expression the manner of deriving the rule is obvious.

As an illustration of the common rule for extracting the square root of any proposed number, we shall suppose that the root of 59049 is required.

Accordingly we have $(a+b+c)^2=59049$, and from hence we are to find the values of a, b, and c.

$$\begin{array}{rl}
 & 59049\left(200=a\right. \\
a^2=200\times200= & 40000 \quad 40=b \\
 & \qquad\qquad 3=c \\ \hline
2a=400 & 19049 \\
b=\ \ 40 & \\ \hline
2a+b=440 & 17600=(2a+b)b \\
2a+2b=480 & 1449 \\
c=\ \ \ 3 & \\ \hline
2a+2b+c=483 & 1449=(2a+2b+c)c
\end{array}$$

Hence 243 is the root required.

II. To extract the cube root. Cube root.

Range the terms of the quantity according to the powers of some one of the letters.

Find the root of the first term, for the first part of the root sought; subtract its cube from the whole quantity, and divide the remainder by three times the square of the part already found, and the quotient is the second part of the root.

Add together three times the square of the part of the root already found, three times the product of that part and the second part of the root, and the square of the second part; multiply the sum by the second part, and subtract the product from the first remainder, and if nothing remain, the root is obtained; but if there is a remainder, it must be divided by three times the square of the sum of the parts already found, and the quotient is a third term of the root, and so on, till the whole root is obtained.

Ex. Required the cube root of $a^3+3a^2x+3ax^2+x^3$.

$$\begin{array}{rl}
 & a^3+3a^2x+3ax^2+x^3\left(a+x,\right. \text{ the root required.} \\
 & a^3 \\ \hline
3a^2+3ax+x^2\,) & 3a^2x+3ax^2+x^3 \\
 & 3a^2x+3ax^2+x^3 \\ \hline
 & * \quad * \quad *
\end{array}$$

The reason of the preceding rule is evident from the composition of a cube; for if any quantity, as $a+b+c$, be raised to the third power, we have $(a+b+c)^3=a^3+(3a^2+3ab+b^2)b+\{3(a+b)^2+3(a+b)c+c^2\}c$, and by consider-

ing in what manner the terms a, b, and c are deduced from this expression for the cube of their sum, we also see the reason for the common rule for extracting the cube root in numbers. Let it be required to find the cube root of 13312053, where the root will evidently consist of three figures; let us suppose it to be represented by $a+b+c$, and the operation for finding the numerical values of these quantities may stand as follows :—

$$\begin{array}{r|l}
 & 13312053(200=a \\
 & x^3= \ 8000000 \quad 30=b \\
 & \qquad\qquad\qquad 7=c \quad \therefore 237 \text{ is the root required.} \\
3a^2=120000 & 5312053 \\
3ab=\ \ 18000 & \\
b^2=\qquad 900 & \\
\hline
3a^2+3ab+b^2=138900 & 4167000=(3a^2+3ab+b^2)b \\
\hline
3(a+b)^2=158700 & 1145053 \\
3(a+b)c=\quad 4830 & \\
c^2=\qquad 49 & \\
\hline
3(a+b)^2+3(a+b)c+c^2=163579 & 1145053=[3(a+b)^2+3(a+b)c+c^2]c \\
\end{array}$$

Any root. III. To extract any other root.

Range the quantity of which the root is to be found, according to the powers of one of its letters, and extract the root of the first term; that will be the first member of the root required.

Involve the first member of the root to a power less by unity than the number that denominates the root required, and multiply the power that arises by the number itself; divide the second term of the given quantity by the product, and the quotient shall give the second member of the root required.

Find the remaining members of the root in the same manner by considering those already found as making one term.

24. In the preceding examples, the quantities whose roots were to be found have been all such as could have their roots expressed by a finite number of terms; but it will frequently happen that the root cannot be otherwise assigned than by a series consisting of an infinite number of terms. The preceding rules, however, will serve to determine any number of terms of the series. Thus, the square root of a^2+x^2 will be found to be $a+\frac{x^2}{2a}-\frac{x^4}{8a^3}+\frac{x^6}{16a^5}-\frac{5x^8}{128a^7}+$ &c., and the cube root of a^3+x^3 will stand thus, $a+\frac{x^3}{3a^2}-\frac{x^6}{9a^5}+\frac{5x^9}{81a^8}-\frac{10x^{12}}{243a^{11}}+$&c. But as the extraction of roots in the form of series can be more easily performed by the aid of the binomial theorem, we shall refer the reader to the section where this subject is resumed.

Additional Examples.

Ex. 1. Write down the square root of $x^4-2x^3+\frac{3}{2}x^2-\frac{1}{2}x+\frac{1}{16}$, which is given as a perfect square.

Since the square contains 5 terms, the root must contain 3. Of these the first is x^2 on account of x^4, the second $-x$ on account of $2x^3$, and the third $\pm\frac{1}{4}$ on account of $\frac{1}{16}$. But as the last term but one of the square is $-$, and the last term but one of the root also $-$, the last term of the root must be $+$.

$$\therefore x^2-x+\frac{1}{4} \text{ is the root required.}$$

Ex. 2. Extract the square root of $25x^4+16y^4-6xy\,(5x^2+4y^2)+49x^2y^2$. We must first arrange the square in terms of some one quantity (say x).

The first term of the square is $25x^4$, which gives $5x^2$ as the first term of the root. The second term of the square, $-30x^3y$ gives $-3xy$ as the second term of the root. The last term $16y^4$ gives $\pm 4y^2$; which, since the last term but one is $-$, leads to the root $5x^2-3xy+4y^2$.

Ex. 3. Extract the cube root of

$$8x^6-36x^5+66x^4-63x^3+33x^2-9x+1.$$

Since there are seven terms in the cube, there must be three terms in the root. The first is $2x^2$, the second $-3x$, the third 1, as will be seen at once by examining the cube of $p-q+1$, viz., $p^3-3p^2q+\ldots-3q+1$.

These examples have been solved by the assumption that the root is capable of extraction without leaving a remainder. When this is not the case, or when there is no certainty that it is so, the only resource is to work the example through, abbreviating the process by the aid of detached coefficients.

Ex. 4. Extract the square root of $4x^6+12x^5y+5x^4y^2-2x^3y^3+7x^2y^4-2xy^5+y^6$. The work is written thus :

$$\begin{array}{rl}
 & 4+12+5-2+7-2+1(2x^3+3x^2y-xy^2+y^3 \\
 & \underline{4} \\
4+3) & 12+5 \\
 & \underline{12+9} \\
4+6-1) & -4-2+7 \\
 & \underline{-4-6+1} \\
4+6-2+1\ ) & \underline{4+6-2+1} \\
\end{array}$$

Ex. 5. Extract the cube root of

$$27x^6-27x^5y-45x^4y^2+35x^3y^3+30x^2y^4-12xy^5-8y^6.$$

We have

$$\begin{array}{rl}
 & 27-27-45+35+30-12-8(3x^2-xy-2y^2 \\
 & \underline{27} \\
27\quad) & -27-45+35 \\
 & \underline{-27+\ 9-\ 1} \\
27-18+3) & -54+36+30-12-8 \\
 & \left[\begin{array}{r} -54+36-\ 6 \qquad\qquad \\ +36-12 \quad \\ -8 \end{array}\right] \\
\end{array}$$

Sect. III.—Fractions.

25. In the operation of division, the divisor may be sometimes greater than the dividend, or may not be contained in it an exact number of times : in either case the quotient is expressed by means of a fraction. There can be no difficulty, however, in estimating the magnitude of such a quotient; if, for example, it were the fraction $\frac{5}{7}$, we may consider it as denoting either that some unit is divided into 7 equal parts, and that 5 of these are taken, or that

5 times the same unit is dividet into 7 equal parts, and one of them taken.

In any fraction the upper number, or the dividend, is called the *numerator*, and the lower number or divisor is called the *denominator*. Thus, in the fraction $\frac{a}{b}$, a is the numerator, and b the denominator.

If the numerator be less than the denominator, such a fraction is called a *proper* fraction; but if the numerator be either equal to or greater than the denominator, it is called an *improper* fraction; and if a quantity be made up of an integer and a fraction, it is called a *mixed* quantity. Thus, $\frac{a}{a+x}$ is a proper fraction; $\frac{a}{a}$ and $\frac{a+x}{a}$ are both improper fractions; and $b+\frac{x}{a}$ is a mixed quantity.

The *reciprocal* of a fraction is another fraction, having its numerator and denominator respectively equal to the denominator and numerator of the former.

Thus, $\frac{b}{a}$ is the reciprocal of the fraction $\frac{a}{b}$.

26. The following proposition is the foundation of the operations relating to fractions.

If the numerator and denominator of a fraction be either both multiplied or both divided by the same quantity, the value of the resulting fraction is the same as before.

To demonstrate this proposition we shall throw the definition of a fraction into a categorical form. We shall accordingly define the fraction $\frac{a}{b}$ as such a magnitude, that when it is multiplied by b, the product is a.

Then since $$\frac{a}{b}\times b=a.$$

$$n\times\frac{a}{b}\times b=na$$

i.e. (Art. 9, Law 3), $$\frac{a}{b}\times nb=na$$

But $$\frac{na}{nb}\times nb=na \text{ (Def.)}$$

$$\therefore\ \frac{a}{b}=\frac{na}{nb}.$$

From this proposition, it is obvious that a fraction may be very differently expressed without changing its value, and that any integer may be reduced to the form of a fraction, by placing the product arising from its multiplication by any assumed quantity as the numerator, and the assumed quantity as the denominator of the fraction. It also appears that a fraction very complex in its form may often be reduced to another of the same value, but more simple, by finding a quantity which will divide both the numerator and denominator, without leaving a remainder. Such a common divisor, or common measure, may be either simple or compound; if it be simple, it is readily found by inspection, but if it be compound, it may be found as in the following problem.

27. PROB. I.—*To find the greatest common Measure of two Quantities.*

Rule 1. Range the quantities according to the power of some one of the letters, as in division, leaving out the simple divisors of each quantity.

2. Divide that quantity which is of most dimensions by the other one, and if there be a remainder, divide it by its greatest simple divisor; and then divide the last compound divisor by the resulting quantity, and if anything yet remain, divide it also by its greatest simple divisor, and the last compound divisor by the resulting quantity. Proceed in this way till nothing remain, and the last divisor shall be the common measure required.

Note.—It will sometimes be necessary to multiply the dividends by simple quantities in order to make the divisions succeed.

The demonstration of this proposition depends on the AXIOM, that whatever divides a number divides any multiple of the number; and whatever divides two numbers divides their sum or difference. It was given by Euclid in Prop. 2, Book vii., very much as follows:—

Let a, b be the quantities, the smaller of which is b.

Let a be divided by b, with a remainder c,

b by c, with a remainder d,

c by d, with no remainder,

d is the greatest common measure of a and b.

We have $$a-pb=c,\ b-qc=d,\ c=rd.$$

Now, (1.) d is a common measure of a and b; for d divides $c \therefore qc \therefore qc+d \therefore b \therefore pb \therefore pb+c \therefore a$; *i.e.*, d divides a and b.

(2.) It is *the greatest* common divisor. For if not, let e be the greatest; then, since e divides a and b, it divides a and pb, $\therefore a-pb \therefore c \therefore qc \therefore b-qc \therefore d$; *i.e.*, e is less than d, and not greater.

Cor. Every other divisor of a and b divides their greatest common measure.

Observe that no fraction is in a form to be interpreted until it is reduced to its lowest terms.

Ex. 1. Required the greatest common measure of the quantities a^2x-x^3 and $a^3-2a^2x+ax^2$. The simple divisor x being taken out of the former of these quantities, and a out of the latter, they are reduced to a^2-x^2 and $a^2-2ax+x^2$; and as the quantity a rises to the same dimensions in both, we may take either of them as the first divisor: let us take that which consists of fewest terms, and the operation will stand thus:

$$\begin{array}{r} a^2-x^2)a^2-2ax+x^2(1 \\ \underline{a^2-x^2\qquad\quad} \\ -2ax+2x^2 \text{ remainder,} \end{array}$$

which, divided by $-2x$, is
$$\begin{array}{r} a-x)a^2-x^2(a+x \\ \underline{a^2-ax\qquad} \\ +ax-x^2 \\ \underline{+ax-x^2} \\ *\quad * \end{array}$$

Hence it appears that $a-x$ is the greatest common measure required.

Ex. 2. Required the greatest common measure of $8a^2b^2-10ab^3+2b^4$, and $9a^4b-9a^3b^2+3a^2b^3-3ab^4$.

It is evident, from inspection, that b is a simple divisor of both quantities; it will therefore be a factor of the common measure required. Let the simple divisors be now left out of both quantities, and they are reduced to $4a^2-5ab+b^2$, and $3a^3-3a^2b+ab^2-b^3$; but as the second of these is to be divided by the first, it must be multiplied by 4 to make the division succeed, and the operation will stand thus:

$$\begin{array}{r} 4a^2-5ab+b^2)12a^3-12a^2b+4ab^2-4b^3(3a \\ \underline{12a^3-15a^2b+3ab^2\qquad\quad} \\ +\ 3a^2b+ab^2-4b^3 \end{array}$$

This remainder is to be divided by b, and the new dividend multiplied by 3, to make the division again succeed, and the work will stand thus:

$$\begin{array}{r} 3a^2+ab-4b^2)12a^2-15ab+\ 3b^2(4 \\ \underline{12a^2+\ 4ab-16b^2} \\ -19ab+19b^2 \end{array}$$

This remainder is to be divided by $-19b$, which being done, and the last divisor taken as a dividend as before, the rest of the operation will be as follows:—

$$\begin{array}{l} a-b)3a^2+\ ab-4b^2(3a+4b \\ \quad\ \ 3a^2-3ab \\ \hline \quad\qquad +4ab-4b^2 \\ \quad\qquad +4ab-4b^2 \\ \hline \quad\qquad\quad * \quad * \end{array}$$

from which it appears that the common divisor sought is $a-b$, and remarking that the quantities proposed have also a simple divisor b, the greatest common measure which is required will be $b(a-b)$.

It will be seen that the examples we have given are not on numbers, but on algebraic quantities. In fact, the axiom and the demonstration founded on it apply, with some restrictions and modifications, to such quantities. The most important of the modifications is this: that the divisor, instead of being a whole number, is an expression of the form $x+m$, where m is of the nature of a numerical quantity, and does not depend on x.

The application of this modified form of the axiom has a wide range in the higher analysis. We offer two additional examples for advanced students.

Ex. 1. If ax^2+bx+c, $a'x^2+b'x+c'$ have a common divisor of the form $x+m$, prove that

$$(a'b-ab')(b'c-bc')=(a'c-ac')^2.$$

Multiply the first expression by a', and the second by a, and subtract the products, the difference $(a'b-ab')x+a'c-ac'$, is by the axiom divisible by $x+m$,

$$\therefore\ x+\frac{a'c-ac'}{a'b-ab'} \text{ is } x+m.$$

Again, multiply the first expression by c', and the second by c, and subtract them; the difference $(a'c-ac')x^2+(b'c-bc')x$ is divisible by $x+m$, $\therefore\ x+\frac{b'c-bc'}{a'c-ac'}$ is $x+m$.

Consequently, $$\frac{b'c-bc'}{a'c-ac'}=\frac{a'c-ac'}{a'b-ab'},$$

the condition required.

Ex. 2. If ax^3+3bx^2+d, $bx^3+3dx+e$, have a common divisor; then

$$(4bd-ae)^3+27(ad^2+b^2e)^2=0.$$

Treating this question exactly as the last, viz., multiplying first by b and a, and then by e and d, and subtracting, it appears (if u be written instead of $bd-ae$ for brevity) that the two following expressions have a common divisor,

$$3b^2x^2-3adx+u \text{ and } ux^2-3bex+3d^2,$$

whence, by the last example, the condition is

$$(3beu-9ad^3)(3adu-9b^3e)=(u^2-9b^2d^2)^2,$$

from which u divides out as a common factor, and the result reduces to that enunciated.

28. Prob. II.—*To Reduce a Fraction to its Lowest Terms.*

Rule. Divide both numerator and denominator by their greatest common measure, which may be found by Prob. I.

Ex. 1. Reduce $\frac{a^2x-x^3}{a^3-2a^2x+ax^2}$ to its lowest terms.

We have already found in the first example of Prob. I. that the greatest common measure of the numerator and denominator is $a-x$; and dividing both by this quantity, we have $$\frac{a^2x-x^3}{a^3-2a^2x+ax^2}=\frac{ax+x^2}{a^2-ax}.$$

In like manner we find

$$\frac{9a^4b-9a^3b^2+3a^2b^3-3ab^4}{8a^2b^2-10ab^3+2b^4}=\frac{9a^3+3ab^2}{8ab-2b^2},$$

the common measure being $b(a-b)$, as was shown in Example 2, Problem I.

Ex. 2. Reduce $\frac{a^2-b^2-c^2+2bc}{a^2+b^2-c^2+2ab}$ to its lowest terms.

$$\frac{a^2-b^2-c^2+2bc}{a^2+b^2-c^2+2ab}=\frac{a^2-(b-c)^2}{(a+b)^2-c^2}=\frac{(a+\overline{b-c})(a-\overline{b-c})}{(a+b+c)(a+b-c)}=\frac{a-b+c}{a+b+c}.$$

Ex. 3. To find the value of $\frac{(x+1)^2-3x-3}{x^2-2x}$ when $x=2$.

Here the substitution of 2 in place of x renders the numerator and denominator separately equal to 0. This shows (Art. 20) that $x-2$ is a divisor of each of them. We get, therefore,

$$\frac{(x+1)^2-3x-3}{x^2-2x}=\frac{x+1}{x}, \text{ which when } x=2 \text{ becomes } \frac{3}{2}.$$

Ex. 4. Find the value of $\frac{x^3-4x^2+2x+1}{x^4-4x^3+6x^2-4x+1}$ when $x=1$.

Dividing numerator and denominator by $x-1$, the result is $\frac{x^2-3x-1}{x^3-3x^2+3x-1}$, which, when 1 is written in place of x, becomes $\frac{3}{0}$, or infinity.

29. Prob. III.—*To Reduce a Mixed Quantity to an Improper Fraction.*

Rule. Multiply the integer by the denominator of the fraction, and to the product add the numerator; and the denominator being placed under this sum, the result will be the improper fraction required.

Ex. 1. Reduce $a-x+\frac{x^2}{a+x}$ to an improper fraction.

$$a-x+\frac{x^2}{a+x}=\frac{(a+x)(a-x)+x^2}{a+x}=\frac{a^2}{a+x}, \text{ Ans.}$$

30. Prob. IV.—*To Reduce an Improper Fraction to a Whole or Mixed Number.*

Rule. Divide the numerator by the denominator for the integral part, and place the remainder, if any, over the denominator; it will be the mixed quantity required.

Ex. 1. Reduce $\frac{ax+2x^2}{a+x}$ and $\frac{x^2-y^2}{x-y}$ to whole or mixed quantities.

First $\frac{ax+2x^2}{a+x}=x+\frac{x^2}{a+x}$, the answer.

And $\frac{x^2-y^2}{x-y}=x+y$ a whole quantity, which is the answer.

31. Prob. V.—*To Reduce Fractions having different Denominators to others of the same value which shall have a common Denominator.*

Rule. Multiply each numerator separately into all the denominators except its own for the new numerators, and all the denominators together for the common denominator.

Ex. 1. Reduce $\frac{ax}{a-x}$ and $\frac{a^2-x^2}{a+x}$ to fractions of equal value, having a common denominator.

$$\left.\begin{array}{l} ax(a+x)=a^2x+ax^2 \\ (a^2-x^2)(a-x)=a^3-a^2x-ax^2+x^3 \end{array}\right\}\text{the new numerators}$$

$(a-x)(a+x)=a^2-x^2$, the common denominator.

Hence $\frac{ax}{a-x}=\frac{a^2x+ax^2}{a^2-x^2}$ and $\frac{a^2-x^2}{a+x}=\frac{a^3-a^2x-ax^2+x^3}{a^2-x^2}$.

32. Prob. VI.—*To Add or Subtract Fractions.*

Rule. Reduce the fractions to a common denominator, and add or subtract their numerators; and the sum or difference placed over the common denominator is the sum or remainder required.

In practice, however, it is generally better to separate the process into two or more parts analogous to the addition or subtraction of sums of money, where the pounds are added to the pounds, the shillings to the shillings, &c., and the result afterwards combined.

Ex. 1. Add together $\frac{a}{a-b}$ and $\frac{b}{b-a}$.

The latter fraction is $-\frac{b}{a-b}$.

$\therefore$ the sum required is $\frac{a}{a-b}-\frac{b}{a-b}=\frac{a-b}{a-b}=1$.

Similarly, $\frac{1}{a^n-1}+\frac{1}{a^{-n}-1}=\frac{1}{a^n-1}+\frac{a^n}{1-a^n}=\frac{1-a^n}{a^n-1}=-1$.

Ex. 2. Collect into a single fraction

$$\frac{1}{a-b}-\frac{1}{a+b}+\frac{2a}{a^2-b^2}.$$

Since $\qquad \frac{1}{a-b}-\frac{1}{a+b}=\frac{2b}{a^2-b^2}$

$$\therefore \frac{1}{a-b}-\frac{1}{a+b}+\frac{2a}{a^2-b^2}=\frac{2(b+a)}{a^2-b^2}=\frac{2}{a-b}.$$

Ex. 3. Collect $\frac{1}{4x-8}+\frac{1}{3x-6}+\frac{7}{24-12x}$.

We observe that $x-2$ is common to all the denominators; the question may therefore be written,

$$\frac{\frac{1}{4}}{x-2}+\frac{\frac{1}{3}}{x-2}-\frac{\frac{7}{12}}{x-2}=0.$$

Ex. 4. Collect $\frac{1}{3x+2y}+\frac{1}{x-4y}+\frac{1}{3x-2y}-\frac{25x+4y}{x^2-16y^2}$.

Here we commence by adding the 1st and 3d together, and the 2d and 4th together; which results in

$$\frac{6x}{9x^2-4y^2}-\frac{24x}{x^2-16y^2}$$

$$=6x\left(\frac{1}{9x^2-4y^2}-\frac{4}{x^2-16y^2}\right)=6x\frac{-35x^2}{(9x^2-4y^2)(x^2-16y^2)}$$

$$=-\frac{210x^3}{(9x^2-4y^2)(x^2-16y^2)}$$

Ex. 5. Find the sum of $\frac{1+x+x^2+x^3}{1-x+x^2-x^3}+\frac{1-x+x^2-x^3}{1+x+x^2+x^3}$.

The numerator will consist of the sum of two products, the one containing $+x$, exactly in the same way that the other contains $-x$. If, then, we write down one of these products, and double the even powers of x in it, omitting the odd powers, we shall obtain the required result. The product of the denominators again may be readily obtained by regarding it as that of the difference and sum of $1+x^2$ and $x+x^3$. As such processes are of constant occurrence, we will indicate the work in full.

$$\begin{array}{llllllll}
\text{Numerator,} & 1 & +1 & +1 & +1 & & & \\
 & 1 & +1 & +1 & +1 & & & \\
\hline
 & 1 & +1 & +1 & +1 & & & \\
 & & +1 & +1 & +1 & +1 & & \\
 & & & +1 & +1 & +1 & +1 & \\
 & & & & +1 & +1 & +1 & +1 \\
\hline
\text{Double of} & 1 & & +3x^2 & & +3x^4 & & +1
\end{array}$$

Denominator, $\{1+x^2-(x+x^3)\}\ \{1+x^2+(x+x^3)\}=(1+x^2)^2-(x+x^3)^2=1+2x^2+x^4-x^2-2x^4-x^6=1+x^2-x^4-x^6$.

And the result is $\frac{2+6x^2+6x^4+2x^6}{1+x^2-x^4-x^6}$.

Ex. 6. Collect into one fraction $\frac{1}{1+x^{m-n}+x^{m-p}}+\frac{1}{1+x^{n-m}+x^{n-p}}+\frac{1}{1+x^{p-m}+x^{p-n}}$.

Multiply numerator and denominator of the first fraction by x^{-m}, &c., and the given quantity becomes

$$\frac{x^{-m}}{x^{-m}+x^{-n}+x^{-p}}+\frac{x^{-n}}{x^{-m}+x^{-n}+x^{-p}}+\frac{x^{-p}}{x^{-m}+x^{-n}+x^{-p}}=1$$

Ex. 7. If $\frac{1}{1+l+ln}+\frac{m}{1+m+ml}+\frac{nm}{1+n+nm}=1$, and

$$\frac{l}{1+l+ln}+\frac{ml}{1+m+ml}+\frac{1}{1+n+nm}=1,$$

none of the denominators being zero, then $l=m=n$.

Multiply the first quantity by l, and subtract, there results $l=\frac{1+m}{1+n}n$, which, when substituted in the first quantity, gives $m=n$, whence the proposition.

33. The converse problem to collecting many fractions into one is frequently as important as the direct—the problem, namely, of resolving a compound fraction into its components or *partial fractions*. For a first example, if it be required to find what simple fractions make up the compound fraction $\frac{2x}{x^2-a^2}$, we commence by observing that the denominator x^2-a^2 is the product of $x+a$ and $x-a$. Hence, $\frac{2x}{x^2-a^2}$ is the sum of the fractions whose denominators are $x+a$ and $x-a$. Partial fractions.

Let $\frac{2x}{x^2-a^2}=\frac{A}{x+a}+\frac{B}{x-a}$, where A and B are quantities which involve a only, not x, since x^2 does not appear in the numerator of the sum.

By addition, $\frac{2x}{x^2-a^2}=\frac{A(x-a)+B(x+a)}{x^2-a^2}$.

$$\therefore\ 2x=A(x-a)+B(x+a).$$

To obtain A and B from this equality, we remark that the equality is an identity, as in Art. 20. We may, therefore, deal with it in either of two ways: 1. Make the x's on the left hand side to coincide with the x's on the right, and the a's in like manner. 2. As in Art. 20, write anything we please in place of x on both sides. We will in this example take the first method, and illustrate the second method by the subsequent examples. We get $2=A+B$, $0=A-B$; $\therefore$ $A=B=1$, and the result is

$$\frac{2x}{x^2-a^2}=\frac{1}{x-a}+\frac{1}{x-a}.$$

Ex. 2. $\frac{1}{(x-a)(x-b)}=\frac{A}{x-a}+\frac{B}{x-b}$.

$$\therefore\ 1=A(x-b)+B(x-a).$$

Write a for x, then $1=A(a-b)\ \therefore\ A=\frac{1}{a-b}$.

Write b for x, then $1=B(b-a)=-(a-b)\ \therefore\ B=-\frac{1}{a-b}$;

hence, $\frac{1}{(x-a)(x-b)}=\frac{1}{a-b}\left(\frac{1}{x-a}-\frac{1}{x-b}\right)$.

The reader will observe that we have treated $\frac{1}{a-b}$ as if it were not itself a fraction. In fact, in the application of the subject before us, the letters a and b stand for arithmetical quantities, and the fraction $\frac{1}{a-b}$ is simply an arithmetical fraction, as contradistinguished from an algebraical fraction like $\frac{1}{x-a}$.

Ex. 3. $\frac{px+q}{(x-a)(x-b)(x-c)}=\frac{A}{x-a}+\frac{B}{x-b}+\frac{C}{x-c}$

gives $px+q=A(x-b)(x-c)+B(x-a)(x-c)+C(x-a)(x-b)$,

$\therefore\ pa+q=A(a-b)(a-c)$, &c.,

and $\frac{px+q}{(x-a)(x-b)(x-c)}=\frac{pa+q}{(a-b)(a-c)}\cdot\frac{1}{x-a}+\frac{pb+q}{(b-a)(b-c)}\cdot\frac{1}{x-b}+\frac{pc+q}{(c-a)(c-b)}\cdot\frac{1}{x-c}$.

Ex. 4. Find the sum of $\frac{a+b}{(b-c)(c-a)}+\frac{b+c}{(c-a)(a-b)}+\frac{c+a}{(a-b)(b-c)}$.

Let $a+b+c=s$; and write in alphabetical order; it gives

$$\frac{a-s}{(a-b)(a-c)}+\frac{b-s}{(b-a)(b-c)}+\frac{c-s}{(c-a)(c-b)},$$

i.e. (Ex. 3), the A, B, C of the resolved fraction,

$$\frac{x-s}{(x-a)(x-b)(x-c)}=\frac{A}{x-a}+\frac{B}{x-b}+\frac{C}{x-c},$$

and since $x-s=A(x-b)(x-c)+B(x-a)(x-c)+C(x-a)(x-b)$, the sum required, being the coefficient of x^2, is equal to 0.

The reader will easily extend this process to other cases, as, for instance, to prove

Ex. 5. $\frac{bcd}{(a-b)(a-c)(a-d)}+\frac{cda}{(b-c)(b-d)(b-a)}+\frac{dab}{(c-d)(c-a)(c-b)}+\frac{abc}{(d-a)(d-b)(d-c)}=1$.

34. PROB. VII.—*To Multiply Fractions.*

Rule. Multiply the numerators of the fractions for the numerator of the product, and the denominators for the denominator of the product.

The demonstration follows at once from the definition of a fraction given in Art. 26; thus since $\frac{a}{b}\times b=a$, $\frac{c}{d}\times d=c$, we have $\frac{a}{b}\times b\times\frac{c}{d}\times d=ac$, *i.e.*, by the commutative law $\frac{a}{b}\times\frac{c}{d}\times bd=ac$.

But $$\frac{ac}{bd}\times bd=ac$$

$$\therefore\quad \frac{a}{b}\times\frac{c}{d}=\frac{ac}{bd}.$$

35. PROB. VIII.—*To Divide Fractions.*

Rule. Multiply the dividend by the reciprocal of the divisor, the product will be the quotient required.

This rule requires no demonstration.

Examples in Multiplication and Division of Fractions.

Ex. 1. Multiply $\frac{a}{b}-\frac{b}{a}$ by $\frac{a^2}{a^2-b^2}$. Since $\frac{a}{b}-\frac{b}{a}=\frac{a^2-b^2}{ab}$, $\therefore$ the product is

$$\frac{a^2-b^2}{ab}\times\frac{a^2}{a^2-b^2}=\frac{a^2}{ab}=\frac{a}{b}.$$

Ex. 2. Multiply $\frac{x^3-3x+2}{x^3+2x^2+2x+1}$ by $\frac{x^2+2x+1}{x^2-5x+4}$.

Because the numerator of the first fraction, and the denominator of the second both become 0, when 1 is written for x, each is divisible by $x-1$ (Art. 20). In the same way the denominator of the first fraction, and the numerator of the second are both divisible by $x+1$. Hence,

$$\frac{x^3-3x+2}{x^3+2x^2+2x+1}\times\frac{x^2+2x+1}{x^2-5x+4}=\frac{x^3-3x+2}{x^2-5x+4}\times\frac{x^2+2x+1}{x^3+2x^2+2x+1}$$
$$=\frac{x^2+x-2}{x-4}\times\frac{x+1}{x^2+x+1}=\frac{x^3+2x^2-x-2}{x^3-3x^2-3x-4}.$$

Ex. 3. Divide $\frac{a}{b}-\frac{b}{a}$ by $\frac{a^2}{b^2}-\frac{b^2}{a^2}$.

The quotient is $\frac{a^2-b^2}{ab}\times\frac{a^2b^2}{a^4-b^4}=\frac{ab}{a^2+b^2}$.

Ex. 4. Reduce $1-\left(\frac{b^2+c^2-a^2}{2bc}\right)^2$ to factorials.

$$1-\left(\frac{b^2+c^2-a^2}{2bc}\right)^2=\left(1+\frac{b^2+c^2-a^2}{2bc}\right)\left(1-\frac{b^2+c^2-a^2}{2bc}\right)$$
$$=\frac{(b+c)^2-a^2}{2bc}\times\frac{a^2-(b-c)^2}{2bc}$$
$$=\frac{(b+c+a)(b+c-a)(a+b-c)(a-b+c)}{4b^2c^2}.$$

Ex. 5. Reduce $1-\left(\frac{a^2+b^2-c^2-d^2}{2(ab+cd)}\right)^2$ to factorials.

$$1-\left(\frac{a^2+b^2-c^2-d^2}{2(ab+cd)}\right)^2=\left\{1+\frac{a^2+b^2-c^2-d^2}{2(ab+cd)}\right\}\times$$
$$\left\{1-\frac{a^2+b^2-c^2-d^2}{2(ab+cd)}\right\}=\frac{(a+b)^2-(c-d)^2}{2(ab+cd)}\times\frac{(c+d)^2-(a-b)^2}{2(ab+cd)}$$
$$=\frac{(a+b+c-d)(a+b-c+d)(c+d+a-b)(c+d-a+b)}{4(ab+cd)^2}.$$

Miscellaneous Examples in Fractions.

Ex. 1. Find the value of $\frac{1}{ab-ax}-\frac{1}{bx-ab}+\frac{x}{(x-a)(bc-cx)}$, when $x=\frac{2abc}{ab+ac+bc}$. Writing down every term with x first, there results—

$$-\frac{1}{a(x-b)}-\frac{1}{b(x-a)}-\frac{x}{c(x-a)(x-b)}=-\frac{\frac{x}{a}+\frac{x}{b}+\frac{x}{c}-2}{(x-a)(x-b)}=0.$$

Ex. 2. Find the value of $\frac{1}{x-3a}+\frac{1}{x-3b}+\frac{1}{x+3c}$, when $\frac{1}{a}+\frac{1}{b}=\frac{1}{c}$ and $x=2(a+b-c)$.

Restore symmetry by writing $-c$ for c; the numerator of the sum is $(x-3b)(x-3c)+(x-3a)(x-3c)+(x-3a)(x-3b)=3\{x^2-2(a+b+c)x+3(ab+ac+bc)\}$. But $x=2(a+b+c)$, whence the first and second terms make up 0; and $\frac{1}{a}+\frac{1}{b}+\frac{1}{c}=0$, is the third term divided by abc, $\therefore$ the sum required is 0.

Ex. 3. Given that $(a^2+bc)(b^2+ac)(c^2+ab)+(a^2-bc)(b^2-ac)(c^2-ab)=0$, when multiplied out and reduced, may be written $a^3+b^3+c^3+abc=0$, prove that $(a^2+bc)(b^2+ac)(c^2+ab)-(a^2-bc)(b^2-ac)(c^2-ab)=0$, may be reduced to $\frac{1}{a^3}+\frac{1}{b^3}+\frac{1}{c^3}+\frac{1}{abc}=0$. The latter given equality, by dividing it by $a^2bc\times b^2ac\times c^2ab$, becomes

$$\left(\frac{1}{bc}+\frac{1}{a^2}\right)\left(\frac{1}{ac}+\frac{1}{b^2}\right)\left(\frac{1}{ab}+\frac{1}{c^2}\right)-$$
$$\left(\frac{1}{bc}-\frac{1}{a^2}\right)\left(\frac{1}{ac}-\frac{1}{b^2}\right)\left(\frac{1}{ab}-\frac{1}{b^2}\right)=0$$

i.e. $$\left(\frac{1}{bc}+\frac{1}{a^2}\right)\left(\frac{1}{ac}+\frac{1}{b^2}\right)\left(\frac{1}{ab}+\frac{1}{c^2}\right)+$$
$$\left(\frac{1}{a^2}-\frac{1}{bc}\right)\left(\frac{1}{b^2}-\frac{1}{ac}\right)\left(\frac{1}{c^2}-\frac{1}{ab}\right)=0,$$

which is identical with the first given equality, but with $\frac{1}{a},\frac{1}{b},\frac{1}{c}$, written in place of a, b, c. The result therefore of

reducing the second equality will be identical with that of reducing the first, when $\frac{1}{a}, \frac{1}{b}, \frac{1}{c}$, are written in place of a, b, c. Now the former result is $a^3+b^3+c^3+abc=0$, $\therefore$ the latter is $\frac{1}{a^3}+\frac{1}{b^3}+\frac{1}{c^3}+\frac{1}{abc}=0$.

Ex. 4. Prove that $\frac{a_1^{m-1}}{(a_1-a_2)(a_1-a_3)\ldots(a_1-a_n)}+\frac{a_2^{m-1}}{(a_2-a_1)(a_2-a_3)\ldots(a_2-a_n)}+$ &c., is equal to 0 if $m<n$, and equal to 1 if $m=n$. This is easily proved by resolving $\frac{x^{m-1}}{(x-a_1)(x-a_2)\ldots(x-a_n)}$ into partial fractions (Art. 33).

We have

$$\frac{x^{m-1}}{(x-a_1)\ldots(x-a_n)}=\frac{A_1}{x-a_1}+\frac{A_2}{x-a_2}+\text{ &c.},$$

$$\therefore\ x^{m-1}=A_1(x-a_2)\ldots(x-a_n)+\text{ &c.}\ \ldots (1),$$

whence, writing a_1, a_2, &c., successively for x, we get A_1, A_2, &c.

The given quantity is $A_1+A_2+\ldots+A_n$, and the equation marked (1), gives, by equating coefficients of like powers of x, the result required.

Ex. 5. If $\frac{p}{q}=\frac{r}{s}$, then $\frac{p+q}{p-q}=\frac{r+s}{r-s}$.

For $\frac{p}{q}+1=\frac{r}{s}+1$ gives $\frac{p+q}{q}=\frac{r+s}{s}$, and $\frac{p}{q}-1=\frac{r}{s}-1$ gives $\frac{p-q}{q}=\frac{r-s}{s}$. Divide the former by the latter.

Ex. 6. If $\frac{1}{a}+\frac{1}{b}+\frac{1}{c}=\frac{1}{a+b+c}$, then $a^2=b^2=c^2$.

For $\frac{a+b}{ab}=\frac{1}{a}+\frac{1}{b}=\frac{1}{a+b+c}-\frac{1}{c}=-\frac{a+b}{c(a+b+c)}$,

$$\therefore \text{ either } a+b=0, \text{ or } \frac{1}{ab}=-\frac{1}{ac}-\frac{1}{bc}-\frac{1}{c^2}.$$

In the latter case, $-\frac{1}{c^2}=\frac{1}{ab}+\frac{1}{ac}+\frac{1}{bc}$,

which is not changed by interchanging c and b or c and a,

$$\therefore\ \frac{1}{c^2}=\frac{1}{b^2}=\frac{1}{a^2},$$

so that on either alternative the proposition is true.

Ex. 7. Given that $\frac{ad-bc}{a-b-c+d}=\frac{ac-bd}{a-b+c-d}$, and a not equal to b, nor c equal to d; to prove that $a+b=c+d$; and that either of the fractions equals $\frac{a+b+c+d}{4}$.

Write the equality thus,—

$$\frac{ac-bd}{ad-bc}=\frac{a-b+(c-d)}{a-b-(c-d)}.$$

Apply Example 5, and there results,

$$\frac{ac-bd+ad-bc}{ac-bd-ad+bc}=\frac{a-b}{c-d},$$

i.e. $\frac{(a-b)(c+d)}{(c-d)(a+b)}=\frac{a-b}{c-d}$, whence $a+b=c+d$

If now $a-c$ or $d-b$ be written by a single symbol x, the first fraction becomes

$$\frac{(c+x)(b+x)-cb}{2x}=\frac{b+c+x}{2}=\frac{a+b}{2}=\frac{a+b+c+d}{4}.$$

Ex. 8. If $x=\frac{1}{\sqrt{b}+\sqrt{c}-\sqrt{a}}$, $y=\frac{1}{\sqrt{c}+\sqrt{a}-\sqrt{b}}$,

$$z=\frac{1}{\sqrt{a}+\sqrt{b}-\sqrt{c}},\ u=\frac{1}{\sqrt{a}+\sqrt{b}+\sqrt{c}};$$

prove that

$$\frac{(y+z-x+u)(z+x-y+u)(x+y-z+u)}{(x+y+z-u)^3}=\frac{(b+c-a)(c+a-b)(a+b-c)}{8abc}.$$

Deal with the reciprocals of x, y, z, u; thus,

$$y+z-x+u=y+z-(x-u)$$
$$=yz\left(\frac{1}{z}+\frac{1}{y}\right)-xu\left(\frac{1}{u}-\frac{1}{x}\right)=2\sqrt{a}(yz-xu)$$
$$=2\sqrt{a}yzxu\left(\frac{1}{xu}-\frac{1}{yz}\right)$$
$$=4\sqrt{a}yzxu(c+b-a).$$

Hence, by symmetry, the numerator of the left hand fraction becomes

$$64\sqrt{abc}\,y^3z^3x^3u^3(b+c-a)(c+a-b)(a+b-c).$$

Also, $x+y+z-u=xy\left(\frac{1}{y}+\frac{1}{x}\right)+zu\left(\frac{1}{u}-\frac{1}{z}\right)$

$$=2\sqrt{c}(xy+zu)=2\sqrt{c}xyzu\left(\frac{1}{zu}+\frac{1}{xy}\right)$$
$$=8\sqrt{abc}\,xyzu,$$

Hence the result.

SECT. IV.—SURDS.

36. It has been already observed (Art. 23), that the root of any proposed quantity is found by dividing the exponent of the quantity by the index of the root; and the rule has been illustrated by examples, in all of which, however, the quotient expressing the exponent of the result is a whole number; but there may be cases in which the quotient is a fraction. Thus, if the cube root of a^2 were required, it might be expressed, agreeably to the method of notation already explained, either thus, $\sqrt[3]{a^2}$, or thus, $a^{\frac{2}{3}}$.

Quantities which have fractional exponents are called *surds*, or imperfect powers, and are said to be *irrational*, in opposition to others with integral exponents, which are called *rational*.

Surds may be denoted by means of the radical sign, but it will be often more convenient to use the notation of fractional exponents. The following examples will show how they may be expressed either way.

$$\sqrt[3]{a}=a^{\frac{1}{3}},\quad \sqrt{4ab^2}=2ba^{\frac{1}{2}},\quad \sqrt[4]{a^3b^2}=a^{\frac{3}{4}}b^{\frac{2}{4}},$$
$$\sqrt{a^2+b^2}=(a^2+b^2)^{\frac{1}{2}},\quad \sqrt[5]{(a-b)^2}=(a-b)^{\frac{2}{5}},$$
$$\frac{\sqrt{a+b}}{\sqrt{ab}}=(a+b)^{\frac{1}{2}}a^{-\frac{1}{2}}b^{-\frac{1}{2}}.$$

The operations concerning surds depend on the following principles:—

1. If the numerator and denominator of a fractional exponent be either both multiplied or both divided by the same quantity, the value of the power is the same. Thus, $a^{\frac{m}{n}}=a^{\frac{cm}{cn}}$.

2. The product of like powers (integral or fractional) is the same power of the product. Thus, $a^{\frac{1}{2}}b^{\frac{1}{2}}=(ab)^{\frac{1}{2}}$.

37. I.—*Reduction of a Rational Quantity to the form of a Surd of any given denomination.*

Rule. Reduce the exponent of the quantity to the form of a fraction of the same denomination as the given surd.

Ex. Reduce a^2 to the form of the cube root.

Here the exponent 2 must be reduced to the form of a

fraction having 3 for a denominator, which will be the fraction $\frac{6}{3}$; therefore $a^2 = a^{\frac{6}{3}} = \sqrt[3]{a^6}$.

38. II.—*Reduction of Surds of different denominations to others of the same value and of the same denomination.*

Rule. Reduce the fractional exponents to others of the same value, and having the same common denominator.

Ex. Reduce $\sqrt{a}$ and $\sqrt[3]{b^2}$, or $a^{\frac{1}{2}}$ and $b^{\frac{2}{3}}$ to other equivalent surds of the same denomination.

The exponents $\frac{1}{2}$, $\frac{2}{3}$. when reduced to a common denominator, are $\frac{3}{6}$ and $\frac{4}{6}$; therefore the surds required are $a^{\frac{3}{6}}$ and $b^{\frac{4}{6}}$, or $\sqrt[6]{a^3}$ and $\sqrt[6]{b^4}$.

39. III.—*Reduction of Surds to their most simple terms.*

Rule. Reduce the surd into two factors, so that one of them may be a complete power, having its exponent divisible by the index of the surd. Extract the root of that power, and place it before the remaining quantities, with the proper radical sign between them.

Ex. 1. Reduce $\sqrt{48}$ to its most simple terms.

The number 48 may be resolved into the two factors 16 and 3, of which the first is a complete square; therefore $\sqrt{48} = (4^2 \times 3)^{\frac{1}{2}} = 4 \times 3^{\frac{1}{2}} = 4\sqrt{3}$.

Ex. 2. Reduce $\sqrt{98a^4x}$, and $\sqrt[3]{24a^3x + 40a^3x^2}$, each to its most simple terms.

First, $\sqrt{98a^4x} = (7^2a^4 \times 2x)^{\frac{1}{2}} = 7a^2 \times (2x)^{\frac{1}{2}} = 7a^2\sqrt{2x}$.

Also $\sqrt[3]{24a^3x + 40a^3x^2} = (2^3a^3(3x + 5x^2))^{\frac{1}{3}} = 2a\sqrt[3]{3x + 5x^2}$.

40. IV.—*Addition and Subtraction of Surds.*

Rule. If the surds are of different denominations, reduce them to others of the same denomination, by prob. 2, and then reduce them to their simplest terms by last problem. Then, if the surd part be the same in them all, annex it to the sum or difference of the rational parts, with the sign of multiplication, and it will give the sum or difference required. But if the surd part be not the same in all the quantities, they can only be added or subtracted by placing the signs + or − between them.

Ex. 1. Required the sum of $\sqrt{27}$ and $\sqrt{48}$.

By prob. 3 we find $\sqrt{27} = 3\sqrt{3}$ and $\sqrt{48} = 4\sqrt{3}$, therefore $\sqrt{27} + \sqrt{48} = 3\sqrt{3} + 4\sqrt{3} = 7\sqrt{3}$.

Ex. 2. Required the sum of $3\sqrt[3]{\frac{1}{4}}$ and $5\sqrt[3]{\frac{1}{32}}$.

$$3\sqrt[3]{\tfrac{1}{4}} = 3\sqrt[3]{\tfrac{2}{8}} = \tfrac{3}{2}\sqrt[3]{2} \text{ and } 5\sqrt[3]{\tfrac{1}{32}} = 5\sqrt[3]{\tfrac{2}{64}} = \tfrac{5}{4}\sqrt[3]{2},$$

therefore $3\sqrt[3]{\frac{1}{4}} + 5\sqrt[3]{\frac{1}{32}} = \frac{3}{2}\sqrt[3]{2} + \frac{5}{4}\sqrt[3]{2} = \frac{11}{4}\sqrt[3]{2}$.

Ex. 3. Required the difference between $\sqrt{80a^4x}$ and $\sqrt{20a^2x^3}$.

$\sqrt{80a^4x} = (4^2a^4 \times 5x)^{\frac{1}{2}} = 4a^2\sqrt{5x}$, and $\sqrt{20a^2x^3} = (2^2a^2x^2 \times 5x)^{\frac{1}{2}} = 2ax\sqrt{5x}$; therefore $\sqrt{80a^4x} - \sqrt{20a^2x^3} = (4a^2 - 2ax)\sqrt{5x}$.

41. V.—*Multiplication and Division of Surds.*

Rule. If they are surds of the same rational quantity, add or subtract their exponents.

But if they are surds of different rational quantities, let them be brought to others of the same denomination, by prob. 2. Then, by multiplying or dividing these rational quantities, their product or quotient may be set under the common radical sign.

Note. If the surds have any rational coefficients, their product or quotient must be prefixed.

Ex. 1. Required the product of $\sqrt[3]{a^2}$ and $\sqrt[5]{a^3}$.

$$\sqrt[3]{a^2} \times \sqrt[5]{a^3} = a^{\frac{2}{3}} \times a^{\frac{3}{5}} = a^{\frac{2}{3}+\frac{3}{5}} = a^{\frac{19}{15}} = \sqrt[15]{a^{19}}, \text{ Ans.}$$

Ex. 2. Divide $\sqrt{a^2 - b^2}$ by $\sqrt[3]{a+b}$.

These surds, when reduced to the same denomination, are $(a^2 - b^2)^{\frac{3}{6}}$ and $(a+b)^{\frac{2}{6}}$. Hence $\frac{\sqrt{a^2-b^2}}{\sqrt[3]{a+b}} = \left(\frac{(a^2-b^2)^3}{(a+b)^2}\right)^{\frac{1}{6}}$

$$= \left(\frac{(a+b)^3(a-b)^3}{(a+b)^2}\right)^{\frac{1}{6}} = \left((a+b)(a-b)^3\right)^{\frac{1}{6}} = \sqrt[6]{(a+b)(a-b)^3}.$$

42. VI.—*Involution and Evolution of Surds.*

The powers and roots of surds are found in the same manner as any other quantities, namely, by multiplying or dividing their exponents by the index of the power or root required. Thus, the square of $3\sqrt[3]{3}$ is $3 \times 3 \times (3)^{\frac{2}{3}} = 9\sqrt[3]{9}$. The nth power of $x^{\frac{1}{m}}$ is $x^{\frac{n}{m}}$. The cube root of $\frac{1}{8}\sqrt{2}$ is $\frac{1}{2}(2)^{\frac{1}{6}} = \frac{1}{2}\sqrt[6]{2}$, and the nth root of $x^{\frac{1}{m}}$ is $x^{\frac{1}{mn}}$.

43. The reduction of quadratic surds is facilitated by the following considerations, which appear hardly to require demonstration:

1. $\sqrt{a}$ cannot $= b + \sqrt{c}$, when $\sqrt{c}$ is a surd.
2. $a + \sqrt{b}$ cannot $= c + \sqrt{d}$ when $\sqrt{b}$, $\sqrt{d}$ are unequal surds.
3. a cannot $= \sqrt{b}\sqrt{c}$ when $\sqrt{b}$, $\sqrt{c}$ are surds not involving the same irrational part, $\sqrt{2}$ and $\sqrt{3}$ for example.
4. $\sqrt{a}$ cannot equal $\sqrt{b} + \sqrt{c}$ when all are surds not involving the same irrational part.

Note. The irrational part of $\sqrt{8}$, for instance, is $\sqrt{2}$, for $\sqrt{8} = 2\sqrt{2}$.

44. For example, we extract the square root of a binomial surd such as $28 + 10\sqrt{3}$ in the following way:

Let $\sqrt{28 + 10\sqrt{3}} = x + y$, where one or both of x and y must be a surd.

Then $\quad 28 + 10\sqrt{3} = x^2 + y^2 + 2xy$,

$\therefore \quad 28 = x^2 + y^2$,

$\quad 10\sqrt{3} = 2xy$,

or No. 2 above would be violated.

Hence $\quad \sqrt{28 - 10\sqrt{3}} = \sqrt{x^2 + y^2 - 2xy} = x - y$.

And $\quad \sqrt{784 - 300} = x^2 - y^2$,

or $\quad x^2 + y^2 = 28$

$\quad x^2 - y^2 = 22$

$\quad x = 5,\ y = \sqrt{3}$

and $5 + \sqrt{3}$ is the root required.

Additional Examples in Surds.

Ex. 1. Add together $\frac{1}{1+\sqrt{2}}$, $\frac{1}{1-\sqrt{2}}$, $\frac{1}{\sqrt{3}+1}$, and $\frac{1}{\sqrt{3}-1}$.

$$\frac{1}{1+\sqrt{2}} + \frac{1}{1-\sqrt{2}} = \frac{2}{1-2} = -2$$

$$\frac{1}{\sqrt{3}+1} + \frac{1}{\sqrt{3}-1} = \frac{2\sqrt{3}}{3-1} = \sqrt{3},$$

$\therefore \quad \sqrt{3} - 2$ is the sum required.

Ex. 2. Find the difference between

$$\frac{a+x+\sqrt{(a+x)}}{(a+x)+\sqrt{(a+x)^3}} \text{ and } \sqrt{\left(\frac{(a+x)-\sqrt{(a+x)}}{(a+x)^2-\sqrt{(a+x)^3}}\right)}$$

The former is $\frac{1}{\sqrt{(a+x)}} \cdot \frac{\sqrt{(a+x)}+1}{1+\sqrt{(a+x)}} = \frac{1}{\sqrt{(a+x)}}$.

The latter is the square root of

$$\frac{1}{a+x} \cdot \frac{\sqrt{(a+x)}-1}{\sqrt{(a+x)}-1}, \text{ i.e., of } \frac{1}{a+x}.$$

$\therefore \quad$ the difference required is 0.

Ex. 3. Find the value of $\dfrac{\sqrt{(a^2+x^2)}+x}{\sqrt{(a^2+x^2)}-x}$,

when $$x=\frac{(b-c)\,a}{2\sqrt{bc}}.$$

At the first reduction a divides out, and the fraction is reduced to

$$\frac{\sqrt{\left(1+\frac{(b-c)^2}{4bc}\right)}+\frac{b-c}{2\sqrt{bc}}}{\sqrt{\left(1+\frac{(b-c)^2}{4bc}\right)}-\frac{b-c}{2\sqrt{bc}}}=\frac{b+c+(b-c)}{b+c-(b-c)}=\frac{b}{c}$$

Ex. 4. Find the value of $\dfrac{x+\sqrt{(2a-x)}}{x-\sqrt{(2a-x)}}$,

when $$x=\sqrt{(b^2+4ab)}-b.$$

By the process explained in this article

$$\sqrt{2a-x}=\sqrt{(2a+b-\sqrt{b^2+4ab})}=\sqrt{\frac{4a+b}{2}}-\sqrt{\frac{b}{2}},$$

whence the fraction reduces to $\dfrac{\sqrt{2b}+1}{\sqrt{2b}-1}$.

45. In arithmetic the square root of a number is another number, which, when multiplied by itself, shall produce the first number. In algebra, where quantity takes the place of number, the definition leads to a less limited result than in arithmetic. In the latter science there cannot be two square roots of the same thing; in the former, there will necessarily be two. For both $+2\times+2$ gives 4, and -2×-2 gives 4; hence the square root of 4 is -2 as well as $+2$.

And, further, as in algebra, -2 is a quantity subject to all the operations and definitions of the science, it is clearly competent to express, in some form or other, the result of extracting its square root. That form must of necessity be something very different in character from $\sqrt{2}$, whether $\sqrt{2}$ be $+$ or $-$. For the definition requires that the square root of -2 shall be such a quantity as when multiplied by itself shall produce -2. It is then clearly no arithmetical quantity either $+$ or $-$, but some quantity connected with numerical quantities by its properties, but not by its nature. It is termed an impossible or imaginary quantity, and may be written $\sqrt{-2}$ or $\sqrt{2}\sqrt{-1}$, and the same notation applies to the square roots of all negative quantities.

The properties of imaginary quantities are almost identical with those of surds, and we need not stop to consider them. One example of their application will suffice. It affords strong confirmation of the safety of assuming the commutative law to exist in every branch of pure algebra.

Ex. The product of the sum of two squares by the sum of two squares can always be represented under the form of the sum of two squares.

$$\begin{aligned}\text{For}\quad (a^2+b^2)(c^2+d^2)&=(a+b\sqrt{-1})\,(a-b\sqrt{-1})\\&\quad\times(c+d\sqrt{-1})\,(c-d\sqrt{-1})\\&=(a+b\sqrt{-1})(c+d\sqrt{-1})\times(a-b\sqrt{-1})(c-d\sqrt{-1})\\&=(\overline{ac-bd}+\overline{ad+bc}\sqrt{-1})\,(\overline{ac-bd}-\overline{ad+bc}\sqrt{-1})\\&=(ac-bd)^2+(ad+bc)^2.\end{aligned}$$

Cor. $(a^2+b^2)(c^2+d^2)=(ac+bd)^2+(ad-bc)^2$, or the product may be represented in two different ways, under the form of the sum of two squares.

SECT. V.—PROPORTION AND PROGRESSION.

Proportion and Progression.

46. In comparing together any two quantities of the same kind in respect of magnitude, we may consider how much the one is greater than the other, or else how many times the one contains either the whole or some part of the other: or, which is the same thing, we may consider either what is the difference between the quantities, or what is the quotient arising from the division of the one quantity by the other: the former of these is called their *arithmetical ratio*, and the latter their *geometrical ratio*. These denominations, however, have been assumed arbitrarily, and have little or no connection with the relations they are intended to express.

I. *Arithmetical Proportion and Progression.*

47. When of four quantities the difference between the first and second is equal to the difference between the third and fourth, the quantities are called *arithmetical proportionals*. Such, for example, are the numbers 2, 5, 9, 12; and, in general, the quantities a, $a+d$, b, $b+d$.

48. The principal property of four arithmetical proportionals is this:—If four quantities be arithmetically proportional, the sum of the extreme terms is equal to the sum of the means. Let the quantities be a, $a+d$, b, $b+d$; where d is the difference between the first and second, and also between the third and fourth, the sum of the extremes is $a+b+d$, and that of the means $a+d+b$; so that the truth of the proposition is evident.

49. If a series of quantities be such, that the difference between any two adjacent terms is always the same, these terms form an *arithmetical progression*. Thus, the numbers 2, 4, 6, 8, 10, &c., form a series in arithmetical progression, and, in general, such a series may be represented thus:

a, $a+d$, $a+2d$, $a+3d$, $a+4d$, $a+5d$, $a+6d$, &c., where a denotes the first term, and d the common difference.

By a little attention to this series, we readily discover that it has the following properties:

1. The last term of the series is equal to the first term, together with the common difference taken as often as there are terms *after* the first. Thus, when the number of terms is 7, the last term is $a+6d$; and so on. Hence if z denote the last term, n the number of terms, and a and d express the first term and common difference, we have $z=a+(n-1)d$.

2. The sum of the first and last term is equal to the sum of any two terms at the same distance from them. Thus, suppose the number of terms to be 7, then the last term is $a+6d$, and the sum of the first and last $2a+6d$; but the same is also the sum of the second and last but one, of the third and last but two, and so on till we come to the middle term, which, because it is equally distant from the extremes, must be added to itself.

3. To find the sum of the series, it is only necessary to observe that, if the progression is written down twice, 1° from the beginning, 2° from the end, the terms of the former increase by the same amount as that by which the terms of the latter diminish; so that the sum of any two terms which stand under each other is always the same, viz., the same as the sum of the first and last terms; hence the double series converts addition into multiplication; so that if s denote the sum of the series, we have $2s=n(a+z)$, and $s=\frac{n}{2}(a+z)$.

Ex. The sum of the odd numbers 1, 3, 5, 7, 9, &c., continued to n terms, is equal to the square of the number of terms. For in this case $a=1$, $d=2$, $z=1+(n-1)\,d=2n-1$, therefore $s=\frac{n}{2}\times 2n=n^2$.

II. *Geometrical Proportion and Progression.*

50. When, of four quantities, the quotient arising from the division of the first by the second is equal to that arising from the division of the third by the fourth, these quantities are said to be in *geometrical proportion*, or are

called simply *proportionals*. Thus, 12, 4, 15, 5, are four numbers in geometrical proportion; and, in general, na, a, nb, b, may express any four proportionals, for $\frac{na}{a}=n$, and also $\frac{nb}{b}=n$.

To denote that any four quantities a, b, c, d, are proportionals, it is common to place them thus, $a:b::c:d$; or thus, $a:b=c:d$; which notation, when expressed in words, is read thus, a is to b as c to d, or the ratio of a to b is equal to the ratio of c to d.

The first and third terms of a proportion are called the *antecedents*, and the second and fourth the *consequents*.

When the two middle terms of a proportion are the same, the remaining terms, and that quantity, constitute three geometrical proportionals; such as 4, 6, 9, and in general na, a, $\frac{a}{n}$. In this case the middle quantity is called a mean proportional between the other two.

51. The principal properties of four proportionals are the following:

1. If four quantities be proportionals, the product of the extremes is equal to the product of the means. Let a, b, c, d, be four quantities, such that $a:b::c:d$; then, from the nature of proportionals, $\frac{a}{b}=\frac{c}{d}$: let these equal quotients be multiplied by $b\,d$, and we have $ad=bc$. It follows, that if any three of four proportionals be given, the remaining one may be found. Thus, let a, b, c, the first three, be given, and let it be required to find x, the fourth term; because $a:b::c:x$, $ax=bc$, and dividing by a, $x=\frac{bc}{a}$.

The converse is obviously true, viz., if four quantities be such that the product of two of them is equal to the product of the other two, these quantities are proportionals.

2. If four quantities are proportional, that is, if $a:b::c:d$, then will each of the following combinations or arrangements of the quantities be also four proportionals.

1*st*, By inversion, $b:a::d:c$.

2*d*, By alternation, $a:c::b:d$.

Note.—The quantities in the second case must be all of the same kind.

3*d*, By composition, $a+b:a::c+d:c$,
or, $a+b:b::c+d:d$.

4*th*, By division, $a-b:a::c-d:c$,
or, $a-b:b::c-d:d$.

5*th*, By mixing, $a+b:a-b::c+d:c-d$.

6*th*, By taking any equimultiples of the antecedents, and also any equimultiples of the consequents,

$$na:pb::nc:pd.$$

7*th*, Or, by taking any parts of the antecedents and consequents, $\frac{a}{n}:\frac{b}{p}::\frac{c}{n}:\frac{d}{p}$.

That the preceding combinations of the quantities a, b, c, d, are proportionals, may be readily proved, by taking the products of the extremes and means; for from each of them we derive this conclusion, that $ad=bc$, which is known to be true, from the original assumption of the quantities.

8*th*, If four quantities be proportional, and also other four, the product of the corresponding terms will be proportional.

$$\begin{aligned}&\text{Let } a:b::c:d,\\&\text{And } e:f::g:h;\\&\text{Then } ae:bf::cg:dh.\end{aligned}$$

For $ad=bc$, and $eh=fg$, as before, therefore, multiplying together these equal quantities, $adeh=bcfg$, or $ae\times dh=bf\times cg$; therefore, by the converse of the first property, $ae:bf::cg:dh$.

Hence it follows, that if there be any number of proportions whatever, the products of the corresponding terms will still be proportional.

52. If a series of quantities be so related to each other, that the quotient arising from the division of any term by that which precedes it is always the same quantity, these are said to be in *geometrical progression;* such are the numbers 2, 4, 8, 16, 32, &c., also $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$, $\frac{1}{16}$, &c., and in general, a series of such quantities may be represented thus, a, ar, ar^2, ar^3, ar^4, ar^5, &c. Here a is the first term, and r the quotient of any two adjoining terms, which is also called the *common ratio.*

By inspecting this series, we find that it has the following properties:

1. The last term is equal to the first, multiplied by the common ratio raised to a power, the index of which is one less than the number of terms. Therefore, if z denote the last term, and n the number of terms, $z=ar^{n-1}$.

2. The product of the first and last term is equal to the product of any two terms equally distant from them: thus, supposing ar^5 the last term, it is evident that $a\times ar^5=ar\times ar^4=ar^2\times ar^3$, &c.

The sum of n terms of a geometrical series may be found thus:

$$\begin{aligned}&\text{Let} && s=a+ar+ar^2+ar^3\ldots+ar^{n-1}.\\&\text{Then} && rs=ar+ar^2+ar^3\ldots+ar^{n-1}+ar^n.\\&\text{Subtract,} && rs-s=ar^n-a.\\&\text{That is,} && (r-1)\,s=a(r^n-1).\\&\text{Hence} && s=\frac{r^n-1}{r-1}a,\text{ or }\frac{1-r^n}{1-r}a.\end{aligned}$$

Cor. The sum to infinity $=\frac{a}{1-r}$.

Additional Examples in Proportion and Progression.

Ex. 1. How many strokes does a clock strike in twelve hours?

If s denote the number

$$\begin{aligned}s&=1+2+\ldots12\\s&=12+11+\ldots1\\\therefore\ 2s&=13+13+\ldots13=13\times12;\ s=78.\end{aligned}$$

Ex. 2. Find the number of shot lying close together in the shape of an equilateral triangle.

Let n be the number of shot in a side of the triangle. Counting from one angle, and taking in successive rows parallel to the opposite side, we get as the number required.

$$1+2+\ldots n=\frac{n(n+1)}{2}.$$

Ex. 3. To find the number of shot in a pile of the form of a triangular pyramid.

As each shot lies in the hollow formed by those below it, the number of shot in the successive sides from the base upwards will evidently be

$$n-1,\ n-2,\ldots1.$$

Hence the number of shot in the pile will be

$$\frac{n(n+1)}{2}+\frac{(n-1)n}{2}+\frac{(n-2)(n-1)}{2}+\ldots\frac{1.2}{2}.$$

To sum this series induction may be employed. The result is

$$\frac{n(n+1)(n+2)}{6}.$$

Ex. 4. A ratio of greater inequality is diminished, and of less inequality increased, by adding the same quantity to each of its terms.

Let $a>b$; then $\frac{a+x}{b+x}<\frac{a}{b}$.

By multiplying out, this is evident.

Ex. 5. Find the vulgar fraction which is equivalent to the recurring decimal.

$$\cdot 3\dot{1}4\dot{2}$$

Let $x = \cdot 3\dot{1}4\dot{2}$,

then $10x = 3\cdot\dot{1}4\dot{2}$

$10{,}000x = 3142\cdot\dot{1}4\dot{2}$

$\therefore$ subtracting $9990x = 3139$

$$x = \frac{3139}{9990}$$

Ex. 6. A sum of money doubles itself in fifteen years at a rate a little below 5 per cent. A noble Scotch family have retained in their possession gold coins of the value of £500 since the days of Mary Stuart (300 years); what have they lost by not allowing the money to accumulate at the above rate?

Every pound would have amounted to £2^{20}; $\therefore$ £500 $(2^{20}-1)$ is the loss. It amounts to upwards of £524,000,000.

Ex. 7. The sum of the mixed series

$$a+(a+b)r+(a+2b)r^2+\ldots\ldots$$

$$\text{is } \frac{a}{1-r}+\frac{br(1-r^{n-1})}{(1-r)^2}-\frac{(a+\overline{n-1}b)r^n}{1-r}.$$

SECT. VI.—RESOLUTION OF EQUATIONS INVOLVING ONE UNKNOWN QUANTITY.

Simple Equations. 53. The primary object of algebraic investigation is to discover certain unknown quantities, by comparing them with other quantities which are given, or supposed to be known. The relation between the known and unknown quantities is either that of equality, or else such as may be reduced to equality; and a proposition which affirms that certain combinations of quantities are equal to one another is called an *equation*. Such are the following:—

$$\frac{x}{2}+\frac{x}{3}=\frac{24}{x},$$

$$2x+3y=xy.$$

The first of these equations expresses the relation between an unknown quantity x and certain known numbers; and the second expresses the relation which the two indefinite quantities x and y have to each other.

The conditions of a problem may be such as to require several equations and symbols of unknown quantities for their complete expression. These, however, by rules hereafter to be explained, may be reduced to one equation, involving only one unknown quantity and its powers, besides the known quantities; and the method of expressing that quantity by means of the known quantities constitutes the theory of equations, one of the most important as well as most intricate branches of algebraic analysis.

An equation is said to be *resolved* when the unknown quantity is made to stand alone on one side, and only known quantities on the other side; and the value of the unknown quantity is called a *root* of the equation. The general definition of a root of an equation is, that it is a *numerical quantity* (*i.e.*, some combination of numbers) which, when written in place of the unknown quantity, renders the equation a numerical ideality; thus 1 is the root of the equation $x=1$, 1 and -1 are both roots of the equation $x^2=1$; 1, $\sqrt{-1}$, $-\sqrt{-1}$ and -1 are all roots of the equation $x^4=1$.

54. Equations containing only one unknown quantity and its powers, are divided into different *orders*, according to the highest power of that quantity contained in any one of its terms. The equation, however, is supposed to be reduced to such a form that the unknown quantity is found only in the numerators of the terms, and that the exponents of its powers are expressed by positive integers.

If an equation contains only the first power of the unknown quantity, it is called a *simple* equation, or an equation of the first order. Such is $ax+b=c$, where x denotes an unknown, and a, b, c, known quantities.

If the equation contains the second power of the unknown quantity, it is said to be of the second degree, or is called a *quadratic* equation; such is $4x^2+3x=12$, and in general $ax^2+bx=c$. If it contains the third power of the unknown quantity, it is of the third degree, or is a *cubic* equation; such are $x^3+2x^2+4x=10$, and $ax^3+bx^2+cx=d$; and so on with respect to equations of the higher orders. A simple equation is sometimes said to be *linear*, or of one *dimension*. In like manner, quadratic equations are said to be of two dimensions, and cubic equations of three dimensions.

When in the course of an algebraic investigation we arrive at an equation involving only one unknown quantity, that quantity will often be so entangled in the different terms as to render several previous reductions necessary before the equation can be expressed under its characteristic form, so as to be resolved by the rules which belong to that form.

These reductions depend upon the operations which have been explained in the former part of this treatise, and the application of a few self-evident principles, namely, that if equal quantities be added to or subtracted from equal quantities, the sums or remainders will be equal; if equal quantities be multiplied or divided by the same quantity, the products or quotients will be equal, and, lastly, if equal quantities be raised to the same power, or have the same root extracted out of each, the results will still be equal.

From these considerations are derived the following rules, which apply alike to equations of all orders, and are alone sufficient for the resolution of simple equations.

55. *Rule* 1. Any quantity may be transposed from one side of an equation to the other, by changing its sign.

Thus, if $3x-10=2x+5$,
Then $3x-2x=5+10$,
Or $x=15$.
Again, if $ax+b=cx-dx+e$,
Then $ax-cx+dx=e-b$,
Or $(a-c+d)x=e-b$.

The reason of this rule is evident, for the transposing of a quantity from one side of an equation to the other is nothing more than adding the same quantity to each side of the equation, if the sign of the quantity transposed was $-$; or subtracting it, if the sign was $+$.

From this rule we may infer, that if any quantity be found on each side of the equation with the same sign, it may be left out of both. Also, that the signs of all the terms of an equation may be changed into the contrary, without affecting the truth of the equation.

Thus, if $a+x=b+a+c$,
Then $x=b+c$;
And if $a-x=b-d$,
Then $x-a=d-b$.

56. *Rule* 2. If the unknown quantity in an equation be multiplied by any quantity, that quantity may be taken away, by dividing all the other terms of the equation by it.

If $3x=24$,

Then $x=\frac{24}{3}=8$.

If $ax=b-c$,

Then $x=\frac{b-c}{a}=\frac{b}{a}-\frac{c}{a}$.

Here equal quantities are divided by the same quantity, and therefore the quotients are equal.

57. *Rule* 3. If any term of an equation be a fraction, its denominator may be taken away, by multiplying all the other terms of the equation by that denominator.

If $\frac{x}{5}=7$,

Then $x=35$.

If $\frac{x}{a}=b-c+d$,

Then $x=ab-ac+ad$.

If $a-\frac{b}{x}=c$,

We have $ax-b=cx$ and $x=\frac{b}{a-c}$.

In these examples, equal quantities are multiplied by the same quantity, and therefore the products are equal.

58. *Rule* 4. If the unknown quantity is found in any term which is a surd, let that surd be made to stand alone on one side of the equation, and the remaining terms on the opposite side; then involve each side to a power denoted by the index of the surd, and thus the unknown quantity shall be freed from the surd expression.

If $\sqrt{x}+6=10$,

Then, by transposition, $\sqrt{x}=10-6=4$;

And, squaring both sides, $\sqrt{x}\times\sqrt{x}=4\times4$,

Or $x=16$.

Also, if $\sqrt{a^2+x^2}-b=x$,

By trans. $\sqrt{a^2+x^2}=b+x$,

And, squaring, $a^2+x^2=(b+x)^2=b^2+2bx+x^2$,

Hence $a^2=b^2+2bx$, $x=\frac{a^2-b^2}{2b}$.

59. *Rule* 5. If the side of the equation which contains the unknown quantity be a perfect power, the equation may be reduced to another of a lower order, by extracting the root of that power out of each side of the equation.

Thus, if $x^3=64a^3$,

Then, by extracting the cube root, $x=4a$;

And if $(a+x)^2=b^2-a^2$,

Then $a+x=\sqrt{b^2-a^2}$.

60. In these examples we have been able to determine the value of the unknown quantity by the rules already delivered, because in every case the first, or at most the second power of that quantity, has been made to stand alone on one side of the equation, while the other consisted only of known quantities; but the same methods of reduction serve to bring equations of all degrees to a proper form for solution. Thus, if $\frac{1-p+q+r}{x+1}=1-p-x+\frac{r}{x}$; by proper reduction, we have $x^3+px^2+qx=r$, a cubic equation which may be resolved by rules to be afterwards explained.

SECT. VII.—REDUCTION OF EQUATIONS INVOLVING MORE THAN ONE UNKNOWN QUANTITY.

61. Having shown in the last section in what manner an equation involving one unknown quantity may be resolved, or at least fitted for a final solution, we are next to explain the methods by which two or more equations, involving as many unknown quantities, may at last be reduced to one equation and one unknown quantity.

As the unknown quantities may be combined together in very different ways, so as to constitute an equation, the methods most proper for their elimination must therefore be various. The three following, however, are of general application, and the last of them may be used with advantage, not only when the unknown quantity to be eliminated rises to the same power in all the equations, but also when the equations contain different powers of that quantity.

62. *Method* 1. Observe which of the unknown quantities is the least involved, and let its value be found from each equation, by the rules of last section.

Let the values thus found be put equal to each other, and hence new equations will arise, from which that quantity is wholly excluded. Let this operation be now repeated with these equations, thus eliminating the unknown quantities one by one, till at last an equation be found which contains only one unknown quantity.

Ex. Let it be required to determine x and y from these two equations.

$$2x+3y=23,$$
$$5x-2y=10.$$

From the first equation, $x=\frac{23-3y}{2}$.

From the second equation, $x=\frac{10+2y}{5}$.

Let these values of x be now put equal to each other,

And we have $\frac{10+2y}{5}=\frac{23-3y}{2}$,

Or $20+4y=115-15y$;

$\therefore$ $19y=95$,

And $y=5$:

And since $x=\frac{23-3y}{2}$, or $x=\frac{10+2y}{5}$, from either of these values we find $x=4$.

63. *Method* 2. Let the value of the unknown quantity which is to be eliminated be found from that equation wherein it is least involved. Let this value and its powers be substituted for that quantity, and its respective powers in the other equations; and with the new equations thus arising, let the operation be repeated till there remain only one equation and one unknown quantity.

Ex. Let the given equations, as in last method, be

$$2x+3y=23,$$
$$5x-2y=10.$$

From the first equation, $x=\frac{23-3y}{2}$;

And this value of x being substituted in the second equation, we have $5\times\frac{23-3y}{2}-2y=10$,

Or $115-15y-4y=20$;

$\therefore$ $95=19y$,

And $y=5$

And hence $x=\frac{23-3y}{2}=4$, as before.

64. *Method* 3. Let the given equations be multiplied or divided by such numbers or quantities, whether known or unknown, that the term which involves the highest power of the unknown quantity may be the same in each equation.

Then, by adding or subtracting the equations, as occasion may require, that term will vanish, and a new equation emerge, wherein the number of dimensions of the unknown quantity in some cases, and in others the number of unknown quantities will be diminished; and by a repetition of the same or similar operations, a final equation may be at last obtained, involving only one unknown quantity.

Ex. Let the same example be taken, as in the illustration of the former methods, namely,

$$2x+3y=23,$$
$$5x-2y=10.$$

To eliminate x, let the first equation be multiplied by 5, and the second by 2; thus we have

$$10x+15y=115,$$
$$10x-\ 4y=\ 20.$$

Here the term involving x is the same in both equations; and it is obvious, that by subtracting the one from the other, the resulting equation will contain only y, and known numbers; for by such subtraction we find $19y=95$, and therefore $y=5$.

Having got the value of y, it is easy to see how x may be found from either of the given equations; but it may also be found in the same manner as we found y. For let the first of the given equations be multiplied by 2, and the second by 3, we have

$$4x+6y=46,$$
$$15x-6y=30.$$

By adding these equations, we find

$$19x=76, \text{ and } x=4.$$

65. The following examples will serve further to illustrate these different methods of eliminating the unknown quantities from equations.

Ex. 1. Given $\left\{\begin{array}{l} ax+by=c \\ dx+fy=g \end{array}\right\}$ to determine x and y.

To eliminate y, let the first equation be multiplied by f, and the second by b, and we have

$$afx+bfy=cf,$$
$$bdx+bfy=bg.$$

Taking now the difference between these equations,

$$afx-bdx=cf-bg,$$

Or $\quad (af-bd)x=cf-bg,$

And therefore $\quad x=\dfrac{cf-bg}{af-bd}.$

In the same manner may y be determined, by multiplying the first of the given equations by d, and the second by a; for we find

$$adx+bdy=cd,$$
$$adx+afy=ag.$$

And taking the difference as before, we get

$$bdy-afy=cd-ag,$$

And therefore $\quad y=\dfrac{cd-ag}{bd-af}.$

66. This example may be considered as a general solution of the following problem. Two equations expressing the relation between the first powers of two unknown quantities being given, to determine those quantities; for whatever be the number of terms in each equation, it will readily appear, as in Art. 55, that by proper reduction they may be brought to the same form as those given in the above example.

67. Let us next consider such equations as involve three unknown quantities.

Ex. 2. Given $\left\{\begin{array}{l} \frac{x}{2}+\frac{y}{3}+\frac{z}{4}=62 \\ \frac{x}{3}+\frac{y}{4}+\frac{z}{5}=47 \\ \frac{x}{4}+\frac{y}{5}+\frac{z}{6}=38 \end{array}\right\}$ to find x, y, and z.

Here the given equations, when cleared from fractions, become

$$12x+\ 8y+\ 6z=1488,$$
$$20x+15y+12z=2820,$$
$$30x+24y+20z=4560.$$

To eliminate z by the third method, let the first equation be multiplied by 10, the second by 5, and the third by 3, the results will be these:

$$120x+80y+60z=14880,$$
$$100x+75y+60z=14100,$$
$$90x+72y+60z=13680.$$

Let the second equation be now subtracted from the first, and the third from the second, and we have

$$20x+5y=780,$$
$$10x+3y=420.$$

Next, to eliminate y, let the first of these equations be multiplied by 3, and the second by 5; hence,

$$60x+15y=2340,$$
$$50x+15y=2100.$$

Subtracting now the latter equation from the former,

$$10x=240 \text{ and } x=24,$$

$\therefore \quad y=\dfrac{420-10x}{3}=60,$

And $\quad z=\dfrac{1448-12x-8y}{6}=120.$

Ex. 3. Given $x^2-yz=a^2$, $y^2-xz=b^2$, $z^2-xy=c^2$, to find x, y, and z.

By subtraction, we have

$$(x-y)(x+y+z)=a^2-b^2 \ (1),$$
$$(z-x)(x+y+z)=c^2-a^2 \ (2),$$
$$(y-z)(x+y+z)=b^2-c^2.$$

Squaring, adding, and dividing by 2, we get

$$(x^2+y^2+z^2-xy-xz-yz)(x+y+z)^2= a^4+b^4+c^4-a^2b^2-a^2c^2-b^2c^2.$$

But $x^2+y^2+z^2-xy-xz-yz$ is the sum of the three given expressions, and $\therefore$ equal to $a^2+b^2+c^2$.

Hence $(a^2+b^2+c^2)(x+y+z)^2=a^4+b^4+c^4-a^2b^2-a^2c^2-b^2c^2$, which gives $x+y+z$.

Equations (1) and (2) are now two simple equations, which, combined with the value of $x+y+z$ as determined, give x, y, and z.

Ex. 4. Given

$$\sqrt{x}=\sqrt{yz}\left(-\frac{a}{x}+\frac{b}{y}+\frac{c}{z}\right)$$
$$\sqrt{y}=\sqrt{xz}\left(\frac{a}{x}-\frac{b}{y}+\frac{c}{z}\right)$$
$$\sqrt{z}=\sqrt{xy}\left(\frac{a}{x}+\frac{b}{y}-\frac{c}{z}\right)$$

Multiply the first by $\sqrt{x}$, the second by $\sqrt{y}$, and the third by $\sqrt{z}$, and add two and two. There results

$$x+y=\sqrt{xyz}\,\frac{2c}{z}$$
$$x+z=\sqrt{xyz}\,\frac{2b}{y}$$
$$y+z=\sqrt{xyz}\,\frac{2a}{x}$$

i.e.

$$xz+yz=\sqrt{xyz}\ 2c$$
$$xy+yz=\sqrt{xyz}\ 2b$$
$$xy+xz=\sqrt{xyz}\ 2a$$

$\therefore$

$$yz=\sqrt{xyz}\,(b+c-a)$$
$$xz=\sqrt{xyz}\,(a+c-b)$$
$$xy=\sqrt{xyz}\,(a+b-c)$$

Multiplying any two of these we get one of the unknown quantities:

$\therefore \quad x=(a+c-b)(a+b-c)$, &c.

SECT. VIII.—QUESTIONS PRODUCING SIMPLE EQUATIONS.

68. When the conditions of a problem have been ex-

pressed by equations, or translated from the common language into that of algebra, we must consider whether the problem be properly limited; for in some cases the conditions may be such as to admit of innumerable solutions, and in others they may involve an absurdity, and thus render the problem altogether impossible.

Now, by considering the examples of last section, it will appear, that to determine any number of unknown quantities, there must be given as many equations as there are unknown quantities. These, however, must be such as cannot be derived from each other, and they must not involve any contradiction; for in the one case the problem would admit of an unlimited number of answers, and in the other case it would be impossible. For example, if it were required to determine x and y from these two equations, $2x-3y=13$, $4x-6y=26$; as the latter equation is a consequence of the former (for each term of the one is the half of the corresponding term of the other), it is evident that innumerable values of x and y might be found to satisfy both equations. Again, if x and y were to be determined from these equations, $x+2y=8$, $3x+6y=26$, it is easy to see that it is impossible to find such values of x and y as will satisfy both; for, from the first, we find $3x=24-6y$; and from the second, $3x=26-6y$; and therefore $24-6y=26-6y$, or $24=26$, which is absurd; and so also must have been the conditions from which this conclusion is drawn.

69. But there is yet another case in which a problem may be impossible; and that is, when there are more equations than unknown quantities; for it appears, that in this case, by the rules of last section, we should at last find two equations, each involving the same unknown quantity. Now, unless these happened to agree, the problem would admit of no solution. On the whole, therefore, it appears that a problem is limited when the conditions furnish just as many independent equations as there are unknown quantities to be determined: if there be fewer, the problem is indeterminate; but if there be more, the problem in general admits of no solution whatever.

70. We shall now apply the preceding observations to some examples, which are so chosen as to admit of being resolved by simple equations.

Ex. 1. What is that number, to which if there be added its half, its third, and its fourth parts, the sum will be 50?

Let x denote the number sought; then its half will be $\frac{x}{2}$, its third $\frac{x}{3}$, and its fourth $\frac{x}{4}$;

$$\therefore \quad x+\frac{x}{2}+\frac{x}{3}+\frac{x}{4}=50.$$

$$\text{Hence} \quad 24x+12x+8x+6x=1200,$$

$$\text{Or} \quad 50x=1200;$$

$$\therefore \quad x=24.$$

Thus it appears that the number sought is 24, which upon trial will be found to answer the conditions of the question.

Ex. 2. A post is $\frac{1}{4}$ of its length in the mud, $\frac{1}{3}$ in the water, and 10 feet above the water; what is its whole length?

Let its length be x feet, then the part in the mud is $\frac{x}{4}$, and that in the water $\frac{x}{3}$; therefore, from the nature of the question,

$$\frac{x}{4}+\frac{x}{3}+10=x.$$

From this equation we find $7x+120=12x$, and $x=24$.

Ex. 3. A market-woman bought a certain number of eggs at 2 a penny, and as many at 3 a penny, and sold them all out again at 5 for 2d.; but, instead of getting her own money for them, as she expected, she lost 4d.: what number of eggs did she buy?

Let x be the number of eggs of each sort;

Then will $\frac{x}{2}$ be the price of the first sort;

And $\frac{x}{3}=$ the price of the second sort.

Now, the whole number being $2x$, we have

$5:2x::2:\frac{4x}{5}=$ price of both sorts at 5 for 2d.

$\therefore \quad \frac{x}{2}+\frac{x}{3}-\frac{4x}{5}=4$, by the question.

Hence $15x+10x-24x=120$,

And $x=120$, the number of each sort.

Ex. 4. A person at play lost $\frac{1}{4}$ of his money, and then won 3s.; after which he lost $\frac{1}{3}$ of what he then had, and then won 2s.; lastly he lost $\frac{1}{7}$ of what he then had, and, this done, found he had only 12s. left: what had he at first?

Suppose he began to play with x shillings.

He lost $\frac{1}{4}$ of his money, or $\frac{x}{4}$, and had left $x-\frac{x}{4}=\frac{3x}{4}$.

He won 3s. and had then $\frac{3x}{4}+3=\frac{3x+12}{4}$.

He lost $\frac{1}{3}$ of $\frac{3x+12}{4}$, or $\frac{x+4}{4}$, and had left $\frac{3x+12}{4}-\frac{x+4}{4}=\frac{2x+8}{4}$.

He won 2s. and had then $\frac{2x+8}{4}+2=\frac{2x+1}{4}$

He lost $\frac{1}{7}$ of $\frac{2x+16}{4}$, or $\frac{2x+16}{28}$, and had left $\frac{2x+16}{4}-\frac{2x+16}{28}=\frac{12x+96}{28}$.

And because he had now 12s. left, we have this equation,

$$\frac{12x+96}{28}=12.$$

Hence $12x=240$, and $x=20$.

Ex. 5. To divide the number 90 into 4 such parts, that if the first be increased by 2, the second diminished by 2, the third multiplied by 2, and the fourth divided by 2, the sum, difference, product and quotient shall be all equal to each other.

In this question there are four quantities to be determined; but instead of introducing several letters, having put x to denote the first of them, we may find an expression for each of the remaining ones, as follows

Because $x+2=$ second quantity -2,

$\therefore \quad x+4=$ the second quantity;

And because $x+2=$ third $\times 2$;

$\therefore \quad \frac{x+2}{2}=$ the third quantity.

And in like manner $2(x+2)=$ the fourth quantity.

Now by the question, the sum of all the four $=90$;

$$\therefore \quad x+x+4+\frac{x+2}{2}+2(x+2)=90.$$

$$\text{Hence} \quad 9x=162, \text{ and } x=18;$$

Therefore the numbers required are 18, 22, 10, and 40.

Ex. 6. A and B together can perform a piece of work in 12 hours, A and C in 20, and B and C in 15 hours; in what time will each be able to perform it when working separately?

That we may have a general solution, let us suppose A and B can perform the work in a hours, A and C in b hours, and B and C in c hours. Let x, y, and z, denote the times in which A, B, and C, could perform it respectively, if each worked alone; and let the whole work be represented by 1. The question gives at once—

$$\frac{1}{x}+\frac{1}{y}=\frac{1}{a},\ \frac{1}{x}+\frac{1}{z}=\frac{1}{b},\ \frac{1}{y}+\frac{1}{z}=\frac{1}{c}.$$

If these be added, and their sum divided by 2, we find

$$\frac{1}{x}+\frac{1}{y}+\frac{1}{z}=\frac{1}{2a}+\frac{1}{2b}+\frac{1}{2c}.$$

From this equation let each of the three preceding be subtracted in its turn: thus we get

$$\frac{1}{z}=-\frac{1}{2a}+\frac{1}{2b}+\frac{1}{2c}=\frac{+ab+ac-bc}{2abc},$$

$$\frac{1}{y}=\frac{1}{2a}-\frac{1}{2b}+\frac{1}{2c}=\frac{+ab-ac+bc}{2abc},$$

$$\frac{1}{x}=\frac{1}{2a}+\frac{1}{2b}-\frac{1}{2c}=\frac{-ab+ac+bc}{2abc},$$

Hence
$$z=\frac{2abc}{+ab+ac-bc}=\frac{7200}{120}=60,$$

$$y=\frac{2abc}{+ab-ac+bc}=\frac{7200}{360}=20.$$

$$x=\frac{2abc}{-ab+ac+bc}=\frac{7200}{240}=30.$$

Sect. IX.—Solution of Quadratic Equations.

Quadratic Equations

71. We are next to explain the resolution of equations of the second degree, or quadratic equations. These involve the second power of the unknown quantity, and may be divided into two kinds, *pure* and *adfected.*

I. *Pure* quadratic equations are such as after proper reduction have the square of the unknown quantity in one term, while the remaining terms contain only known quantities. Thus, $x^2=64$, and $ax^2+b=c$, are examples of pure quadratics.

II. *Adfected* quadratic equations contain the square of the unknown quantity in one term, and its first or simple power in another; the remaining terms consisting entirely of known quantities. Such are the following, $x^2+3x=28$, $2x^2=33-5x$, $ax^2+bx-c=d$.

The manner of resolving a pure quadratic equation is sufficiently evident. If the unknown quantity be made to stand alone on one side, with unity as a coefficient, while the other side consists entirely of known quantities, and the square root of each side be taken, we immediately obtain the value of the simple power of the unknown quantity as directed by rule 5th of Sect. VI.

In extracting the square root of any quantity, it is necessary to observe, that the sign of the root may be either $+$ or $-$, and that consequently a quadratic must always have two solutions.

72. When an adfected quadratic equation is to be resolved, it may always, by proper reduction, be brought to the following form:

$$x^2+px=q;$$

where p and q are numerical quantities, $+$ or $-$.

Let us compare the side of it which involves the unknown quantity x with the square of a binomial $x+a$; that is, let us compare x^2+px with $x^2+2ax+a^2=(x+a)^2$, and it will presently appear, that if we suppose $p=2a$, or $\frac{p}{2}=a$, the quantities x^2+px and x^2+2ax will be equal; and as x^2+2ax is rendered a complete square, by adding to it a^2, so also may x^2+px be completed into a square by adding to it $\frac{p^2}{4}$, which is equal to a^2; therefore, let $\frac{p^2}{4}$ be added to both sides of the equation $x^2+px=q$, and we have

$$x^2+px+\frac{p^2}{4}=\frac{p^2}{4}+q,\text{ or }\left(x+\frac{p}{2}\right)^2=\frac{p^2}{4}+q;$$

and, extracting the square root of each side,

$$x+\frac{p}{2}=\pm\sqrt{\frac{p^2}{4}+q};\text{ hence }x=-\frac{p}{2}\pm\sqrt{\frac{p^2}{4}+q}.$$

73. From these observations we derive the following general rules for resolving adfected quadratic equations.

1. Bring all the terms involving the unknown quantity to one side, and the known quantities to the other side, and so that the term involving the square of the unknown quantity may be positive.

2. If the square of the unknown quantity be multiplied by a coefficient, let the other terms be divided by it, so that the coefficient of the square of the unknown quantity may be 1.

3. Add to both sides the square of half the coefficient of the unknown quantity itself, and the side of the equation involving the unknown quantity will now be a complete square.

4. Extract the square root of both sides of the equation, by which it becomes simple with respect to the unknown quantity; and, by transposition, that quantity may be made to stand alone on one side of the equation, while the other side consists of known quantities; and therefore the equation is resolved.

Ex. 1. Given $x^2+2x=35$, to determine x.

Here the coefficient of the second term is 2; therefore, adding the square of its half to each side, we have

$$x^2+2x+1=35+1=36,$$

And, extracting the square root, $x+1=\sqrt{36}=\pm 6$.

Hence $x=\pm 6-1$, that is, $x=+5$, or $x=-7$, and either of these numbers will be found to satisfy the equation, for $5\times 5+2\times 5=35$, also $-7\times -7+2\times -7=35$.

Ex. 2. Given $\frac{x^2}{6}-12=x$, to find x.

This equation, when reduced, becomes $x^2-6x=72$,

And, by completing the square, $x^2-6x+9=72+9=81$.

Hence, by extracting the square root, $x-3=\pm 9$, and $x=\pm 9+3$;

Therefore $x=+12$, or $x=-6$; and upon trial we find that each of these values satisfies the original equation, for

$$\frac{12\times 12}{6}-12=12,\text{ also }\frac{-6\times -6}{6}-12=-6.$$

Ex. 3. Given $x^2+28=11x$, to find x.

Then $x^2-11x=-28$.

And, by completing the square,

$$x^2-11x+\frac{121}{4}=\frac{121}{4}-28=\frac{9}{4}.$$

Therefore, by extracting the root, $x-\frac{11}{2}=\pm\frac{3}{2}$.

Hence $x=\frac{11}{2}\pm\frac{3}{2}$; that is, $x=+7$, or $x=+4$.

In the first two examples, we found one positive value for x in each, and also one negative value; but in this example both the values of x are positive, and, upon trial, each of them is found to satisfy the equation; for $7\times 7+28=11\times 7$, also $4\times 4+28=11\times 4$.

74. As at first sight it appears remarkable, that in every quadratic equation the unknown quantity admits always of two distinct values or roots, it will be proper to consider a little further the circumstances upon which this peculiarity depends.

To do this, let us re-examine the equation $x^2+2x=35$. By bringing all the terms to one side, the equation may be expressed thus, $x^2+2x-35=0$; so that we shall have determined x, when we have found such a number as, when substituted for it in the quantity $x^2+2x-35$, will render the result equal to 0. But $x^2+2x-35$ is the product of these two factors $x-5$ and $x+7$, as may be proved by actual multiplication; therefore, to find x, we have $(x-5)(x+7)=0$; and as a product can only become $=0$ when one of its factors is reduced to 0, it follows that either of the two factors $x-5$ and $x+7$ may be assumed $=0$. If

$x-5=0$, then $x=5$; but if $x+7=0$, then $x=-7$; so that the two values of x, or two roots of the equation $x^2+2x=35$, are $+5$ and -7, as we have already found in a different manner.

75. What has been shown in a particular case is true of any quadratic equation whatever; that is, if $x^2+px=q$, or, by bringing all the terms to one side, $x^2+px-q=0$, it is always possible to find two factors $x-a$, and $x+b$, such, that

$$x^2+px-q=(x-a)\ (x+b),$$

where a and b are known quantities, which depend only upon p and q, the given numbers in the equation; and since that to have $(x-a)(x+b)=0$, we may either assume $x-a=0$ or $x+b=0$, it evidently follows that the conditions of the equation $x^2+px-q=0$, or $x^2+px=q$, are alike satisfied by taking $x=+a$ or $x=-b$.

From these considerations it follows, that x can have only two values in a quadratic equation; for if it could be supposed to have three or more values, then it would be possible to resolve x^2+px-q into as many factors, $x-c$, $x-d$, &c.; but the product of more than two factors must necessarily contain the third or higher powers of x, and as x^2+px-q contains no higher power than the second, therefore no such resolution can take place.

76. *Solution of Questions which produce Quadratic Equations.*

Ex. 1. It is required to divide the number 10 into two such parts that the sum of their squares may be 58.

Let x be the one part;

Then, since their sum is 10, the other is $10-x$;

$\therefore$ by the question, $x^2+(10-x)^2=58$;

That is, $x^2+100-20x+x^2=58$,

Or $2x^2-20x=58-100=-42$;

Hence $x^2-10x=-21$.

And completing the square, $x^2-10x+25=25-21=4$;

Hence, by extracting the root, $x-5=\pm\sqrt{4}=\pm 2$,

And $x=5\pm 2$,

That is, $x=7$, or $x=3$.

If we take the greater value of x, viz. 7, the other number $10-x$ will be 3; and if we take the less value of x, viz. 3, then the other number is 7. Thus it appears, that the greater value of the one number corresponds to the less value of the other; and indeed this must necessarily be the case, seeing that both are alike concerned in the question. Hence, the only numbers that will answer the conditions of the question are 7 and 3.

Ex. 2. A grazier bought as many sheep as cost him £60, out of which he reserved 15, and sold the remainder for £54, gaining 2s. each upon them. How many sheep did he buy, and what did each cost him?

Suppose that he bought x sheep.

Then each would cost him $\frac{1200}{x}$ shillings.

Therefore, since after reserving 15, he sold each of the remaining $x-15$ for $\frac{1200}{x}+2$ shillings, he would receive for them $(x-15)\left(\frac{1200}{x}+2\right)$ shillings. And, because £54 $=1080$ shillings, we have by the question,

$$(x-15)\left(\frac{1200}{x}+2\right)=1080;$$

which, by proper reduction, becomes $x^2+45\ x=9000$; whence $x=\pm\frac{195}{2}-\frac{45}{2}$. And, taking the positive root, $x=75$, the number of sheep; and consequently $\frac{1200}{75}=16$ shillings, the price of each.

Ex. 3. It is required to find two numbers, of which the product shall be 6, and the sum of their cubes 35.

Let x be the one number; then $\frac{6}{x}$ will be the other.

Therefore, by the question, $x^3+\frac{216}{x^3}=35$;

Hence $x^6+216=35x^3$,

Or $x^6-35x^3=-216$.

This equation, by putting $x^3=y$, becomes

$y^2-35y=-216$;

Hence we find $y=27$, or $y=8$.

And since $x^3=y$, $\therefore\ x=3$, or $x=2$.

If $x=3$, then the other number is 2, and if $x=2$, the other number is 3; so that 2 and 3 are the numbers required.

In general, if it be required to find two numbers which are exactly alike concerned in a question that produces a quadratic equation, they will be the roots of that equation. A similar observation applies to any number of quantities which require for their determination the resolution of an equation of any degree whatever.

77. *On some Anomalies in the Solution of a Problem which results in an Equation.*

From what has preceded, it will be evident that a *root* of an equation may be a very different thing from the solution of the problem on which the equation is based. It will be proper to give a few illustrations of this difference before passing on to consider equations in general.

(1.) A solution may be *inapplicable* to the problem as a problem of arithmetic, applying only to the algebraic problem.

Ex. Find a number such that if it be first increased by 10, and then diminished by 10, the difference of the square roots of the results shall be equal to 10.

Let x be the number; then the problem requires that

$$\sqrt{x+10}-\sqrt{x-10}=10.$$

Transposing and squaring, we get

$$x+10=100+20\sqrt{x-10}+x-10.$$

Transposing and squaring again, there results $x-10=16$, $x=26$.

Now, it is obvious that 26 does not satisfy the conditions of the problem, but that it is the solution of another problem, viz., that which substitutes "sum" for "difference" in the enunciation. Generally we may remark that an algebraic statement is not definite like an arithmetical one. The algebraic square root of a quantity being + or −, algebra cannot, as arithmetic does, distinguish between the two. The equation $\sqrt{x+10}-\sqrt{x-10}=10$ is algebraically the same as $\sqrt{x+10}+\sqrt{x-10}=10$, &c.

(2.) A solution may be inverted, or rather may invert the statement.

Ex. Divide 15 into two such parts that the greater shall exceed three times the less by as much as half the less exceeds 3.

Let x be the greater, and $\therefore$ $15-x$ the less. The statement produces the equation,

$$x-3\ (15-x)=\tfrac{1}{2}\ (15-x)-3,$$

which gives at once $x=11$, so that 11 is the greater, 4 the less part. But, on trying the solution, we find it is not that of the problem given, but of another problem, in which "exceeds" is replaced by "falls short of." Algebra cannot, in every case, as arithmetic does, distinguish the order of subtraction in stating a *difference*.

Ex. 2. Find a number such that the square root of the difference between its fourth power and its square being

found and increased by 1, the square root of the sum shall be equal to the given number diminished by 1.

Let x be the number, then

$$\sqrt{(1+\sqrt{x^4-x^2})}=x-1,$$

$$\therefore \quad \sqrt{x^4-x^2}=x^2-2x, \text{ whence } x=0,\ x=\frac{5}{4},$$

neither of which solves the problem as stated.

(3.) A solution may be illusory—that is, it may assume the form $\frac{0}{0}$.

Ex. 1. There are two pieces of cloth of a and a' yards respectively. The owner sells the same number of yards of each at b and b' shillings per yard respectively, he then sells the remainder at c and c' shillings a yard, and finds that the prices received for both pieces are the same. Required the number of yards first sold.

The number is $\quad \dfrac{ac-a'c'}{b'-b+c-c'}$.

As a particular case, if a and a' are 60 and 80; b and b' 10 shillings and 9 shillings; and c and c' 4 shillings and 3 shillings, the answer assumes the form $\frac{0}{0}$.

The answer is in this case indeterminate; in other words, the conditions of the problem are satisfied independently of the number of yards first sold; any number will do.

It is not, however, a necessary interpretation of the form $\frac{0}{0}$, that it may be replaced by any number whatever. Most frequently this form results from the fact that some fraction is not in its lowest terms. Solutions of this kind frequently occur—in ordinary equations they may be avoided; and we offer an example simply to show the method applicable to cases in which they cannot be avoided.

Ex. 2. Find two numbers such that the sum of their products by a and b respectively is c, and the difference of their squares d.

We have
$$ax+by=c$$
$$x^2-y^2=d$$

i.e.
$$x^2-\left(\frac{c-ax}{b}\right)^2=d$$

$$\therefore \quad (a^2-b^2)\,x^2-2acx=-(c^2+b^2d)$$

$$x=\frac{ac\pm\sqrt{a^2c^2-(a^2-b^2)\,(c^2+b^2d)}}{a^2-b^2}.$$

To find the solution when $a=b$, we observe that (taking the negative sign of the square root) $x=\frac{0}{0}$.

This arises from the fact that some power or root of $a-b$ is common to the numerator and denominator of the fraction.

To divide this out, we may put $a^2-b^2=pa^2$, and we shall get

$$x=\frac{ac-ac\sqrt{1-p\,\dfrac{c^2+b^2d}{c^2}}}{pa^2}$$

$$=\frac{ac-ac+\frac{1}{2}pac\dfrac{c^2+b^2d}{c^2}+\&c.}{pa^2}$$

$$=\frac{1}{2}\,\frac{c^2+b^2d}{ac}=\frac{1}{2}\,\frac{c^2+a^2d}{ac},$$

when a is written for b, and 0 for p.

(4.) A solution may be *introduced* by the operation.

In the example last given, the positive sign presents us with a solution introduced by the operation, which, when $a=b$, is not a solution of the problem at all.

For in that case the two equations become $x+y=\frac{c}{a}$, $x^2-y^2=d$; the latter of which is at once reduced to the simple equation $x-y=\frac{aa}{c}$ by means of the former. Accordingly, both equations are in this case simple equations, and can admit of only one solution.

(5.) As a solution may be introduced by the operation, so may it be *dropped out*, even when the operation is a perfectly legitimate one.

Ex. $\quad \sqrt{(2x+1)}-\sqrt{(x+4)}=\sqrt{(4x+4)}-\sqrt{(3x+7)}$.

Taking reciprocals, we have

$$\frac{1}{\sqrt{(2x+1)}-\sqrt{(x+4)}}=\frac{1}{\sqrt{(4x+4)}-\sqrt{(3x+7)}}$$

$$\therefore \quad \frac{\sqrt{(2x+1)}+\sqrt{(x+4)}}{x-3}=\frac{\sqrt{(4x+4)}+\sqrt{(3x+7)}}{x-3}$$

or $\quad \sqrt{(2x+1)}+\sqrt{(x+4)}=\sqrt{(4x+4)}+\sqrt{(3x+7)},$

which either added to the original equation, or subtracted from it, produces $x=-\frac{3}{2}$.

But $x=3$ is a solution of the equation which has been dropped out by the omission of the common denominator $x-3$.

It is not necessary to point out that a solution may appear under the form $\sqrt{-a}$ or ∞.

In neither case can the problem be solved arithmetically.

SECT. X.—EQUATIONS IN GENERAL.

78. Before we proceed to the resolution of cubic and the higher orders of equations, it will be proper to explain some general properties which belong to equations of every degree, and also certain transformations which must frequently be performed upon equations in order to prepare them for solution.

In treating of equations in general, we shall suppose all the terms brought to one side, and put equal to 0; so that an equation of the fourth degree will stand thus:

$$x^4+px^3+qx^2+rx+s=0,$$

where x denotes an unknown quantity, and p, q, r, s, numbers or fractions, either positive or negative. Here the coefficient of the highest power of x is unity, but had it been any other quantity, that quantity might have been taken away, and the equation reduced to the above form by rules already explained (Sect. VI).

The terms being thus arranged, if such a quantity be found as, when substituted for x, will render both sides $=0$, and therefore satisfy the equation, that quantity, whether it be positive or negative, or even imaginary, is defined to be a root of the equation. But we have seen that every quadratic equation has always two roots, real or imaginary; we may therefore assume that a similar diversity will take place in all equations of a higher degree; and this assumption appears to be well founded, by the following proposition, which is of great importance in the theory of equations. Definition of root.

If a root of any equation, as $x^4+px^3+qx^2+rx+s=0$, be represented by a, the first side of that equation is divisible by $x-a$;

For since $\quad x^4+px^3+qx^2+rx+s=0,$
And also $\quad a^4+pa^3+qa^2+ra+s=0;$

Therefore, by subtraction,

$$x^4-a^4+p\,(x^3-a^3)+q\,(x^2-a^2)+r\,(x-a)=0.$$

But any quantity of this form x^n-a^n, where n denotes a whole positive number, is divisible by $x-a$ (Art. 20, *Ex.* 1).

Hence, since every term contains a factor of this form, the equation may be written under the form

$$(x-a)\,(x^3+p'x^2+q'x+r')=0.$$

i.e., the expression $x^4+px^3+qx^2+rx+s$ is divisible by

$x-a$; and since the same mode of reasoning will apply to any equation whatever, the truth of the proposition is evident.

We have found that $(x-a)(x^3+p'x^2+qx+r')=0$; and as a product becomes $=0$ when any one of its factors $=0$, therefore the equation will have its conditions fulfilled, not only when $x-a=0$, but also when $x^3+p'x^2+q'x+r'=0$.

Let us now suppose that b is a root of this equation; then, by reasoning exactly as before,

$$x^3+p'x^2+q'x+r'=(x-b)(x^2+p''x+q'').$$

By proceeding in the same manner with the quadratic equation $x^2+p''x+q''=0$, we shall find that if c denote one of its roots, then

$$x^2+p''x+q''=(x-c)(x+c+p'').$$

So that if we put $d=-(c+p'')$, we at last find $x^4+px^3+qx^2+rx+s=(x-a)(x-b)(x-c)(x-d)$; a, b, c, d, being the roots of the equation, $x^4+px^3+qx^2+rx+s=0$.

The mode of reasoning which has been just now employed in a particular case, may be applied to an equation of any order whatever; we may therefore conclude, that every equation may be considered as the product of as many simple factors as the number denoting its order contains unity, and therefore, that the number of roots in any equation is precisely equal to the exponent of the highest power of the unknown quantity contained in that equation.

Relations of coefficients and roots.

79. By considering equations of all degrees as formed from the products of factors $x-a$, $x-b$, $x-c$, &c., we discover certain relations subsisting between the roots of any equation and its coefficients. Thus, if we limit the number of factors to four, and suppose that a, b, c, d, are the roots of this equation of the fourth degree,

$$x^4+px^3+qx^2+rx+s=0,$$

we shall also have $(x-a)(x-b)(x-c)(x-d)=0$; and therefore, by actual multiplication,

$$x^4\left.\begin{matrix}-a\\-b\\-c\\-d\end{matrix}\right\}x^3\left.\begin{matrix}+ab\\+ac\\+ad\\+bc\\+bd\\+cd\end{matrix}\right\}x^2\left.\begin{matrix}-abc\\-abd\\-acd\\-bcd\end{matrix}\right\}x+abcd=0.$$

If we compare together the coefficients of the same powers of x, we find the following series of equations:

$$\begin{aligned}a+b+c+d&=-p,\\ ab+ac+ad+bc+bd+cd&=+q,\\ abc+abd+acd+bcd&=-r,\\ abcd&=+s;\end{aligned}$$

and as similar results will be obtained for equations of all degrees, we hence derive the following propositions, which are of great importance in the theory of equations.

1. The coefficient of the second term of any equation, taken with a contrary sign, is equal to the sum of all the roots.

2. The coefficient of the third term is equal to the sum of the products of the roots multiplied together two and two.

3. The coefficient of the fourth term, taken with a contrary sign, is equal to the sum of the roots multiplied together three and three; and so on for the remaining coefficients, till we come to the last term of the equation, which is equal to the product of all the roots having their signs changed.

Instead of supposing an equation to be produced by multiplying together simple equations, we may consider it as formed by the product of equations of any degree, provided that the sum of their dimensions be equal to that of the proposed equation. Thus, an equation of the fourth degree may be formed either from a simple and cubic equation, or from two quadratic equations.

80. When the roots of an equation are all positive, its simple factors will have this form, $x-a$, $x-b$, $x-c$, &c., and if, for the sake of brevity, we take only these three, the cubic equation which results from their product will have this form,

$$x^3-px^2+qx-r=0,$$
$$\text{where } p=a+b+c,\ q=ab+ac+bc,\ r=abc;$$

and here it appears that the signs of the terms are $+$ and $-$ alternately.

Hence we infer, that when the roots of an equation are all positive, the signs of its terms are positive and negative alternately.

If again the roots of the equation be all negative, and therefore its factors $x+a$, $x+b$, $x+c$, then p, q, and r being as before, the resulting equation will stand thus:

$$x^3+px^2+qx+r=0.$$

And hence we conclude, that when the roots are all negative, there is no change whatever in the signs.

In general, if the roots of an equation be all real, that equation will have as many positive roots as there are changes of the signs from $+$ to $-$, or from $-$ to $+$; and the remaining roots are negative. This rule, however, does not apply when the equation has impossible roots, unless such roots be considered as either positive or negative.

The connection between the signs of the roots and the signs of the terms of an equation can be deduced from the proposition, that the introduction of a new positive root introduces a new change of signs amongst the terms of the equation.

The demonstration of this proposition depends on the fact already established, that an equation may be resolved into the product of simple factors, so that, for example, every equation of the fifth degree may be derived from some equation of the fourth, by multiplying the latter by $x-a$ where a is the additional root. We shall show that the introduction of a new *positive* root produces an equation with at least one more change of signs than the original, and the introduction of a new *negative* root produces an equation with at least one more continuation of the same sign. To save space, it will suffice if we write the signs without the letters; thus, x^2+px-q may be written $++-$. Let, then, any equation be written down (of the sixth degree, for instance), $++--+-+$; multiply by $x-a$, and write the multiplication in the usual form,

Rule of signs.

$$\begin{array}{l}++--+-+\\ \underline{\quad--++-+-}\\ +\,?\,-\,?\,+-+-\end{array}$$

The signs of the product are all determinate except two, which we have marked with a (?). Now the changes of sign in the original equation are three—one between the 1st and 3d terms, one between the 3d and 5th, and one between the 5th and 6th; and it is evident that whatever be the signs marked (?), the produced equation has as many changes of sign as the original between the same limits, and one change beyond those limits, viz., between the 7th and 8th terms. This proposition is perfectly general, that the introduction of a positive root causes the introduction of at least all the original changes of sign within their limits, and one more change beyond those limits. In the same manner we may prove that the introduction of a negative root introduces at least one more continuation of the same sign. Hence the conclusion, that *an equation cannot have more positive roots than it has changes of sign, nor more negative roots than it has continuations of the same sign.* This proposition is known as Descartes' Rule of Signs.

81. Surd and impossible roots enter equations by pairs. Let $a+\sqrt{b}$ be a root, where b is a positive or negative number or fraction; then $a-\sqrt{b}$ is also a root.

If $a+\sqrt{b}$ be written for x in the quantity $x^n+px^{n-1}+$ &c., the result is composed of a series of powers of a and $\sqrt{b}$. Of these all but the odd powers of $\sqrt{b}$ are numerical, whilst odd powers of $\sqrt{b}$ may be written as numerical products of $\sqrt{b}$ itself. The result of the substitution is therefore of the form $\mathrm{A}+\mathrm{B}\sqrt{b}$. But since $a+\sqrt{b}$ is a root of the equation $x^n+px^{n-1}+$ &c. $=0$, we must have $\mathrm{A}+\mathrm{B}\sqrt{b}=0$, and $\therefore \mathrm{A}=0$, $\mathrm{B}=0$.

Now if $a-\sqrt{b}$ be substituted for x, the result will be $\mathrm{A}-\mathrm{B}\sqrt{b}$, because even powers of $-\sqrt{b}$ are the same as those of $+\sqrt{b}$. But $\mathrm{A}=0$, $\mathrm{B}=0 \therefore \mathrm{A}-\mathrm{B}\sqrt{b}=0$; consequently $a-\sqrt{b}$ is a root of the equation.

From this proposition it appears that every equation whose degree is denoted by an odd number, must have at least one real root.

Transformation of equations.

82. We shall now explain some transformations which are frequently necessary to prepare the higher orders of equations for solution.

Any equation may have its positive roots changed into negative roots of the same value, and its negative roots into such as are positive, by changing the signs of the terms alternately, beginning with the second. The truth of this remark will be evident if we take the equation

$$(x-a)(x-b)(x+c)=x^3+px^2+qx+r=0,$$

and write $-x$ in place of x, producing

$$-(x+a).-(x+b).(-x+c)=-x^3+px^2-qx+r=0,$$

i.e., $$(x+a)(x+b)(x-c)=x^3-px^2+qx-r=0,$$

where it appears that the signs of the first and third terms are the same as in the original equation, but the signs of the second and fourth are the opposite. And this will be found to hold true of all equations, to whatever order they belong.

83. It will sometimes be useful to transform an equation into another that shall have each of its roots greater or less than the corresponding roots of the other equation, by some given quantity.

Let $(x-a)(x-b)(x+c)=0$ be any proposed equation which is to be transformed into another, having its roots greater or less than those of the proposed equation by the given quantity n; then, because the roots of the transformed equation are to be $+a\pm n$, $+b\pm n$, and $-c\pm n$, the equation itself will be

$$(y\mp n-a)(y\mp n-b)(y\mp n+c)=0.$$

Hence the reason of the following rule is evident.

If the new equation is to have its roots greater than those of the proposed equation, for x and its powers substitute $y-n$ and its powers; but if the roots are to be less, then, for x substitute $y+n$; and, in either case, a new equation will be produced, the roots of which shall have the property required.

84. By the preceding rule, an equation may be changed into another, which has its roots either all positive or all negative; but it is chiefly used in preparing cubic and biquadratic equations for solution, by transforming them into others of the same degree, but which want their second term.

Let $x^3+px^2+qx+r=0$ be any cubic equation; if we substitute $y+n$ for x, the equation is changed into the following:

$$\left.\begin{matrix} y^3+3n \\ +\ p \end{matrix}\right\} y^2 \left.\begin{matrix} +\ 3n^2 \\ +2pn \\ +\ q \end{matrix}\right\} y \left.\begin{matrix} +n^3 \\ +pn^2 \\ +qn \\ +r \end{matrix}\right\} =0.$$

Now, that this equation may want its second term, it is evident that we have only to suppose $3n+p=0$, or $n=-\frac{p}{3}$; for this assumption being made, and the value of n substituted in the remaining terms, the equation becomes

$$y^3+\left(q-\frac{p^2}{3}\right)y+\frac{2p^3}{27}-\frac{pq}{3}+r=0;$$

or, putting $-\frac{p^2}{3}+q=q'$, and $+\frac{2p^3}{27}-\frac{pq}{3}+r=r'$, the same equation may stand thus,

$$y^3+q'y+r'=0.$$

85. In general, any equation whatever may be transformed into another, which shall want its second term, by the following rule.

Divide the coefficient of the second term of the proposed equation by the exponent of the first term, and add the quotient, with its sign changed, to a new unknown quantity; the sum being substituted for the unknown quantity in the proposed equation, a new equation will be produced, which will want the second term, as required.

By this rule any adfected quadratic equation may be readily resolved; for by transforming it into another equation which wants the second term, we thus reduce its solution to that of a pure quadratic. Thus, if the quadratic equation $x^2-5x+6=0$ be proposed; by substituting $y+\frac{5}{2}$ for x, we find

$$\left.\begin{matrix} y^2+5y+\frac{25}{4} \\ -5y-\frac{25}{2} \\ +6 \end{matrix}\right\} =0, \text{ or } y^2-\tfrac{1}{4}=0.$$

Hence $y=\pm\frac{1}{2}$, and since $x=y+\frac{5}{2}$, therefore $x=\pm\frac{1}{2}+\frac{5}{2}=+3$, or $+2$.

86. Instead of taking away the second term from an equation, any other term may be made to vanish, by an assumption similar to that which has been employed to take away the second term. Thus, if in Art. 84 we assume $3n^2+2pn+q=0$, by resolving this quadratic equation, a value of n will be found which, when substituted in the equation, will cause the third term to vanish; and, by the resolution of a cubic equation, the fourth term may be taken away; and so on.

87. Another species of transformation, of use in the resolution of equations, is that by which an equation, having the coefficients of some of its terms expressed by fractional quantities, is changed into another, the coefficients of which are all integers.

Let $x^3+\frac{p}{a}x^2+\frac{q}{b}x+\frac{r}{c}=0$ denote an equation to be so transformed, and let us assume $y=abcx$, and therefore $x=\frac{y}{abc}$; then, by substitution, our equation becomes

$$\frac{y^3}{a^3b^3c^3}+\frac{p}{a^3b^2c^2}y^2+\frac{q}{ab^2c}y+\frac{r}{c}=0;$$

and multiplying the whole equation by $a^3b^3c^3$, we have

$$y^3+bcpy^2+a^2bc^2qy+a^3b^3c^2r=0.$$

Thus we have an equation free from fractions, while at the same time the coefficient of the highest power of the unknown quantity is unity, as before.

Examples of the Transformation and Solution of Equations when certain relations amongst the roots are known.

Ex. 1. If a, b, c are the roots of the equation $x^3-x^2+2x-3=0$, to form the equation of which the roots are

(1.) $$a+b,\ b+c,\ c+a.$$

Let y be any one root of the required equation; put $y=a+b+c-x=1-x$ (Art. 79), and the values of y will be the roots of the equation required, which is therefore

$$(1-y)^3-(1-y)^2+2(1-y)-3=0,$$

or $$y^3-2y^2+3y+1=0.$$

(2.) $$\frac{a}{b+c-a},\ \frac{b}{a+c-b},\ \frac{c}{a+b-c}.$$

Let $y=\frac{x}{a+b+c-2x}=\frac{x}{1-2x}$;

$\therefore$ $y^3+\frac{29}{17}y^2+\frac{16}{17}y+\frac{3}{17}=0$

is the equation required.

(3.) $a^2,\ b^2,\ c^2.$

If $y=x^2$, the values of y are a^2, b^2, c^2. Accordingly we require to throw the given equation into a form which involves no odd powers of x. This is done as follows:

$$x^3-x^2+2x-3=x(x^2+2)-(x^2+3)=0;$$

$\therefore$ $x(x^2+2)=x^2+3.$

squaring, $x^2(x^2+2)^2=(x^2+3)^2$,

or $y(y+2)^2=(y+3)^2$,

or $y^3+3y^2-2y-9=0.$

(4.) $\frac{a}{bc},\ \frac{b}{ac},\ \frac{c}{ab}.$

Let $y=\frac{x^3}{abc}=\frac{x^2}{3}$, and $y^3+y^2-\frac{2}{9}y-\frac{1}{3}=0$

is the equation required.

Ex. 2. Two roots of the equation

$$x^4-16x^3+86x^2-176x+105=0$$

are 1 and 5. Find the other roots.

The quantity on the left hand side of the equation is (Art. 78) divisible by $(x-1)(x-5)$, or by x^2-6x+5.

The quotient is $x^2-10x+21$, which, being put $=0$, gives 3 and 7, the roots required.

Ex. 3. The equation $x^3-4x^2+x+r=0$ has one root, 3; find r and the other roots.

Write 3 for x, then $r=6$, and the equation may be written

$$(x-3)(x^2-x-2)=0,$$

which gives $x=2,\ x=-1.$

Ex. 4. The equation $x^3+x^2-16x-16=0$ has two roots of the form $+a,\ -a$; find them.

If we write $-x$ for x, we get the equation

$$x^3-x^2-16x+16=0,$$

which has also two roots, $-a,\ +a,\ \therefore\ x^2-a^2$ is a common measure of the two quantities. But x^2-16 is easily found to be a common measure of the two quantities, $\therefore\ a=4$.

Ex. 5. The roots of the equation

$$x^3-6x^2+11x-6=0$$

are in arithmetical progression; find them.

If $a,\ a+b,\ a+2b$ be the roots, their sum is $3(a+b)$, *i.e.*, three times the middle root. But (Art. 79) their sum is 6, $\therefore$ $a+b=2$,

also $a(a+b)(a+2b)=6$,

i.e., $a(4-a)=3,\ a^2-4a+3=0$,

$\therefore$ $a=1,\ a=3.$

Ex. 6. The three roots of the equation $x^3-7x^2+16x-8=0$ are in geometrical progression; find them.

Let $a,\ ar,\ ar^2$ be the roots; then their product is $(ar)^3$, $\therefore\ (ar)^3=8$, and $ar=2$, $\therefore$ their sum $a+ar+ar^2=7$,

which gives $a=1,\ r=2,$

and 1 2, 4 are the roots.

Sect. XI.—Solution of Cubic Equations.

88. Cubic equations, like all equations above the first degree, are divided into two classes: they are said to be *pure* when they contain only one power of the unknown quantity; and *adfected* when they contain two or more powers of that quantity.

Pure cubic equations are therefore of this form, $x^3=125$, or $x^3=-27$, or, in general, $x^3=r$; and hence it appears that a value of the simple power of the unknown quantity may always be found without difficulty, by extracting the cube root of each side of the equation; thus, from the first of the three preceding examples we find $x=+5$, from the second $x=-3$, and from the third, $x=\sqrt[3]{r}$.

It would seem at first sight that the only value which x can have in the cubic equation $x^3=r$, or putting $r=c^3$, $x^3-c^3=0$, is this one, $x=c$; but since x^3-c^3 may be resolved into these two factors, $x-c$ and x^2+cx+c^2, it follows, that besides the value of x already found, which results from making the factor $x-c=0$, it has yet other two values, which may be found by making the other factor $x^2+cx+c^2=0$; and accordingly, by resolving the quadratic equation $x^2+cx=-c^2$, we find these values to be $\frac{-c+\sqrt{-3c^2}}{2}$ and $\frac{-c-\sqrt{-3c^2}}{2}$, or $\frac{-1+\sqrt{-3}}{2}c$ and $\frac{-1-\sqrt{-3}}{2}c$. Thus it appears, that any cubic equation of this form, $x^3=c^3$, or $x^3-c^3=0$, has these three roots,

$$x=c,\ x=\frac{-1+\sqrt{-3}}{2}c,\ x=\frac{-1-\sqrt{-3}}{2}c;$$

the first of which is real, but the two last are imaginary. If, however, each of the imaginary values of x be raised to the third power, the same results will be obtained as from the real value of x; the original equation $x^3-c^3=0$ may also be reproduced, by multiplying together the three factors $x-c,\ x-\frac{-1+\sqrt{-3}}{2}c$, and $x-\frac{-1-\sqrt{-3}}{2}c$.

89. Let us now consider such cubic equations as have all their terms, and which are therefore of this form,

$$x^3+Ax^2+Bx+C=0,$$

where A, B, and C denote known quantities, either positive or negative.

It has been shown (Art. 84) how an equation having all its terms may be transformed into another which wants the second term; therefore, assume $x=y-\frac{A}{3}$, as directed in that article; then, by proper substitution, the above equation will be changed into another of this form,

$$y^3+qy+r=0,$$

where q and r denote known quantities, whether positive or negative; now the roots of this equation being found, it is evident that those of the former may be readily obtained by means of the assumed equation $x=y-\frac{A}{3}$.

Resuming, therefore, the equation $y^3+qy+r=0$, let us suppose $y=v+z$, and it becomes

$$\left.\begin{array}{r} v^3+3v^2z+3vz^2+z^3 \\ +qv+qz \\ +r \end{array}\right\}=0.$$

Thus we have a new equation, which, as it involves two unknown quantities, v and z, may be resolved into any two others, which will simplify the determination of those quantities.

Now, it appears, that the only way in which we can divide that equation into two others, so as to simplify the question, is the following:

$$3v^2z+3vz^2+qv+qz=0,$$
$$v^3+z^3+r=0.$$

The first of these may also be expressed thus,

$$(3vz+q)(v+z)=0.$$

Hence, we must either suppose that $v+z=0$, or that $3vz+q=0$; but the former supposition cannot be admitted without supposing also that $y=0$; therefore we must adopt the latter. So that to determine v and z we have these two equations,

$$3vz+q=0,\quad v^3+z^3+r=0.$$

From the first, we find $vz=-\frac{q}{3}$, and $\therefore v^3z^3=-\frac{q^3}{27}$. This reduces the second equation to a quadratic in v^3, viz. $v^6+rv^3-\frac{q^3}{27}=0$, the solution of which equation is

$v^3=-\frac{1}{2}r+\sqrt{\frac{1}{27}q^3+\frac{1}{4}r^2}$; $z^3=-\frac{1}{2}r-\sqrt{\frac{1}{27}q^3+\frac{1}{4}r^2}$;
$v=\sqrt[3]{-\frac{1}{2}r+\sqrt{\frac{1}{27}q^3+\frac{1}{4}r^2}}$; $z=\sqrt[3]{-\frac{1}{2}r-\sqrt{\frac{1}{27}q^3+\frac{1}{4}r^2}}$;
and $y=v+z$

$$=\sqrt[3]{-\tfrac{1}{2}r+\sqrt{\tfrac{1}{27}q^3+\tfrac{1}{4}r^2}}+\sqrt[3]{-\tfrac{1}{2}r-\sqrt{\tfrac{1}{27}q^3+\tfrac{1}{4}r^2}}.$$

Thus we have obtained a value of the unknown quantity y, in terms of the known quantities q and r; therefore the equation is resolved.

90. But this is only one of three values which y may have. Let us, for the sake of brevity, put

$$A=-\tfrac{1}{2}r+\sqrt{\tfrac{1}{27}q^3+\tfrac{1}{4}r^2},\ B=-\tfrac{1}{2}r-\sqrt{\tfrac{1}{27}q^3+\tfrac{1}{4}r^2},$$

$$\text{and put }\left\{\begin{array}{l}\alpha=\dfrac{-1+\sqrt{-3}}{2},\\[2mm] \beta=\dfrac{-1-\sqrt{-3}}{2}\end{array}\right.$$

Then, from what has been shown (Art. 88), it is evident that v and z have each these three values,

$$v=\sqrt[3]{A},\ v=\alpha\sqrt[3]{A},\ v=\beta\sqrt[3]{A};$$
$$z=\sqrt[3]{B},\ z=\alpha\sqrt[3]{B},\ z=\beta\sqrt[3]{B}.$$

To determine the corresponding values of v and z, we must consider that $vz=-\frac{q}{3}=\sqrt[3]{AB}$. Now if we observe that $\alpha\beta=1$, it will immediately appear that $v+z$ has these three values,

$$v+z=\sqrt[3]{A}+\sqrt[3]{B},$$
$$v+z=\alpha\sqrt[3]{A}+\beta\sqrt[3]{B}$$
$$v+z=\beta\sqrt[3]{A}+\alpha\sqrt[3]{B},$$

which are therefore the three values of y.

The first of these formulæ is commonly known by the name of Cardan's rule; but it is well known that Cardan was not the inventor, and that it ought to be attributed to Nicholas Tartalea and Scipio Ferreus, who discovered it much about the same time, and independently of each other. (See the *Historical Introduction.*)

The formulæ given above for the roots of a cubic equation may be put under a different form, better adapted to the purposes of arithmetical calculation, as follows:— Because $vz=-\frac{q}{3}$, therefore $z=-\frac{q}{3}\times\frac{1}{v}=-\frac{\frac{1}{3}q}{\sqrt[3]{A}}$; hence $v+z=\sqrt[3]{A}-\frac{\frac{1}{3}q}{\sqrt[3]{A}}$: thus it appears that the three values of y may also be expressed thus:

$$y=\sqrt[3]{A}-\frac{\frac{1}{3}q}{\sqrt[3]{A}}$$
$$y=\alpha\sqrt[3]{A}-\frac{\frac{1}{3}q\beta}{\sqrt[3]{A}}$$
$$y=\beta\sqrt[3]{A}-\frac{\frac{1}{3}q\alpha}{\sqrt[3]{A}}.$$

91. To show the manner of applying these formulæ, let it be required to determine x from the cubic equation

$$x^3+3x^2+9x-13=0.$$

As this equation has all its terms, the first step towards its resolution is to transform it into another which shall want the second term, by substituting $y-1$ for x as directed (Art. 84). The operation will stand thus:

$$\begin{array}{rl} x^3= & y^3-3y^2+3y-\ 1\\ +3x^2= & \quad\ +3y^2-6y+\ 3\\ +9x= & \qquad\qquad +9y-\ 9\\ -13= & \qquad\qquad\quad -13\end{array}$$

$\therefore$ adding these, the transformed equation is

$$y^3+6y-20=0,$$

which being compared with the general equation,

$$y^3+qy+r=0,$$

gives $q=6$, $r=-20$; hence

$$A=\sqrt[3]{-\tfrac{1}{2}r+\sqrt{\tfrac{1}{27}q^3+\tfrac{1}{4}r^2}}=\sqrt[3]{10+\sqrt{108}},$$

therefore the second formula of last article gives $y=\sqrt[3]{10+\sqrt{108}}-\frac{2}{\sqrt[3]{10+\sqrt{108}}}$; but as this expression involves a radical quantity, let the square root of 108 be taken and added to 10, and the cube root of the sum found; thus we have $\sqrt[3]{10+\sqrt{108}}=2\cdot732$ nearly, and therefore $\frac{2}{\sqrt[3]{10+\sqrt{108}}}=\frac{2}{2\cdot732}=\cdot732$; hence we at last find one of the values of y to be $2\cdot732-\cdot732=2$.

In finding the cube root of the radical quantity $\sqrt[3]{10+\sqrt{108}}$, we have taken only its approximate value, so as to have the expression for the root under a rational form, and in this way we can always find, as near as we please, the cube root of any surd of the form $a+\sqrt{b}$, where b is a positive number. But it will sometimes happen that the cube root of such a surd can be expressed exactly by another surd of the same form; and accordingly, in the present case, it appears that the cube root of $10+\sqrt{108}$ is $1+\sqrt{3}$, as may be proved by actually raising $1+\sqrt{3}$ to the third power. Hence we find $\frac{2}{\sqrt[3]{10+\sqrt{108}}}=\frac{2}{1+\sqrt{3}}=\frac{2(1-\sqrt{3})}{(1-\sqrt{3})(1+\sqrt{3})}=-(1-\sqrt{3})$; so that $y=1+\sqrt{3}+1-\sqrt{3}=2$, as before.

The other two values of y will be had by substituting $1+\sqrt{3}$ and $1-\sqrt{3}$ for $\sqrt[3]{A}$ and $\frac{\frac{1}{3}q}{\sqrt[3]{A}}$ in the second and third formulæ of last article, and restoring the values of α and β. We thus have

$$y=\frac{-1+\sqrt{-3}}{2}\times(1+\sqrt{3})+\frac{-1-\sqrt{-3}}{2}\times(1-\sqrt{3})=-1+\sqrt{-9}.$$

$$y=\frac{-1-\sqrt{-3}}{2}\times(1+\sqrt{3})+\frac{-1+\sqrt{-3}}{2}\times(1-\sqrt{3})=-1-\sqrt{-9}.$$

So that the three values of y are

$$+2,\qquad -1+\sqrt{-9},\qquad -1-\sqrt{-9};$$

and since $x=y-1$, the corresponding values of x are

$$+1,\qquad -2+\sqrt{-9},\qquad -2-\sqrt{-9}.$$

Thus it appears that one of the roots of the proposed equation is real, and the other two imaginary.

The two imaginary roots might have been found otherwise, by considering that since one root of the equation is 1, the equation must be divisible by $x-1$ (Art. 78). Accordingly, the division being actually performed, and the quotient put $=0$, we have the quadratic equation,

$$x^2+4x+13=0;$$

which gives $x=-2\pm\sqrt{-9}$, the same imaginary values as before.

92. In the application of the preceding formulæ to the resolution of the equation $y^3+qy+r=0$, it is necessary to find the square root of $\frac{1}{27}q^3+\frac{1}{4}r^2$; now, when that quantity is positive, as in the equation $y^3+6y-20=0$, which was resolved in last article, no difficulty occurs, for its root may be found either exactly or to as great a degree of accuracy as we please.

As, however, the coefficients q and r are independent of each other, it is evident that q may be negative, and such that $\frac{1}{27}q^3$ is greater than $\frac{1}{4}r^2$. In this case, the expression $\frac{1}{27}q^3+\frac{1}{4}r^2$ will be negative, and therefore its square root an imaginary quantity; so that all the roots appear under an imaginary form. But we are certain (Art. 81) that every cubic equation must have at least one real root. The truth is that roots are frequently real, though they appear under

an imaginary form. Take, for instance, the equation $y^3-6y+4=0$, of which the roots are found to be

$$y=\sqrt[3]{2+2\sqrt{-1}}+\sqrt[3]{2-2\sqrt{-1}}$$
$$y=\alpha\sqrt[3]{2+2\sqrt{-1}}+\beta\sqrt[3]{2-2\sqrt{-1}}$$
$$y=\beta\sqrt[3]{2+2\sqrt{-1}}+\alpha\sqrt[3]{2-2\sqrt{-1}}$$

It will be found by actual involution that the imaginary expressions $2+2\sqrt{-1}$ and $2-2\sqrt{-1}$ are the cubes of $-1+\sqrt{-1}$ and $-1-\sqrt{-1}$ respectively, whence by substitution we find

$$y=2\,,\ y=1+\sqrt{3}\,,\ \text{and}\ y=1-\sqrt{3}\,.$$

93. We shall now prove, that as often as the roots of the equation $x^3+qx+r=0$ are real, q is negative, and $\frac{1}{27}q^3$ greater than $\frac{1}{4}r^2$; and, conversely, that if $\frac{1}{27}q^3$ be greater than $\frac{1}{4}r^2$, the roots are all real.

Let us suppose a to be a real root of the proposed equation ·

Then $\qquad x^3+qx+r=0\,,$

And $\qquad a^3+qa+r=0\,.$

And therefore, by subtraction, $x^3-a^3+q(x-a)=0$; hence, dividing by $x-a$, we have

$$x^2+ax+a^2+q=0\,.$$

This quadratic equation is formed from the two remaining roots of the proposed equation, and by resolving it we find

$$x=-\tfrac{1}{2}a\pm\sqrt{-\tfrac{3}{4}a^2-q}\,.$$

And as, by hypothesis, all the roots are real, it is evident that q must necessarily be negative, and greater than $\frac{3}{4}a^2$; for otherwise the expression $\sqrt{-\frac{3}{4}a^2-q}$ would be imaginary. Let us change the sign of q, and put $q=\frac{3}{4}a^2+d$; thus the roots of the equation $x^3-qx+r=0$ will be

$$a\,,\ -\tfrac{1}{2}a+\sqrt{d}\,,\ -\tfrac{1}{2}a-\sqrt{d}\,,$$

and here d is a positive quantity.

To find an expression for r in terms of a and d, let $\frac{3}{4}a^2+d$ be substituted for q in the equation $a^3-qa+r=0$; we thence find $r=-\frac{1}{4}a^3+ad$; so that to compare together the quantities q and r, we have these equations,

$$q=\tfrac{3}{4}a^2+d\,,\ r=-\tfrac{1}{4}a^3+ad\,.$$

In order to make this comparison, let the cube of $\frac{1}{3}q$ be taken, also the square of $\frac{1}{2}r$, the results are

$$\tfrac{1}{27}q^3=\tfrac{1}{64}a^6+\tfrac{1}{16}a^4d+\tfrac{1}{12}a^2d^2+\tfrac{1}{27}d^3\,,$$
$$\tfrac{1}{4}r^2=\tfrac{1}{64}a^6-\tfrac{1}{8}a^4d+\tfrac{1}{4}a^2d^2\,;$$

and therefore, by subtraction,

$$\begin{aligned}\tfrac{1}{27}q^3-\tfrac{1}{4}r^2&=\tfrac{3}{16}a^4d-\tfrac{1}{6}a^2d^2+\tfrac{1}{27}d^3\,,\\&=3d(\tfrac{1}{16}a^4-\tfrac{1}{18}a^2d+\tfrac{1}{81}d^2)\\&=3d(\tfrac{1}{4}a^2-\tfrac{1}{9}d)^2\,.\end{aligned}$$

Now the square of any real quantity being always positive, it follows that $3d(\frac{1}{4}a^2-\frac{1}{9}d)^2$ will be positive when d is positive; hence it is evident that in this case $\frac{1}{27}q^3$ must be greater than $\frac{1}{4}r^2$, and that $\frac{1}{27}q^3$ cannot be less than $\frac{1}{4}r^2$, unless d be negative, that is, unless $-\frac{1}{2}a+\sqrt{d}$, $-\frac{1}{2}a-\sqrt{d}$, the two other roots of the equation are imaginary. If we suppose $d=0$, then $\frac{1}{27}q^3=\frac{1}{4}r^2$; and the roots of the equations, which in this case are also real, two of them being equal.

Upon the whole, therefore, we infer, that since a cubic equation has always one real root, its roots will be all real as often as q is negative, and $\frac{1}{27}q^3$ greater than $\frac{1}{4}r^2$; and consequently, that in this case the formulæ for the roots must express real quantities, notwithstanding their imaginary form.

94. Let $y^3-qy+r=0$ denote any equation of the form which has been considered in last article, namely, that which has its roots all real; then, if we put $a=-\frac{1}{2}r$, $b^2=\frac{1}{27}q^3-\frac{1}{4}r^2$, one of the roots, as expressed by the first formula (Art. 90) will be

$$y=\sqrt[3]{a+b\sqrt{-1}}+\sqrt[3]{a-b\sqrt{-1}}\,.$$

This expression, although under an imaginary form, must (as we have shown in last article) represent a real quantity, although we cannot obtain it by the ordinary process of arithmetic.

The case of cubic equations, in which the roots are all real, is now called the *irreducible case.*

It is remarkable that the expression

$$\sqrt{a+b\sqrt{-1}}+\sqrt{a-b\sqrt{-1}}\,,$$

and in general,

$$\sqrt[n]{a+b\sqrt{-1}}+\sqrt[n]{a-b\sqrt{-1}}\,,$$

where n is any power of 2, admits of being reduced to another form, in which no impossible quantity is found. Thus, $\sqrt{a+b\sqrt{-1}}+\sqrt{a-b\sqrt{-1}}=\sqrt{2a+2\sqrt{a^2+b^2}}$,

and $\qquad \sqrt[4]{a+b\sqrt{-1}}+\sqrt[4]{a-b\sqrt{-1}}=$

$$\sqrt{\left(\sqrt{2a+2\sqrt{a^2+b^2}}+2\sqrt[4]{a^2+b^2}\right)}\,,$$

as is easily proved by first squaring and then taking the square root of the imaginary formulæ. But when n is 3, it does not seem that such reduction can possibly take place.

If each of the surds be expanded into an infinite series, and their sum be taken, the imaginary quantity $\sqrt{-1}$ will vanish, and thus the root may be found by a direct process.

Sect. XII.—Solution of Biquadratic Equations.

95. When a biquadratic equation contains all its terms, it has this form,

$$x^4+\mathrm{A}x^3+\mathrm{B}x^2+\mathrm{C}x+\mathrm{D}=0$$

where A, B, C, D denote any known quantities whatever.

We shall first consider pure biquadratics, or such as contain only the first and last terms, and therefore are of this form, $x^4=b^4$. In this case it is evident that x may be readily had by two extractions of the square root; by the first we find $x^2=b^2$, and by the second $x=b$. This, however, is only one of the values which x may have; for since $x^4=b^4$, therefore $x^4-b^4=0$; but x^4-b^4 may be resolved into two factors x^2-b^2 and x^2+b^2, each of which admits of a similar resolution; for $x^2-b^2=(x-b)(x+b)$ and $x^2+b^2=(x-b\sqrt{-1})(x+b\sqrt{-1})$. Hence it appears that the equation $x^4-b^4=0$ may also be expressed thus

$$(x-b)\,(x+b)\,(x-b\sqrt{-1})\,(x+b\sqrt{-1})=0;$$

so that x may have these four values,

$$+b,\qquad -b,\qquad +b\sqrt{-1},\qquad -b\sqrt{-1}\,,$$

two of which are real, and the others imaginary.

96. Next to pure biquadratic equations, in respect of easiness of resolution, are such as want the second and fourth terms, and therefore have this form,

$$x^4+qx^2+s=0\,.$$

These may be resolved in the manner of quadratic equations; for if we put $y=x^2$, we have

$$y^2+qy+s=0\,,$$

from which we find $y=\dfrac{-q\pm\sqrt{q^2-4s}}{2}$, and therefore

$$x=\pm\sqrt{\frac{-q\pm\sqrt{q^2-4s}}{2}}\,.$$

97. When a biquadratic equation has all its terms, the manner of resolving it is not so obvious as in the two former cases, but its resolution may be always reduced to that of a cubic equation. There are various methods by which

such a reduction may be effected. The following, which we select as one of the most ingenious, was first given by Euler in the *Petersburg Commentaries*, and afterwards explained more fully in his *Elements of Algebra.*

We have already explained, Art. 92, how an equation which is complete in its terms may be transformed into another of the same degree, but which wants the second term; therefore any biquadratic equation may be reduced to this form,

$$y^4+py^2+qy+r=0\,,$$

where the second term is wanting, and where p, q, r, denote any known quantities whatever.

That we may form an equation similar to the above, let us assume $y=\sqrt{a}+\sqrt{b}+\sqrt{c}$, and also suppose that the letters a, b, c denote the roots of the cubic equation

$$z^3+\mathrm{P}z^2+\mathrm{Q}z-\mathrm{R}=0\,;$$

then, from the theory of equations we have

$$a+b+c=-\mathrm{P},\qquad ab+ac+bc=\mathrm{Q},\qquad abc=\mathrm{R}.$$

We square the assumed formula

$$y=\sqrt{a}+\sqrt{b}+\sqrt{c},$$

and obtain $y^2=a+b+c+2\,(\sqrt{ab}+\sqrt{ac}+\sqrt{bc})$,
or, substituting $-\mathrm{P}$ for $a+b+c$, and transposing;

$$y^2+\mathrm{P}=2(\sqrt{ab}+\sqrt{ac}+\sqrt{bc}).$$

Let this equation be also squared, and we have

$$y^4+2\mathrm{P}y^2+\mathrm{P}^2=4(ab+ac+bc)+8(\sqrt{a^2bc}+\sqrt{ab^2c}+\sqrt{abc^2})\,;$$

and since $\qquad ab+ac+bc=\mathrm{Q},$

and $\sqrt{a^2bc}+\sqrt{ab^2c}+\sqrt{abc^2}=\sqrt{abc}(\sqrt{a}+\sqrt{b}+\sqrt{c})=\sqrt{\mathrm{R}}\,.\,y,$

the same equation may be expressed thus:

$$y^4+2\mathrm{P}y^2+\mathrm{P}^2=4\mathrm{Q}+8\sqrt{\mathrm{R}}\,.\,y.$$

Thus we have the biquadratic equation

$$y^4+2\mathrm{P}y^2-8\sqrt{\mathrm{R}}\,.\,y+\mathrm{P}^2-4\mathrm{Q}=0\,,$$

one of the roots of which is $y=\sqrt{a}+\sqrt{b}+\sqrt{c}$, while a, b, c are the roots of the cubic equation $z^3+\mathrm{P}z^2+\mathrm{Q}z-\mathrm{R}=0$.

98. In order to apply this resolution to the proposed equation $y^4+py^2+qy+r=0$, we must express the assumed coefficients P, Q, R by means of p, q, r, the coefficients of that equation. For this purpose, let us compare the equations

$$y^4+py^2+qy+r=0\,,$$
$$y^4+2\mathrm{P}y^2-8\sqrt{\mathrm{R}}\,y+\mathrm{P}^2-4\mathrm{Q}=0\,,$$

and it immediately appears that

$$2\mathrm{P}=p\,,\qquad -8\sqrt{\mathrm{R}}=q\,,\qquad \mathrm{P}^2-4\mathrm{Q}=r$$

and from these equations we find

$$\mathrm{P}=\frac{p}{2},\quad \mathrm{Q}=\frac{p^2-4r}{16},\quad \mathrm{R}=\frac{q^2}{64}.$$

Hence it follows that the roots of the proposed equation are generally expressed by the formula

$$y=\sqrt{a}+\sqrt{b}+\sqrt{c}\,;$$

where a, b, c denote the roots of this cubic equation,

$$z^3+\frac{p}{2}z^2+\frac{p^2-4r}{16}z-\frac{q^2}{64}=0\,.$$

But to find each particular root, we must consider, that as the square root of a number may be either positive or negative, so each of the quantities $\sqrt{a}$, $\sqrt{b}$, $\sqrt{c}$ may have either the sign + or − prefixed to it; and hence our formula will give eight different expressions for the root. It is, however, to be observed, that as the product of the three quantities $\sqrt{a}$, $\sqrt{b}$, $\sqrt{c}$ must be equal to $\sqrt{\mathrm{R}}$ or to $-\frac{q}{8}$; when q is positive, their product must be a negative quantity, and this can only be effected by making either one or three of them negative; again, when q is negative, their product must be a positive quantity; so that in this case they must either be all positive, or two of them must be negative. These considerations enable us to determine, that four of the eight expressions for the root belong to the case in which q is positive, and the other four to that in which it is negative.

99. We shall now give the result of the preceding investigation in the form of a practical rule; and as the coefficients of the cubic equation which has been found involve fractions, we shall transform it into another, in which the coefficients are integers, by supposing $z=\frac{v}{4}$. Thus the equation

$$z^3+\frac{p}{2}z^2+\frac{p^2-4r}{16}z-\frac{q^2}{64}=0$$

becomes, after reduction,

$$v^3+2pv^2+(p^2-4r)v-q^2=0\,,$$

it also follows, that if the roots of the latter equation are a, b, c, the roots of the former are $\frac{a}{4}$, $\frac{b}{4}$, $\frac{c}{4}$, so that our rule may now be expressed thus:

Let $y^4+py^2+qy+r=0$ be any biquadratic equation wanting its second term. Form this cubic equation

$$v^3+2pv^2+(p^2-4r)v-q^2=0\,,$$

and find its roots, which, let us denote by a, b, c.

Then the roots of the proposed biquadratic equation are,

when q is negative,	when q is positive,
$y=\frac{1}{2}(\sqrt{a}+\sqrt{b}+\sqrt{c})$,	$y=\frac{1}{2}(-\sqrt{a}-\sqrt{b}-\sqrt{c})$.
$y=\frac{1}{2}(\sqrt{a}-\sqrt{b}-\sqrt{c})$,	$y=\frac{1}{2}(-\sqrt{a}+\sqrt{b}+\sqrt{c})$,
$y=\frac{1}{2}(-\sqrt{a}+\sqrt{b}-\sqrt{c})$,	$y=\frac{1}{2}(\sqrt{a}-\sqrt{b}+\sqrt{c})$,
$y=\frac{1}{2}(-\sqrt{a}-\sqrt{b}+\sqrt{c})$.	$y=\frac{1}{2}(\sqrt{a}+\sqrt{b}-\sqrt{c})$.

100. As an example of the method of resolving a biquadratic equation, let it be required to determine the roots of the following,

$$x^4-25x^2+60x-36=0\,.$$

By comparing this equation with the general formula, we have $p=-25$, $q=+60$, $r=-36$; hence

$$2p=-50,\ p^2-4r=769,\ q^2=3600\,,$$

and the cubic equation to be resolved is

$$v^3-50v^2+769v-3600=0\,;$$

the roots of which are found, by the rules for cubics, to be 9, 16, and 25, so that $\sqrt{a}=3$, $\sqrt{b}=4$, $\sqrt{c}=5$. Now in this case q is positive, therefore

$$x=\tfrac{1}{2}(-3-4-5)=-6,$$
$$x=\tfrac{1}{2}(-3+4+5)=+3,$$
$$x=\tfrac{1}{2}(+3-4+5)=+2,$$
$$x=\tfrac{1}{2}(+3+4-5)=+1.$$

101. We have now explained the particular rules by which the roots of equations belonging to each of the first four orders may be determined; and this is the greatest length mathematicians have been able to go in the direct resolution of equations; for as to those of the fifth, and all higher degrees, no general method has hitherto been found, either for resolving them directly, or reducing them to others of an inferior degree.

It even appears that the formulæ which express the roots of cubic equations are not of universal application; for in one case, that is, when the roots are all real, they become illusory, so that no conclusion can be drawn from them. The same observation will also apply to the formulæ for the roots of biquadratic equations, because, before they can be applied, it is always necessary to find the roots of a cubic equation. But both in cubics and in biquadratic equations, even when the formulæ involve no imaginary quantities, and therefore can be always applied, it is more convenient in practice to employ other methods, which we are hereafter to explain.

SECT. XIII.—SOLUTION OF EQUATIONS IN WHICH CERTAIN RELATIONS ARE KNOWN TO EXIST AMONGST THE ROOTS.

102. When the coefficients of the terms of an equation form the same numerical series, whether taken in a direct or an inverted order, as in this example,

$$x^4+px^3+qx^2+px+1=0\,,$$

it may always be transformed into another of a degree denoted by half the exponent of the highest power of the unknown quantity, if that exponent be an even number; or half the exponent diminished by unity, if it be an odd number.

The same observation will also apply to any equation of this form,

$$x^4+pax^3+qa^2x^2+pa^3x+a^4=0\,.$$

103. That we may effect the proposed transformation upon the equation

$$x^4+px^3+qx^2+px+1=0\,,$$

let every two terms which are equally distant from the extremes be collected into one, and the whole be divided by x^2, then

$$x^2+\frac{1}{x^2}+p\left(x+\frac{1}{x}\right)+q=0\,.$$

Let us assume $\qquad x+\dfrac{1}{x}=z\,;$

then $\qquad x^2+2+\dfrac{1}{x^2}=z^2$, and $x^2+\dfrac{1}{x^2}=z^2-2\,.$

Thus the equation $x^2+\dfrac{1}{x^2}+p\left(x+\dfrac{1}{x}\right)+q=0\,,$

becomes $\qquad z^2+pz+q-2=0$

and since $\quad x+\dfrac{1}{x}=z$, therefore $x^2-zx+1=0\,.$

Hence, to determine the roots of the biquadratic equation

$$x^4+px^3+qx^2+px+1=0\,,$$

we form the quadratic

$$z^2+pz+q-2=0\,,$$

and find its roots, which, let us suppose denoted by z' and z''; then the four roots of the proposed equation will be found by resolving two quadratic equations, viz.

$$x^2-z'x+1=0,\quad x^2-z''x+1=0\,.$$

104. It may be observed, respecting these two quadratic equations, that since the last term of each is unity, if we put a, a' to denote the roots of the one, and b, b' those of the other, we have from the theory of equations, $aa'=1$, and therefore $a'=\dfrac{1}{a}$; also $bb'=1$, and $b'=\dfrac{1}{b}$: now a, a', b, b' are also the roots of the equation

$$x^4+px^3+qx^2+px+1=0\,.$$

Hence it appears that the proposed equation has this property, that one-half of its roots are the reciprocals of the other half; and to that circumstance we are indebted for the simplicity of its resolution.

105. If the greatest exponent of the unknown quantity in a reciprocal equation is an odd number, as in this example,

$$x^5+px^4+qx^3+qx^2+px+1=0\,,$$

the equation will always be satisfied by substituting -1 for x; hence, -1 must be a root of the equation, and therefore the equation must be divisible by $x+1$. Accordingly, if the division be actually performed, we shall have in the present case

$$x^4+(p-1)x^3-(p-q-1)x^2+(p-1)x+1=0\,,$$

another reciprocal equation, in which the greatest exponent of x is an even number, and therefore resolvable in the manner we have already explained.

106. As an application of the theory of reciprocal equations, let it be proposed to find x from this equation,

$$\frac{x^5+1}{(x+1)^5}=a\,,$$

where a denotes a given number.

Every expression of the form x^n+1 is divisible by $x+1$ when n is an odd number. In the present case, the numerator and denominator being divided by $x+1$, the equation becomes

$$\frac{x^4-x^3+x^2-x+1}{x^4+4x^3+6x^2+4x+1}=a;$$

and this again, by proper reduction, becomes

$$(a-1)x^4+(4a+1)x^3+(6a-1)x^2+(4a+1)x+a-1=0\,;$$

and, putting $p=\dfrac{4a+1}{a-1}$, $q=\dfrac{6a-1}{a-1}$,

$$x^4+px^3+qx^2+px+1=0\,;$$

a reciprocal equation, resolvable into two quadratics.

EQUATIONS WHICH HAVE EQUAL ROOTS.

107. When an equation has two or more equal roots, these may always be discovered, and the equation reduced to another of an inferior degree, by a method of resolution which is peculiar to this class of equations.

Although the method of resolution we are to employ will apply alike to equations of every degree, having equal roots, yet, for the sake of brevity, we shall take a biquadratic equation,

$$x^4+px^3+qx^2+rx+s=0\,,$$

the roots of which may be generally denoted by a, b, c, and d. Thus we have, from the theory of equations, $(x-a)(x-b)(x-c)(x-d)=x^4+px^3+qx^2+rx+s\,.$

Let us put

$$\begin{aligned}A&=(x-a)(x-b)(x-c),\ A''=(x-a)(x-c)(x-d)\,,\\ A'&=(x-a)(x-b)(x-d),\ A'''=(x-b)(x-c)(x-d):\end{aligned}$$

then, by actual multiplication, we have

$$A\ =x^3\left.\begin{matrix}-a\\-b\\-c\end{matrix}\right\}x^2\left.\begin{matrix}+ab\\+ac\\+bc\end{matrix}\right\}x-abc\,,$$

$$A'\ =x^3\left.\begin{matrix}-a\\-b\\-d\end{matrix}\right\}x^2\left.\begin{matrix}+ab\\+ad\\+bd\end{matrix}\right\}x-abd\,,$$

$$A''=x^3\left.\begin{matrix}-a\\-c\\-d\end{matrix}\right\}x^2\left.\begin{matrix}+ac\\+ad\\+cd\end{matrix}\right\}x-acd\,,$$

$$A'''=x^3\left.\begin{matrix}-b\\-c\\-d\end{matrix}\right\}x^2\left.\begin{matrix}+bc\\+bd\\+cd\end{matrix}\right\}x-bcd:$$

and taking the sum of these four equations;

$$A+A'+A''+A'''=4x^3\left.\begin{matrix}-3a\\-3b\\-3c\\-3d\end{matrix}\right\}x^2\left.\begin{matrix}+2ab\\+2ac\\+2ad\\+2bc\\+2bd\\+2cd\end{matrix}\right\}x\begin{matrix}-abc\\-abd\\-acd\\-bcd.\end{matrix}$$

But since a, b, c, d are the roots of the equation

$$x^4+px^3+qx^2+rx+s=0\,,$$

$$\begin{aligned}&\text{we have } -3(a+b+c+d)=3p\,,\\ &2(ab+ac+ad+bc+bd+cd)=2q\,,\\ &-(abc+abd+acd+bcd)=r\,;\\ \therefore\ &A+A'+A''+A'''=4x^3+3px^2+2qx+r\,.\end{aligned}$$

This result expressed in its most general form is as follows:—Let A represent the product of all the differences $x-a$, &c., except one, ΣA, the sum of all such products; then $\Sigma A=nx^{n-1}+(n-1)px^{n-2}+(n-2)qx^{n-3}+$ &c.

108. Let us now suppose that the proposed biquadratic equation has two equal roots, or $a=b$; then $x-a=x-b$, and since one or other of these equal factors enters each of the four products A, A′, A″, A‴, it is evident that $A+A'+A''+A'''$, or $4x^3+3px^2+2qx+r$ must be divisible by $x-a$, or $x-b$. Thus it appears that if the proposed equation

$$x^4+px^3+qx^2+rx+s=0$$

have two equal roots, each of them must also be a root of this equation,

$$4x^3+3px^2+2qx+r=0\,;$$

for when the first of these equations is divisible by $(x-a)^2$, the latter is necessarily divisible by $x-a$.

Let us next suppose that the proposed equation has three equal roots, or $a=b=c$; then, two at least of the three equal factors $x-a$, $x-b$, $x-c$, must enter each of the four products A, A′, A″, A‴, it is evident that $A+A'+A''+A'''$, or $4x^3+3px^2+2qx+r$ must be twice divisible by $x-a$. Hence it follows that as often as the proposed equation has three equal roots, two of them must also be equal roots of the equation

$$4x^3+3px^2+2qx+r=0\,.$$

109. Proceeding in the same manner, it may be shown, that whatever number of equal roots are in the proposed equation

$$x^4+px^3+qx^2+rx+s=0\,,$$

they will remain, except one, in this equation

$$4x^3+3px^2+2qx+r=0\,,$$

which may be derived from the former, by multiplying each of its terms by the exponent of x in that term, and then diminishing the exponent by unity.

110. If we suppose that the proposed equation has two equal roots, or $a=b$, and also two other equal roots, or $c=d$, then, by reasoning as before, it will appear that the equation derived from it must have one root equal to a or b, and another equal to c or d; so that when the former is divisible both by $(x-a)^2$ and $(x-c)^2$, the latter will be divisible by $(x-a)\,(x-c)$.

111. As a particular example, let us take this equation,

$$x^5-13x^4+67x^3-171x^2+216x-108=0\,,$$

and apply to it the method we have explained, in order to discover whether it has equal roots, and if so, what they are. We must seek the greatest common measure of the proposed equation and this other equation, which is formed agreeably to what has been shown (Art. 109),

$$5x^4-52x^3+201x^2-342x+216=0\,;$$

and the operation being performed, we find that they have a common divisor, $x^3-8x^2+21x-18$, which is of the third degree, and consequently may have several factors. Let us therefore try whether the last equation, and the following,

$$20x^3-156x^2+402x-342=0\,,$$

which is derived from it by the same process, have any common divisor; and, by proceeding as before, we find that they admit of this divisor, $x-3$, which is also a factor of the last divisor, $x^3-8x^2+21x-18$; and therefore the product of the remaining factors is immediately found by division to be x^2-5x+6, which is evidently resolvable into $x-2$ and $x-3$.

Thus it appears that the common divisor of the original equation, and that which is immediately derived from it, is $(x-2)\,(x-3)^2$; and that the common divisor of the second and third equations is $x-3$. Hence it follows that the proposed equation has $(x-2)^2$ for one factor, and $(x-3)^3$ for another factor, and may therefore be expressed thus, $(x-2)^2\,(x-3)^3=0$. The truth of this conclusion may be easily verified by multiplication. The five roots are 2, 2, 3, 3, and 3.

112. The property proved in Art. 107 enables us to establish numerous relations between the coefficients and roots of an equation, in addition to the fundamental one established in Art. 79, such as the following:—

Since $x^n+px^{n-1}+qx^{n-2}+$ &c. $=(x-a)\,(x-b)\,(x-c)$ &c.

and $nx^{n-1}+(n-1)px^{n-2}+(n-2)qx^{n-3}+$ &c. $=$
$(x-b)(x-c)\ldots+(x-a)(x-c)\ldots+\ldots,$

by division

$$\frac{nx^{n-1}+(x-1)px^{n-2}+(n-2)qx^{n-3}+\text{ \&c.}}{x^n+px^{n-1}+qx^{n-2}+\text{ \&c.}}$$
$$=\frac{1}{x-a}+\frac{1}{x-b}+\frac{1}{x-c}+\text{ \&c.}$$
$$=\frac{1}{x}+\frac{S_1}{x^2}+\frac{S_2}{x^3}+\frac{S_3}{x^4}+\text{ \&c.}$$

where S_1, S_2, S_3, &c., are the sums of the first, second, third, &c., powers of the roots of the equation.

Multiplying out and equating coefficients, we get—

$$\begin{aligned}(n-1)p&=S_1+np\\(n-2)q&=S_2+pS_1+nq\\(n-3)r&=S_3+pS_2+qS_1+\\&\text{\&c.}=\text{\&c.}\end{aligned}$$

Or
$$\begin{aligned}&S_1+p=0\\&S_2+pS_1+2q=0\\&S_3+pS_2+qS_1+3r=0\\&\text{\&c. \&c.}\end{aligned}$$

Ex. 1. As a particular case, take the cubic equation $x^3+qx+r=0$.

Here
$$\begin{aligned}&S_1=0\\&S_2+2q=0\\&S_3+3r=0\\&S_4+qS_2=0\\&S_5+qS_3+rS_2=0\end{aligned}$$
$$\therefore\quad 2S_4=S_2^2,\ S_5=5qr.$$

The last may be written—

$$\frac{S_5}{5}=qr=\frac{S_3}{3}\cdot\frac{S_2}{2}.$$

i.e., if $a+b+c=0$, then will

$$\frac{a^5+b^5+c^5}{5}=\frac{a^3+b^3+c^3}{3}\cdot\frac{a^2+b^2+c^2}{2}.$$

From $S_7+qS_5+rS_4=0$, we get

$$S_7=S_5\cdot\frac{S_2}{2}+S_2\cdot\frac{S_5}{5},$$

Or
$$\frac{S_7}{7}=\frac{S_5}{5}\cdot\frac{S_2}{2},\ \text{\&c. \&c.}$$

Ex. 2. Take the biquadratic equation

$$x^4+qx^2+rx+s=0$$

Here
$$\begin{aligned}&S_1=0\\&S_2+2q=0\\&S_3+3r=0\\&S_4+qS_2+4s=0\\&S_5+qS_3+rS_2=0\end{aligned}$$

$$\therefore\quad S_5=S_3\cdot\frac{S_2}{2}+S_2\cdot\frac{S_3}{3}$$

or
$$\frac{S_5}{5}=\frac{S_3}{3}\cdot\frac{S_2}{2};$$

i.e., if $a+b+c+d=0$,

then
$$\frac{a^5+b^5+c^5+d^5}{5}=\frac{a^3+b^3+c^3+d^3}{3}\cdot\frac{a^2+b^2+c^2+d^2}{2}.$$

Equations whose Roots are Rational

113. It has been shown in Art. 79, that the last term of any equation is always the product of its roots taken with contrary signs. Hence, when the roots are rational, they may be discovered by the following rule:

Bring all the terms of the equation to one side; find all the divisors of the last term, and substitute them successively for the unknown quantity. Then each divisor, which produces a result equal to 0, is a root of the equation.

Ex. Let $x^3-4x^2-7x+10=0$.

The divisors of 10, the last term, are 1, 2, 5, 10, each of which may be taken either positively or negatively; and these being substituted successively for x we obtain the following results:

By putting	$+1$ for x,	$1-4-7+10=0$,
	-1,	$-1-4+7+10=12$,
	$+2$,	$8-16-14+10=-12$,
	-2,	$-8-16+14+10=0$,
	$+5$,	$125-100-35+10=0$.

Here the divisors which produce results equal to 0 are $+1$, -2, and $+5$; therefore these are the three roots of the proposed equation

Sect. XIV. Solution of Equations by Approximation

114. When the roots of an equation cannot be accurately expressed by rational numbers, it is necessary to have recourse to methods of approximation; and by these we can always determine the numerical values of the roots to as great a degree of accuracy as we please.

The application of methods of approximation is rendered easy by means of the following proposition:

If two numbers, either whole or fractional, be found, which, when substituted for the unknown quantity in any equation, produce results with contrary signs, we may conclude that at least one root of the proposed equation is between those numbers, and is consequently real.

Let the proposed equation be

$$x^3-5x^2+10x-15=0,$$

which, by collecting the positive terms into one sum, and the negative into another, may also be expressed thus,

$$x^3+10x-(5x^2+15)=0;$$

then, to determine a root of the equation, we must find such a number as, when substituted for x, will render

$$x^3+10x=5x^2+15.$$

Let us suppose x to increase and to have every degree of magnitude from 0 upwards in the scale of number; then x^3+10x and $5x^2+15$ will both continually increase, but with different degrees of quickness, as appears from the following table:—

Successive values of x;	0,	1,	2,	3,	4,	5,	6,	&c.
———— of x^3+10x;	0,	11,	28,	57,	104,	175,	276,	&c.
———— of $5x^2+15$;	15,	20,	35,	60,	95,	140,	195,	&c.

By inspecting this table, it appears that while x increases from 0 to a certain numerical value, which exceeds 3, the positive part of the equation, or x^3+10x, is always less than the negative part, or $5x^2+15$; so that the expression

$$x^3+10x-(5x^2+15) \text{ or } x^3-5x^2+10x-15$$

must necessarily be negative.

It also appears, that when x has increased beyond that numerical value, and which is evidently less than 4, the positive part of the equation, instead of being less than the negative part, is now greater, and therefore the expression

$$x^3-5x^2+10x-15$$

is changed from a negative to a positive quantity.

Hence we may conclude that there is some real and determinate value of x, which is greater than 3, but less than 4, and which will render the positive and negative parts of the equation equal to one another; therefore that value of x must be a root of the proposed equation; and as what has been just now shown in a particular case will readily apply to any equation whatever, the truth of the proposition is obvious.

115. From the preceding proposition it will not be difficult to discover, by means of a few trials, the nearest integers to the roots of any proposed numerical equation; and those being found, we may approximate to the roots continually, as in the following example:

$$x^4-4x^3-3x+27=0.$$

To determine the limits of the roots, let 0, 1, 2, 3, 4, be substituted successively for x; thus we obtain the following corresponding results:

Substitutions for x,	0,	1,	2,	3,	4,
Results,	$+27$,	$+21$,	$+5$,	-9,	$+15$.

Hence it appears that the equation has two real roots, one between 2 and 3, and another between 3 and 4.

That we may approximate to the first root, let us suppose $x=2+y$, where y is a fraction less than unity, and therefore its second and higher powers small in comparison to its first power: hence, in finding an approximate value of y, they may be rejected. Thus we have

$$\begin{aligned} x^4 &= +16+32y, \text{ \&c.} \\ -4x^3 &= -32-48y, \text{ \&c.} \\ -3x &= -\ \ 6-3y \\ +27 &= +27 \\ \hline \text{Hence } 0 &= \quad 5-19y \text{ nearly,} \end{aligned}$$

and $y=\frac{5}{19}=\cdot 26$; therefore, for a first approximation we have $x=2\cdot 26$.

Let us next suppose $x=2\cdot 26+y'$; then, rejecting as before the second and higher powers of y' on account of their smallness, and retaining three decimal places, we have $y'=\frac{\cdot 135}{18\cdot 119}=\cdot 0075$, and $x=2\cdot 26+y'=2\cdot 2675$. This value of x is true to the last figure, but a more accurate value may be obtained by supposing $x=2\cdot 2675+y''$, and proceeding as before.

116. The method we have hitherto employed for approximating to the roots of equations is known by the name of *the method of successive substitutions*, and was first proposed by Newton. It has been since improved by Lagrange, who has given it a form which has the advantage of showing the progress made in the approximation by each operation. This improved form we now proceed to explain.

Let a denote the whole number next less to the root sought, and $\frac{1}{y}$ the fraction, which, when added to a, completes the root; then $x=a+\frac{1}{y}$. If this value of x be substituted in the proposed equation, a new equation involving y will be had, which, when cleared of fractions, will necessarily have a root greater than unity.

Let b be the whole number which is next less than that root; then, for the first approximation, we have $x=a+\frac{1}{b}$. But b being only an approximate value of y, in the same manner as a is an approximate value of x, we may suppose $y=b+\frac{1}{y'}$; then, by substituting $b+\frac{1}{y'}$ for y, we shall have a new equation, involving only y', which must be greater than unity. Putting therefore b' to denote the next whole number less than the root of the equation involving y', we have $y=b+\frac{1}{b'}$; and substituting this value in that of x, the result is

$$x=a+\cfrac{1}{b+\cfrac{1}{b'}}$$

for a second approximate value of x.

To find a third value, we may take $y'=b'+\frac{1}{y''}$, and so on, to obtain more accurate approximations.

SECT. XV.—INDETERMINATE PROBLEMS.

117. When the conditions of a question are such that the number of unknown quantities exceeds the number of equations, that question will admit of innumerable solutions, and is therefore said to be indeterminate. Thus, if it be required to find two numbers subject to no other limitation than that their sum be 10, we have two unknown quantities x and y, and only one equation, viz. $x+y=10$, which may evidently be satisfied by innumerable different values of x and y, if fractional solutions be admitted. It is, however, usual, in such questions as this, to restrict values of the numbers sought to positive integers, and therefore, in this case, we can have only these nine solutions,

$$x=1,\ 2,\ 3,\ 4,\ 5,\ 6,\ 7,\ 8,\ 9;$$
$$y=9,\ 8,\ 7,\ 6,\ 5,\ 4,\ 3,\ 2,\ 1;$$

which indeed may be reduced to five; for the first four become the same as the last four, by simply changing x into y, and the contrary.

118. Indeterminate problems are of different orders, according to the dimensions of the equation which is obtained after all the unknown quantities but two have been eliminated by means of the given equations. Those of the first order lead always to equations of this form,

$$ax+by=c,$$

where a, b, c, denote given whole numbers, and x, y, two numbers to be found, so that both may be integers. That this condition may be fulfilled, it is necessary that the coefficients a, b, have no common divisor which is not also a divisor of c; for if $a=md$ and $b=me$, then $ax+by=mdx+mey=c$, and $dx+ey=\frac{c}{m}$; but d, e, x, y, are supposed to be whole numbers, therefore $\frac{c}{m}$ is a whole number; hence m must be a divisor of c.

We proceed to illustrate the manner of resolving indeterminate equations of the first order, by some numerical examples.

Ex. 1. Given $2x+3y=25$, to determine x and y in whole positive numbers.

From the given equation we have $x=\frac{25-3y}{2}=12-y-\frac{y-1}{2}$. Now, since x must be a whole number, it follows that $\frac{y-1}{2}$ must be a whole number. Let us assume $\frac{y-1}{2}=z$, then $y=1+2z$; and $x=11-3z$, where z might be any whole number whatever, if there were no limitation as to the signs of x and y. But since these quantities are required to be positive, it is evident, from the value of y, that z must be either 0 or positive, and from the value of x, that it must be less than 4; hence z may have these three values, 0, 1, 2, 3.

$$\text{If } z=0,\quad z=1,\quad z=2,\quad z=3;$$
$$\text{Then}\begin{cases} x=11, & x=8, \quad x=5, \quad x=2,\\ y=1, & y=3, \quad y=5, \quad y=7.\end{cases}$$

Ex. 2. It is required to find all the possible ways in which £60 can be paid in guineas and moidores only.

Let x be the number of guineas, and y the number of moidores. Then the value of the guineas, expressed in shillings, is $21x$, and that of the moidores $27y$; therefore, from the nature of the question, $21x+27y=1200$, or, dividing the equation by 3, $7x+9y=400$; hence, proceeding as before, we obtain

$$y=7v-3,$$
$$x=61-9v.$$

From the value of x, it appears that v cannot exceed 6, and from the value of y, that it cannot be less than 1.

Hence if $v=1,\ 2,\ 3,\ 4,\ 5,\ 6,$
we have $x=52,\ 43,\ 34,\ 25,\ 16,\ 7.$
$y=4,\ 11,\ 18,\ 25,\ 32,\ 39.$

119. In the foregoing examples the unknown quantities x and y have each a determinate number of positive values; and this will evidently be the case as often as the proposed equation is of this form, $ax+by=c$. If, however, b be negative, that is, if the equation be of this form, $ax-by=c$, or $ax=by+c$, we shall have questions of a different kind, admitting each of an infinite number of solutions; these, however, may be resolved in the same manner as the preceding.

120. If an equation were proposed involving three unknown quantities, as $ax+by+cz=d$, by transposition we have $ax+by=d-cz$, and, putting $d-cz=c'$, $ax+by=c'$. From this last equation we may find values of x and y of this form,

$$x=mr+nc',\ y=m\,r+n'c',$$
$$\text{or } x=mr+n(d-cz),\ y=m'r+n'(d-cz);$$

where z and r may be taken at pleasure, except in so far as the values of x, y, z, may be required to be all positive; for from such restriction the values of z and r may be confined within certain limits to be determined from the given equation.

121. We proceed to indeterminate problems of the second degree: limiting ourselves to the consideration of the formula $y^2=a+bx+cx^2$, where x is to be found, so that y may be a rational quantity. The possibility of rendering the proposed formula a square depends altogether upon the coefficients a, b, c; and there are four cases of the problem, the solution of each of which is connected with some peculiarity in its nature.

Case 1. Let a be a square number; then, putting g^2 for a, we have $y^2=g^2+bx+cx^2$. Suppose $\sqrt{g^2+bx+cx^2}=g+mx$; then $g^2+bx+cx^2=g^2+2gmx+m^2x^2$, or $bx+cx^2=2gmx+m^2x^2$, that is, $b+cx=2gm+m^2x$; hence

$$x=\frac{2gm-b}{c-m^2},\ y=\sqrt{g^2+bx+cx^2}=\frac{cg-bm+gm^2}{c-m^2}.$$

Case 2. Let c be a square number $=g^2$; then, putting $\sqrt{a+bx+g^2x^2}=m+gx$, we find $a+bx+g^2x^2=m^2+2mgx+g^2x^2$, or $a+bx=m^2+2mgx$; hence we find

$$x=\frac{m^2-a}{b-2mg},\ y=\sqrt{a+bx+g^2x^2}=\frac{bm-gm^2-ag}{b-2mg}.$$

Case 3. When neither a nor c is a square number, yet if the expression $a+bx+cx^2$ can be resolved into two simple factors, as $f+gx$ and $h+kx$, the irrationality may be taken away as follows:

Assume $\sqrt{a+bx+cx^2}=\sqrt{(f+gx)(h+kx)}=m(f+gx)$, then $(f+gx)(h+kx)=m^2(f+gx)^2$, or $h+kx=m^2(f+gx)$; hence we find

$$x=\frac{fm^2-h}{k-gm^2},\ y=\sqrt{(f+gx)(h+kx)}=\frac{(fk-gh)m}{k-gm^2};$$

and in all these formulæ m may be taken at pleasure.

Case 4. The expression $a+bx+cx^2$ may be transformed into a square as often as it can be resolved into two parts, one of which is a complete square, and the other a product of two simple factors; for then it has this form, p^2+qr, where p, q, and r are quantities which contain no power of x higher than the first. Let us assume $\sqrt{p^2+qr}=p+mq$; thus we have $p^2+qr=p^2+2mpq+m^2q^2$ and $r=2mp+m^2q$, and as this equation involves only the first power of x, we may by proper reduction obtain from it rational values of x and y, as in the three foregoing cases.

The application of the preceding general methods of resolution to any particular case is very easy; we shall therefore conclude with a single example.

Ex. It is required to find two square numbers whose sum is a given square number.

Let a^2 be the given square number, and x^2, y^2, the numbers required; then, by the question, $x^2+y^2=a^2$, and $y=\sqrt{a^2-x^2}$. This equation is evidently of such a form as to be resolvable by the method employed in case 1. Accordingly, by comparing $\sqrt{a^2-x^2}$ with the general expression $\sqrt{g^2+bx+cx^2}$, we have $g=a$, $b=0$, $c=-1$, and substituting these values in the formulæ, and also $-n$ for $+m$, we find

$$x=\frac{2an}{n^2+1}, \; y=\frac{a(n^2-1)}{n^2+1}.$$

If $a=n^2+1$; there results $x=2n$, $y=n^2-1$, $a=n^2+1$. Hence if r be an even number, the three sides of a rational right-angled triangle are $r, \left(\frac{r}{2}\right)^2-1, \left(\frac{r}{2}\right)^2+1$. If r be an odd number, they become (dividing by 2) $r, \frac{r^2-1}{2}, \frac{r^2+1}{2}$.

For example, if $r=4$; 4, $4-1$, $4+1$, or 4, 3, 5 are the sides of a right-angled triangle; if $r=7$, 7, 24, 25 are the sides of a right-angled triangle.

Sect. XVI.—Theorems of Expansion.

1. *Binomial Theorem.*

122. To demonstrate this theorem, which has for its object the expansion of $(a+x)^n$ in the form $P+Qx+Ax^2+Bx^3+$&c., we shall first find P and Q; and then determine the other coefficients A, B, &c. in terms of P and Q.

(1.) $(a+x)^n=\left\{a\left(1+\frac{x}{a}\right)\right\}^n=a^n\left(1+\frac{x}{a}\right)^n$,

it being *assumed* that the power of a product is the product of the powers of the factors, whatever be the index.

(2.) Let n be a whole number. Since

$$(1+x)^1=1+x$$
$$(1+x)^2=1+2x+x^2$$
$$(1+x)^3=1+3x+\text{ \&c.};$$

if we assume $(1+x)^{n-1}=1+(n-1)x+$&c., and multiply both sides by $1+x$, we shall obtain $(1+x)^n=1+nx+$&c.; whence our induction is complete to prove that the numerical of coefficient x is the same as the index.

(3.) Let n be a positive fraction $\frac{p}{q}$. We may take

$$(1+x)^{\frac{p}{q}}=1+Qx+\text{\&c.}$$
$$\therefore \quad (1+x)^p=(1+Qx+\text{\&c.})^q,$$
$$\text{or,} \quad 1+px+\text{\&c.}=1+qQx+\text{\&c.} \quad \text{(Case 2.)}$$
$$\therefore \quad Q=\frac{p}{q}.$$

(4.) If n be negative $=-m$

$$(1+x)^n=(1+x)^{-m}=\frac{1}{(1+x)^m}$$
$$=\frac{1}{1+mx+\text{\&c.}} \quad \text{(Case 3.)}$$
$$=1-mx+\text{\&c. by division.}$$

Hence, generally the numerical coefficient of x is the same as the index.

To obtain A, B, &c., in terms of the first and second terms, we break up x into two parts, y, z, which enables us to write the expression $1+x$ in two different ways: 1*st*, retaining the parts of x in connection; 2*d*, dissevering them. In the first form we simply multiply out, and thus exhibit a result not dependent on the properties of an index, except in so far as relates to the first and second terms. In the second form we apply the properties of an index to every term. The consequence is, that the latter form, bearing a more intimate connection with the property of an index than the former, is more determinate than the other. The comparison of the two results completes the demonstration.

$$\begin{aligned}
\text{I.} \quad (1+x)^n &= (1+y+z)^n \\
&= 1+n(y+z) \quad +A(y+z)^2+B(y+z)^3+\text{\&c.} \\
&= 1+ny+Ay^2 \quad +By^3 \quad +\text{\&c.} \\
&\quad +nz+2Ayz+3By^2z+\text{\&c.} \\
&\quad +\text{\&c.} \quad +\text{\&c.}
\end{aligned}$$

$$\begin{aligned}
\text{II.} \quad (1+x)^n &= (1+y+z)^n=(\overline{1+z}+y)^n \\
&= (1+z)^n\left(1+\frac{y}{1+z}\right)^n \\
&= (1+z)^n\left\{1+\frac{ny}{1+z}+\frac{Ay^2}{(1+z)^2}+B\frac{y^3}{(1+z)^3}+\text{\&c.}\right\} \\
&= (1+z)^n+n(1+z)^{n-1}y+A(1+z)^{n-2}y^2+\text{\&c.} \\
&= 1+ny \quad +Ay^2+\text{\&c.} \\
&\quad +nz+n(n-1)zy+A(n-2)zy^2+\text{\&c.} \\
&\quad +\text{\&c.}+\text{\&c.} \quad +\text{\&c.}
\end{aligned}$$

Now, as these two expansions are the expansions of the same thing in the same form, the coefficients of z, zy, zy^2, &c., must be the same in both. Comparing them, we get

$$n=n, \; 2A=n(n-1), \; 3B=A(n-2) \text{ \&c.}$$
$$\therefore \quad A=\frac{n(n-1)}{1.2}, \; B=\frac{A(n-2)}{3}=\frac{n(n-1)(n-2)}{1.2.3}$$

&c. = &c.; and finally, whatever n be,

$$(1+x)^n=1+nx+\frac{n(n-1)}{1.2}x^2+\frac{n(n-1)(n-2)}{1.2.3}x^3+\text{\&c.}$$

Cor. 1. If n is a positive whole number, the series is finite, since every term after the $(n+1)$th will involve $n-n$ as a factor.

Cor. 2. Since the coefficients, when the index is a whole number, are the results of simple multiplication, they are necessarily whole numbers, *i.e.*, any such expression as $\frac{n(n-1)(n-2)}{1.2.3}$ is a whole number when n is such

Cor. 3. The sum of the numerical coefficients is 2^n, for it is equal to $(1+1)^n$, as will appear if we write 1 for x.

Cor. 4. The sum of the coefficients in the even places is equal to the sum of the coefficients in the odd. This will appear if we write -1 in place of x.

Cor. 5. If the index is a whole number, the coefficients from the end are the same as those from the beginning; for they occur at the beginning of $(x+1)^n$ in the same positions as at the end of $(1+x)^n$.

Cor. 6. The product $1.2.3 \ldots . r$ is sometimes expressed by the abbreviated form $\underline{|r}$. With this notation the coefficient of x^r in $(1+x)^n$ may be written $\frac{\underline{|n}}{\underline{|r}\,.\,\underline{|n-r}}$.

Cor. 7. The sum of the squares of the coefficients of $(1+x)^n$ is the coefficient of x^n in the expansion of $(1+x)^{2n}$, and is equal to $\frac{\underline{|2n}}{(\underline{|n})^2}$.

Examples.

Ex. 1. $(1+x)^{-2}=1+\frac{-2}{1}x+\frac{-2.-3}{1.2}x^2+\frac{-2.-3.-4}{1.2.3}x^3$ + &c.

$$=1-2x+3x^2-4x^3+\text{\&c.}$$

generally $\quad (1+x)^{-n}=1-nx+\frac{n(n+1)}{1.2}x^2-$&c.

and $\quad (1-x)^{-n}=1+nx+\frac{n(n+1)}{1.2}x^2+$&c.

Ex. 2. Find the coefficient of x^7 in $(x+x^2+x^3+x^4+x^5+x^6)^2$.

The expression may be written

$$\left\{ x\left(\frac{1-x^6}{1-x}\right) \right\}^2 = x^2(1-x^6)^2(1-x)^{-2}$$
$$= x^2(1-2x^6+x^{12})(1+2x+3x^2+4x^3+\&c.)$$

The coefficient required is therefore that of x^5 in the last factor, viz. 6.

Ex. 3. Find the sum of $1+2n+3\frac{n(n-1)}{1.2}+4\frac{n(n-1)(n-2)}{1.2.3}$ + &c.

By writing $1+1$ for 2, $1+2$ for 3, &c., this series may be broken up into the sum of $1+n+\frac{n(n-1)}{1.2}+\&c.$

and $$n+2\frac{n(n-1)}{1.2}+\&c.$$

The latter is $n\left\{1+\frac{n-1}{1}+\frac{(n-1)(n-2)}{1.2}+\&c.\right\}$

∴ the sum required is $\quad 2^n+n2^{n-1}$.

Ex. 4. Find the sum of $1+\frac{1}{2}n+\frac{1}{3}\frac{n(n-1)}{1.2}+\&c.$

Multiply by $n+1$; the product is

$$n+1+\frac{(n+1)n}{1.2}+\frac{(n+1)n(n-1)}{1.2.3}+\&c.$$

∴ the sum required is $\quad \frac{2^{n+1}-1}{n+1}$.

Ex. 5. If x_r denote the product $x(x-1)(x-2)\ldots(x-r+1)$ whatever be r, and a similar notation be applied to y, and $(x+y)$, then

$$(x+y)_r = x_r + rx_{r-1}y_1 + \frac{r(r-1)}{1.2}x_{r-2}y_2 + \&c.$$

We have $(1+a)^x = 1+x_1a+\frac{x_2}{1.2}a^2+\frac{x_3}{1.2.3}a^3+\&c.$

$$(1+a)^y = 1+y_1a+\frac{y_2}{1.2}a^2+\&c.$$

∴ $\quad (1+a)^{x+y}$ = their product.

But $(1+a)^{x+y} = 1+(x+y)_1a+\frac{(x+y)_2}{1.2}a^2+\&c.$

Equating coefficients of a^n in the two expressions for $(1+a)^{x+y}$, and multiplying by $1.2\ldots n$, the required result is obtained.

Ex. 6. If x and n be less than 1, then $(1+x)^n<(1+nx)$.

For $(1+x)^n = 1+nx+\frac{n(n-1)}{1.2}x^2+\ldots$

$$=1+nx-\frac{n(1-n)}{1.2}x^2\left(1-\frac{2-n}{3}x\right)-\&c.$$

Ex. 7. On the same hypothesis $(1+x)^n<\frac{1}{1-nx}$

Prove that $(1+x)^{-n}>1-nx$ exactly as in the last example.

Ex. 8. If $x<1$; $n>r<r+1$; then $(1+x)^n>$ the sum of the first $r+1$ terms of the expansion; and $<$ the sum of the first $r+2$ terms.

Ex. 9. The difference between the sums of the squares of the even coefficients of the expansion of $(1+x)^n$, when n is an even whole number, and the sum of the squares of the odd coefficients is $(-1)^{\frac{n}{2}}\left(\frac{\lfloor n}{\lfloor\frac{n}{2}}\right)^2$.

2. *Logarithmic Theorem.*

123. The definition of a logarithm is precisely the same as that of an index or exponent (Art. 21) viz.—*the logarithm of a product is equal to the sum of the logarithms of the factors.* Such being the case, we are at liberty to employ the definition, either in the form first given, or in the algebraic form $a^x=y$. In this last form x is called the logarithm of y to the *index* or *base* a. The base of the common or tabular logarithms is 10.

124. Before proceeding to the demonstration of the theorem by which a logarithm is expressed in the form of a series, it may be as well to illustrate the definition as applied to common logarithms.

1*st*, Since 1 is the logarithm of 10, we may inquire of what is $\frac{1}{2}$ the logarithm; if we resume the form $10^x=y$, and write $\frac{1}{2}$ for x, we have to inquire what is y.

Since $\quad 10^{\frac{1}{2}}=y,\ 10^{\frac{1}{2}}\times10^{\frac{1}{2}}=y^2$.

But $\quad 10^{\frac{1}{2}}\times10^{\frac{1}{2}}=10^{\frac{1}{2}+\frac{1}{2}}$ (def.) $=10$,

∴ $\quad y^2=10$ and $y=\sqrt{10}=3.1622777$,

so that the number of which $\frac{1}{2}$ is the logarithm is not a whole number, but a fraction lying between 3 and $3\frac{1}{5}$.

In the same way, we may, but with great labour, ascertain the numbers of which any given fraction is the logarithm.

2*d*, The definition will evidently enable us to obtain a large number of logarithms, when a few have become known. For example: Given log 2 = .30103 to find log 4 and log 5.

Log 4 = log (2 × 2) = log 2 + log 2 (def.)
$\quad$ = 2 log 2 = .60206;

Log 5 = log $\frac{10}{2}$ = log 10 − log 2
$\quad$ = 1 − log 2 = .69897.

If in addition to log 2, log 3 be known, we can find a vast number of others. For example: Given—

Log 3 = .47712 to find log 6 and log 72.
Log 6 = log 2 × 3 = log 2 + log 3 = .77815,
Log 72 = log 8 × 9 = 3 log 2 + 2 log 3 = 1.85733.

125. To expand log $(1+x)$ in terms of x.

Since log 1 = 0; the expansion must commence with the first power of x, the coefficient of which will depend on the radix or base. This coefficient we shall determine afterwards for the common logarithms. In the meantime we shall denote it by A.

Let then $\log(1+x)=Ax+Bx^2+Cx^3+\&c.$

Put $y+z$ for x; then

$$\text{I.}\quad \begin{aligned}\text{Log}(1+y+z) &= A(y+z)+B(y+z)^2+\&c.\\ &= Ay+By^2+Cy^3+\&c.\\ &\quad+Az+2Byz+3Cy^2z+\&c.\\ &\quad+\&c.\ +\&c.\end{aligned}$$

$$\text{II.}\quad \begin{aligned}\text{Log}(1+y+z) &= \log(1+y)\left(1+\frac{z}{1+y}\right)\\ &= \log(1+y)+\log\left(1+\frac{z}{1+y}\right)\\ &= Ay+By^2+\&c.\\ &\quad+\frac{Az}{1+y}\\ &\quad+\&c.\\ &= Ay+By^2+\&c.\\ &\quad+Az(1-y+y^2-\&c.)\\ &\quad+\&c.\end{aligned}$$

Equating coefficients of z, yz, y^2z, &c., in the two expansions, there results

$$A=A,\ 2B=-A,\ 3C=-A$$

∴ $$\log(1+x)=A\left(x-\frac{x^2}{2}+\frac{x^3}{3}-\&c.\right)$$

126. Cor. If $x=a-1$, where a is the base of the system, we have $1=A\left\{a-1-\frac{1}{2}(a-1)^2+\&c.\right\}$

This expansion of log $(1+x)$ is not convergent, *i.e.*, the terms do not diminish as we advance, but the contrary, when x is any whole number greater than 1. We can, however, readily obtain from it a converging series for the difference between the logarithms of the consecutive numbers.

For $\log(1+x) = A\left(x - \frac{x^2}{2} + \&c.\right)$

$$\log(1-x) = A\left(-x - \frac{x^2}{2} - \&c.\right)$$

$$\therefore \quad \log(1+x) - \log(1-x) = 2A\left(x + \frac{x^3}{3} + \frac{x^5}{5} + \&c.\right)$$

Now $\log(1+x) - \log(1-x) = \log\frac{1+x}{1-x}$,

and x has to be found, so that $\frac{1+x}{1+x}$ shall be the quotient of consecutive numbers $= \frac{1+u}{u}$.

This gives $x = \frac{1}{2u+1}$,

and $\log\frac{1+u}{u} = 2A\left\{\frac{1}{2u+1} + \frac{1}{3}\frac{1}{(2u+1)^3} + \&c.\right\}$

127. To apply this formula to the calculation of common logarithms, we will commence by finding from it a few logarithms of the system for which $A=1$. In this system

1. If $u=1$, $\log 2 = 2\left\{\frac{1}{3} + \frac{1}{3}\cdot\frac{1}{3^3} + \&c.\right\}$
$= .693, 147, 2.$

2. If $u=4$, $\log 5 = \log 4 + 2\left\{\frac{1}{9} + \frac{1}{3}\cdot\frac{1}{9^3} + \&c.\right\}$
$= 1.609, 437, 9.$

Hence $\log 10 = \log 2 + \log 5$
$= 2.302, 585, 1.$

This system, for which $A=1$ is the so-called Napierian system, which assumes no base, but defines a logarithm to be such that the increment of the number shall be the product of the number by the increment of the logarithm. In this system the number of which the logarithm is 1 is 2.718.... and is generally designated by the letter e.

To pass from Napierian logarithms to common, we observe that if $e^x = 10^y = n$; x is the logarithm of n to the base e, and y to the base 10. Now, taking the Napierian logarithm of each side of this equation, we obtain $x = y$ Nap. log 10.

Or
$$y = \frac{x}{\text{Nap. log } 10} = \frac{x}{2.302, 585, 1}.$$
$$= x \times .4342944819$$
$$= x \times .4343 \text{ very nearly.}$$

This multiplier, which was previously denoted by A, is called the *modulus* of the common system of logarithms. A celebrated calculator of the last century, Mr A. Sharp, found it to be

·43429448190325182765112891891660508229439700
5803666566114454.

For further details on the construction and use of logarithmic tables, the reader is referred to the Article on LOGARITHMS.

3. *Exponential Theorem.*

128. It is now required to expand a^x in terms of x.

1. Write $1 + a - 1$ for a, and apply the binomial theorem; the result is

$$\{1+(a-1)\}^x = 1 + x(a-1) + \frac{x(x-1)}{1.2}(a-1)^2 + \&c.$$

Here the only term which does not contain x is 1; and the coefficient of x being traced through the different terms, is easily seen to be

$$a - 1 - \frac{1}{2}(a-1)^2 + \frac{1}{3}(a-1)^3 - \&c.$$

Thus will seem (Art. 126) to be the reciprocal of the modulus of the system of logarithms whose base is a: call it r. We have now to determine B, C, &c., in terms of r, from the form of expansion

$$a^x = 1 + rx + Bx^2 + Cx^3 + \&c.$$

Write $y+z$ is place of x; then

$$\text{I.} \quad \begin{aligned} a^{y+z} &= 1 + r(y+z) \quad + B(y+z)^2 + \&c. \\ &= 1 + ry \;\; + By^2 \;\; + \&c. \\ &\quad\;\; + rz \;\; + 2Byz + \&c. \\ &\quad\quad\quad + \&c. \end{aligned}$$

$$\text{II.} \quad \begin{aligned} a^{y+z} &= a^y \times a^z \;\; = (1 + ry + By^2 + \&c.) \\ &\quad \times (1 + rz \;\; + Bz^2 \;\; + \&c.) \\ &= 1 \;\; + ry \;\; + By^2 \;\; + \&c. \\ &\quad\;\; + rz + r^2yz + rBy^2z \;\; + \&c. \\ &\quad\quad + \&c. \end{aligned}$$

Equating coefficients of z, yz, y^2z, &c., in I. and II., we get

$$r = r,\ 2B = r^2,\ 3C = rB,\ \&c.$$

$$\therefore \quad B = \frac{r^2}{1.2},\ C = \frac{r^3}{1.2.3},\ \&c$$

and
$$a^x = 1 + rx + \frac{r^2x^2}{1.2} + \frac{r^3x^3}{1.2.3} + \&c.$$

129. Now, since e is such (Art. 127) that $e - 1 - \frac{1}{2}(e-1)^2 + \&c. = 1$, and $r = a - 1 - \frac{1}{2}(a-1)^2 + \&c.$, whatever a be, it follows that when e takes the place of a, r becomes 1.

$$\therefore \quad e^x = 1 + x + \frac{x^2}{1.2} + \frac{x^3}{1.2.3} + \&c.$$

and putting $x = 1$, $e = 1 + 1 + \frac{1}{1.2} + \&c.$
$$= 2.718281828459045\ldots$$

Again
$$e^r = 1 + r \;\; + \frac{r^2}{1.2} + \&c.$$

but since,
$$a^x = 1 + rx + \frac{r^2x^2}{1.2} + \&c.$$

we have
$$a = 1 + r \;\; + \frac{r^2}{1.2} + \&c.$$
$$= e^r$$

From this equation we have $r =$ Nap. log a, a result obtained before.

130. We may approximate directly to the value of r when $a = 10$, thus

$$\left(\frac{1}{a}\right)^x = a^{-x} = 1 - rx + \frac{r^2x^2}{1.2} - \&c.$$

so that the coefficient of x in $\left(\frac{1}{a}\right)^x$ is $-r$.

Now $\left(\frac{1}{a}\right)^x = \left(1 + \frac{1}{a} - 1\right)^x$, whence (Art. 128) the coefficient of x in $\left(\frac{1}{a}\right)^x$ is

$$\frac{1}{a} - 1 - \frac{1}{2}\left(\frac{1}{a} - 1\right)^2 + \frac{1}{3}\left(\frac{1}{a} - 1\right)^3 - \&c.$$

$$\therefore \quad r = 1 - \frac{1}{a} + \frac{1}{2}\left(1 - \frac{1}{a}\right)^2 + \frac{1}{3}\left(1 - \frac{1}{a}\right)^3 + \&c.$$
$$= \frac{9}{10} + \frac{1}{2}\left(\frac{9}{10}\right)^2 + \frac{1}{3}\left(\frac{9}{10}\right)^3 + \&c.$$
$$= 2.302\ldots$$

Additional Examples.

Ex. 1. To find the value to which $\left(1 + \frac{x}{m}\right)^m$ approaches as m becomes larger and larger.

By the binomial theorem

$$\left(1+\frac{x}{m}\right)^m = 1 + m\frac{x}{m} + \frac{m(m-1)}{1.2}\left(\frac{x}{m}\right)^2 + \&c.$$

$$= 1 + x + \frac{1-\frac{1}{m}}{1.2}x^2 + \frac{\left(1-\frac{1}{m}\right)\left(1-\frac{2}{m}\right)}{1.2.3}x^3 + \&c.$$

$$= 1 + x + \frac{x^2}{1.2} + \frac{x^3}{1.2.3} + \&c.$$

$$+ \frac{P}{m} + \frac{Q}{m^2} + \&c.$$

so that $\left(1+\frac{x}{m}\right)^m$ approaches the value $1 + x + \frac{x^2}{1.2}$ + &c. or e^x, as m becomes larger and larger.

Ex. 2. $\left(1+\frac{x}{m}\right)^m$ approaches to $e^x\left(1-\frac{x^2}{2m}\right)$ as m increases.

Ex. 3. $n^n - \frac{n}{1}(n-1)^n + \frac{n(n-1)}{1.2}(n-2)^n - \&c.$

$$= 1.2\ldots n$$

when n is a whole number.

$$e^{nx} = 1 + nx + \frac{n^2x^2}{1.2}\ \&c.$$

$$e^{(n-1)x} = 1 + (n-1)x + \frac{(n-1)^2x^2}{1.2} + \&c.$$

$$\ldots = \ldots$$

Now I. $(e^x-1)^n = e^{nx} - ne^{(n-1)x} + \frac{n(n-1)}{1.2}e^{(n-2)x} - \&c.$

But $e^x - 1 = 1 + x + \frac{x^2}{1.2} + \&c. - 1 = x + \frac{x^2}{1.2} + \&c.$

$\therefore$ II. $(e^x-1)^n = x^n + px^{n+1} + \&c.$

Equating coefficients of x^n in I. and II., we get

$$\frac{n^n}{1.2\ldots n} - \frac{n(n-1)^n}{1.2\ldots n} + \frac{n(n-1)}{1.2}\frac{(n-2)^n}{1.2\ldots n} - \&c = 1$$

which is the required result.

Cor. When r is less than n,

$$n^r - n(n-1)^r + \frac{n(n-1)}{1.2}(n-2)^r - \&c. = 0.$$

Ex. 4. The logarithm of a number to the base a^n is a mean proportional between its logarithms to the bases a and a^{n^2}.

If x, y, z, are the logarithms to the three bases in order, we have

$$(a^n)^x = a^y = (a^{n^2})^z$$

$$\therefore\quad nx = y$$

$$nx = n^2z$$

consequently $\quad x^2 = yz.$

Ex. 5. $e^x > 1 + x$, whatever be x.

If x be positive, or if it be negative and less than unity. the expansion may be thrown into the form

$$e^x = 1 + x + \frac{x^2}{1.2}\left(1+\frac{x}{3}\right) + \&c.$$

every term of which after $1 + x$ is positive.

Ex. 6. $e^n > \frac{(1-n)}{\lfloor n}$.

For $\quad e^x > 1 + x \therefore e^{\frac{1}{n}} > 1 + \frac{1}{n}$

$\therefore \quad en^n > (1+n)^n$

Hence $\quad e.1^1 > 2^1$

$e.2^2 > 3^2$

$\ldots\ \ldots$

$en^n > (1+n)^n$

and, by multiplication, $e^n\lfloor n > (1+n)^n$.

Ex. 7. If n be a whole number $> e$, $n^{n+1} > (n+1)^n$.

By the demonstration of *Ex.* 6,

$$en^n > (1+n)^n$$

But $\quad n > e \quad \therefore \quad n^{n+1} > (1+n)^n$.

Ex. 8. If $n^{n+1} = (n+1)^n$, then $n > 1 < e$.

For n is evidently > 1. If then we suppose $n > 1 < 2$,

$$n = \left(1+\frac{1}{n}\right)^n$$

$$= 1 + 1 + \frac{\left(1-\frac{1}{n}\right)}{1.2}\left(1 + \frac{1-\frac{2}{n}}{3}\right) + \&c.$$

$= 2 +$ a series of positive terms by the hypothesis $n < 2$, which is absurd, $\therefore n > 2$.

Taking the Napierian logarithms of each side of the equation $n = \left(1+\frac{1}{n}\right)^n$, we get

$$\log n = 1 - \frac{1}{2n} + \frac{1}{3n^2} - \&c.$$

$$= 1 - \frac{1}{n}\left(\frac{1}{2} - \frac{1}{3n}\right) - \&c.$$

$$< 1$$

$$\therefore \quad n < e.$$

Ex. 9. Nap. $\log x > 1 - \frac{1}{x} < x - 1$.

Because $\log x = -\log\frac{1}{x} = 1 - \frac{1}{x} + \frac{1}{2}\left(1-\frac{1}{x}\right)^2 + \&c.$

$$\therefore \quad \log x > 1 - \frac{1}{x}.$$

And because when $x > 1$, $x < 1 + (x-1) + \frac{1}{1.2}(x-1)^2 +$ &c.

$$< e^{x-1}$$

$$\therefore \quad \log x < x - 1;$$

when $x < 1$, $\quad \log x = \log(1 - \overline{1-x})$

$$= -\left\{1 - x + \frac{1}{2}(1-x)^2 + \&c.\right\}$$

$$= x - 1 - \frac{1}{2}(1-x)^2 - \&c.$$

$$< x - 1.$$

Ex. 10. Nap. $\log x$ approaches to $2^n\left(x^{\frac{1}{2^n}} - 1\right)$ as n increases.

SECT. XVII.—CONTINUED FRACTIONS.

131. Every quantity which admits of being expressed by a common fraction may also be expressed in the form of what is called a *continued fraction*. The nature of such fractions will be easily understood by the following example:

Let the fraction be $\frac{314159}{100000}$, or, which is the same, $3 + \frac{14159}{100000}$. Since $100000 = 7 \times 14159 + 887$, therefore $\frac{14159}{100000} = \frac{14159}{7\times14159+887} = \cfrac{1}{7+\cfrac{887}{14159}}$ and $\frac{314159}{100000} = 3 + \cfrac{1}{7+\cfrac{887}{14159}}$.

By treating the fraction $\frac{887}{14159}$ in the same way, and continuing the process, we readily obtain

$$\frac{314159}{100000} = 3 + \cfrac{1}{7+\cfrac{1}{15+\cfrac{1}{1+\cfrac{1}{25+\cfrac{1}{1+\cfrac{1}{7+\cfrac{1}{4}}}}}}}$$

By an operation in all respects the same as has been just now performed, may any proper fraction whatever be reduced to the form

$$\cfrac{1}{a_1+\cfrac{1}{a_2+\cfrac{1}{a_3}+\&c.}}$$

and it is then called a *continued fraction*.

132. When the root of any equation is found by the

method explained in Art. 116, the value of the unknown quantity is evidently expressed by a continued fraction. For if x be the root sought, we have $x=a+\frac{1}{y'}$, $y=b+\frac{1}{y'}$ $y'=b'+\frac{1}{y''}$, $y''=b''+\frac{1}{y'''}$, &c. where a, b, b', b'', &c. denote the whole numbers, which are next less than the true values of x, y, y', y'', &c. If, therefore, in the value of x we substitute $b+\frac{1}{y'}$ for y, it becomes

$$x=a+\cfrac{1}{b+\cfrac{1}{y'}}.$$

Again, if in this second value of x we substitute $b'+\frac{1}{y''}$ for y', it become

$$x=a+\frac{1}{b}+\cfrac{1}{b'+\cfrac{1}{y''}}.$$

And so on continually,

133. It is easy to see in what manner the inverse of the preceding operation is to be performed, or a continued fraction reduced to a common fraction.

The fractions which result from omitting portions of a continued fraction are termed the *convergents* to that fraction. Thus, if the fraction be $\frac{1}{a_1}+\frac{1}{a_2}+\frac{1}{a_3}$; $\frac{1}{a_1}$ is the first convergent, $\frac{a_2}{a_1\,a_2+1}$ the second, &c.

134. The principal practical application of the properties of continued fractions is to approximate to the value of a given fraction. The proposition on which this application depends is the following:—

No fraction in terms equally low can give so good an approximation to the value of a fraction as a convergent to the continued fraction which expresses it does.

To demonstrate this proposition, it is requisite to establish three preliminary propositions, which we shall do very briefly.

135. (1.) If $\frac{p_n}{q_n}$ denote the nth convergent, or the reduced fraction which results from stopping at a_n, and reducing, then $p_{n+1}=a_{n+1}p_n+p_{n-1}$, $q_{n+1}=a_{n+1}q_n+q_{n-1}$.

Since no denominator can be multiplied by itself, the reduced fraction must give $p_n=a_n\mathrm{A}+\mathrm{B}$.

Now p_{n+1} is obtained by writing $a_n+\frac{1}{a_{n+1}}$ for a_n, and reducing,

$$\therefore\quad p_{n+1}=a_{n+1}(a_n\mathrm{A}+\mathrm{B})+\mathrm{A}=a_{n+1}p_n+\mathrm{A};$$

i.e., the multiplier of any a is the previous p, and the other term is the multiplier of a in the previous convergent, hence the proposition.

136. (2.) $p_{n+1}q_n-q_{n+1}p_n=(-1)^n$.

This is at once obtained by eliminating a_{n+1} from the two equations of last article.

137. (3.) The successive convergents are alternately greater and less than the complete fraction, and each convergent approaches nearer in value to it than the preceding.

If A denote the complete denominator $a_{n+1}+$&c.; u the complete fraction; then $u=\frac{\mathrm{A}p_n+p_{n-1}}{\mathrm{A}q_n+q_{n-1}}$; and by subtracting successively $\frac{p_n}{q_n}$ and $\frac{p_{n-1}}{q_{n-1}}$ from u in this form, it will be seen at once that the results have different signs, and that the latter difference is the larger.

138. We are now able to prove the proposition enunciated.

Let $\frac{p}{q}$ be a fraction nearer to u than $\frac{p_{n+1}}{q_{n+1}}$; then since the convergents are alternately too great and too small; $\frac{p_{n+1}}{q_{n+1}}$, $\frac{p}{q}$, $\frac{p_n}{q_n}$, must be in order of magnitude.

$\therefore$ If the first be the greatest,

$$\frac{p_{n+1}}{q_{n+1}}-\frac{p_n}{q_n}>\frac{p}{q}-\frac{p_n}{q_n}.$$

Reducing and applying Prop. 2, there results $q>q_{n+1}$.

Similarly by inverting the fractions, it may be proved that $p>p_{n+1}$.

Ex. 1. To determine when a transit of Venus may be expected.

The relative sidereal periods of Venus and the earth are 224,700 days and 365,256 days. The continued fraction which expresses the quotient of these numbers is

$$\frac{1}{1}+\frac{1}{1}+\frac{1}{1}+\frac{1}{1}+\frac{1}{2}+\frac{1}{29}+\text{\&c.}$$

The fifth convergent is $\frac{8}{13}$; the sixth $\frac{235}{382}$.

On account of the smallness of $\frac{1}{29}$, the former is a very close approximation, *i.e.*, 8 years and 13 sidereal periods of Venus are very nearly equal.

In consequence of this, a transit occurs after one period of 8 years, and then again not till after 235 years have been completed.

The last pair of transits at the descending node occurred in 1769, 1777; and at the ascending node in 1639, 1647.

The next pair will accordingly occur at the latter node in 1874 and 1882. The days of transit will be December 8 and December 6, respectively.

Ex. 2. To find the periods of probable recurrence of eclipses of the sun.

An eclipse of the sun will occur whenever the place of the new moon is within about 13° of the line of nodes. Now, the interval between two new moons is 29·5306 days; and the mean synodic period of the earth and the line of nodes is 346·6196 days. The proportion of the latter of these numbers to the former, reduced to a continued fraction, gives as convergents $\frac{47}{4}$, $\frac{223}{19}$, &c.

Hence, after 47 lunar months, things have come nearly to their original position, and after 223 lunar months, *very* nearly. This latter period, termed the *saros*, has been known from the remotest antiquity. It enabled the Chaldean shepherds to predict the return of eclipses. It amounts to 18 years and 10 or 11 days. Thus, there was a total eclipse on the 18th July 1860; adding 18 years 11 days, we get for an eclipse 29th July 1878. If we add 47 lunations or 1388 days, we get 6th March 1864, on which day there was an eclipse.

This period of 1388 days, multiplied by 5, makes exactly 19 years—a period which is designated as the cycle of *Meton*, giving eclipses which occur on the same day of the month. Thus, eclipses happened 18th July 1841 and 18th July 1860, and another will happen 18th July 1879.

Ex. 3. The fraction given (Art. 131) represents the ratio of the circumference of a circle to its diameter. By taking the first two terms we have $\pi=3+\frac{1}{7}=\frac{22}{7}$ nearly; and this is the proportion which was found by Archimedes.

Again, by taking the first three terms, we have

$$\pi=3+\frac{1}{7}+\frac{1}{15}\quad=3+\frac{15}{106}=\frac{333}{106},$$

which is nearer the truth than the former.

And, by taking the first four terms, we have

$$\pi = 3 + \frac{1}{7+}\frac{1}{15+} \qquad = \frac{355}{113}$$

which is the proportion assigned by Metius.

Ex. 4. The mean tropical year consists of 365·2422642 days.

The fraction ·2422642, reduced to a continued fraction, gives as successive convergents

$$\frac{1}{4}, \frac{7}{29}, \frac{8}{33}, \frac{39}{161}, \frac{47}{194}, \frac{321}{1325}, \text{\&c.}$$

To make the civil year approximate to the tropical, 1 leap year in 4 (the Julian Calendar) serves but imperfectly. 7 leap years in 29 would be inconvenient. The Gregorian Calendar, now in use, is based on combining the fractions $\frac{47}{194}$ and $\frac{1}{4}$, by doubling the numerator and denominator of the former, and trebling those of the latter, and adding them respectively. The resulting fraction is $\frac{97}{400}$, giving 97 leap years in 400 years, instead of 100 as the Julian does. This diminution of 3 leap years in 400 years is produced periodically, by causing years which indicate the completion of centuries not to be leap years unless the number of *centuries* is divisible by 4. Thus, 1900 will not be a leap year.

SECT. XVIII.—PERMUTATIONS, COMBINATIONS, AND PROBABILITIES.

139. Hitherto we have supposed the letters of the alphabet, a, b, c, &c., to stand for arithmetical quantities of some kind or other. Now we have to employ them, as in geometry, to represent magnitudes or objects, such as pens, pencils, &c., and to investigate the numbers of different ways in which a given set of them can be grouped according to a certain law.

Permutations are their arrangements in a line, reference being had to the order of sequence; thus ab and ba are the two permutations of a and b; *combinations* are their arrangements in groups, without reference to the order of sequence; thus abc is a combination involving a, b, and c; and bac is the same combination, both consisting simply of a, b, and c grouped together.

Prop. 1. To find the number of permutations of n things (1), two and two (2), three and three, &c., together.

Set aside a, and lay down the other things in a line; place a before each of them in succession, and you obtain ab, ac, ad, &c., *i.e.*, $n-1$ arrangements, each containing two things, with a first.

In the same way you can form $n-1$ arrangements, each containing two things, with b first. The same is true of each of the other letters, and as there are n of them, the total number of arrangements of the n things, two together, is $n(n-1)$.

Again, lay aside a, and group the other $n-1$ things, two together; as we have just shown, there are $(n-1)(n-2)$ such groups. Place a before each of them, and there will be formed $(n-1)(n-2)$ arrangements, each containing three things, with a first; and there can be no more arrangements with a first.

Treat b, c, &c., in the same manner, and it will appear that there are $(n-1)(n-2)$ groups of things, three together, in which every separate thing in succession stands first. Hence, the total number of arrangements, three and three, is $n(n-1)(n-2)$.

By proceeding in the same manner we shall find the total number of permutations of n things, r together, to be $n(n-1)\ldots\ldots(n-r+1)$.

Cor. The number of permutations of n things, all together, is $n(n-1)\ldots.3.2.1$.

Prop. 2. To find the number of combinations of n things, r together.

Let x be the number required.

Take any one of the x groups of r things. The number of permutations which can be formed with it will be (Prop. 1. Cor.) $r(r-1)\ldots\ldots 1$, or $1.2\ldots r$.

Now, since each of the x groups is different from all the others, if we treat each of the x groups separately in this way, we shall form $1.2\ldots.r \times x$ permutations, all different. Also, since the x groups contain every possible combination of the n things, r together, we shall thus have formed all the permutations which can be formed; and consequently (Prop. 1) the number is $n(n-1)\ldots(n-r+1)$.

$$\therefore \qquad x = \frac{n(n-1)\ldots.(n-r+1)}{1.2\ldots.r}.$$

Prop. 3. To find the number of combinations which can be formed of n sets of things, containing respectively r, s, t, &c. things, by taking one from each set to form a combination.

1. Let there be two sets, one containing r and the other s things.

Any one (say a) of the r things may be placed successively with each of the s things, and thus form s groups, in each of which a appears. The same is true of b, c, &c.; *i.e.*, each of the r things gives rise to s groups, $\therefore$ the number required is rs.

2. Any one of the t things may be placed in succession with each of the groups of two things referred to in Case 1, so that every one of the t things will give rise to rs combinations of three things; $\therefore$ the number required is rst. The same may be indefinitely extended.

140. The first and most obvious application of the theory of combinations is to the doctrine of chances. As, however, this application will form the subject of a separate article, all that is requisite for us now to do is to indicate the connecting link between the two subjects.

If we agree to designate certainty by unity, then the chance of an event happening, when it is less than certainty, will be designated by a proper fraction. Thus, if the average number of wet days and of dry is the same, the chance of any day named at random turning out wet will be represented by the fraction $\frac{1}{2}$; that is, if the number of days under consideration be 100, the chance is $\frac{50}{100}$, or $\frac{\text{number of wet days}}{\text{total number of days}}$. Chance is accordingly defined by the fraction $\frac{\text{number of favourable events}}{\text{total number of events.}}$.

The only proposition by which chances are combined that we shall offer is this.

If there are two events, and the probability of one of them happening to be $\frac{a}{b}$, and of the other $\frac{c}{d}$; then the probability that both will happen is $\frac{ac}{bd}$.

For a and c may be taken to represent the favourable events respectively, and be combined (Art. 139, Prop. 3) so as to give ac ways in which they may happen together. And in the same way b and d may be combined to give the total number of events.

Ex. A bag contains 3 white and 4 black balls. Find the chance of drawing (1) two white balls; (2) a white and a black; (3) one white at least, when two balls are drawn.

The chance of drawing two white balls is the fraction,

$$\frac{\text{Number of combinations of 3 things, 2 together}}{\text{Number of combinations of 7 things, 2 together.}}$$

$$= \frac{\frac{3.2}{1.2}}{\frac{7.6}{1.2}} = \frac{1}{7}$$

The chance of drawing a white and a black is (Art. 139, Prop 3),

$$\frac{3.4}{\frac{7.6}{1.2}} = \frac{4}{7}.$$

To find the chance of drawing at least a white ball, we may remark that it is the same as the chance of not drawing two black balls, *i.e.*, certainty—the chance of drawing two black balls.

Now the chance of drawing two black balls is

$$\frac{\frac{4.3}{1.2}}{\frac{7.6}{1.2}} = \frac{2}{7}$$

∴ the chance of drawing at least one white ball is

$$1-\frac{2}{7}=\frac{5}{7}.$$

Sect. XIX.—On Series in General; their Summation and Convergence.

141. Certain series, from their very appearance, indicate that they are really the sums or differences of two other series. From this circumstance their sum may frequently be determined, as in the following examples:—

Ex. 1. $$\frac{1}{1.2}+\frac{1}{2.3}+ \ldots \ldots \frac{1}{n(n+1)}$$

Let $$x=\frac{1}{1}+\frac{1}{2} + \ldots \ldots \frac{1}{n}$$

$$x-1+\frac{1}{n+1}=\frac{1}{2}+\frac{1}{3}+ \ldots \ldots \frac{1}{n+1}$$

∴ by subtraction,

$$1-\frac{1}{n+1}=\left(\frac{1}{1}-\frac{1}{2}\right)+\left(\frac{1}{2}-\frac{1}{3}\right)+ \ldots \left(\frac{1}{n}-\frac{1}{n+1}\right)$$
$$= \frac{1}{1.2}+\frac{1}{2.3}+ \ldots \frac{1}{n(n+1)}$$

and the sum is $1-\frac{1}{n+1}$, that is, $\frac{n}{n+1}$.

142. The sum of a series may often be easily found by the method of *increments* or *differences*, and this method is especially adapted to the summation of integral series, such as the squares of the natural numbers. We shall exhibit one or two illustrations only.

If we write $S_n=n(n+1)$, we have

$$S_{n+1}=(n+1)(n+2), \therefore S_{n+1}-S_n=2(n+1).$$

Hence conversely, and dividing by 2; if

$$S_{n+1}-S_n=n+1,$$

then will $$S_n=\frac{n(n+1)}{2}.$$

Similarly, if

$$S_{n+1}-S_n=(n+1)(n+2)\ldots(n+r-1),$$

then will $$S_n=\frac{n(n+1)\ldots(n+r-1)}{r}.$$

This last conclusion, of course, assumes that S_n is 0 when n is 0. If it be otherwise, some numerical constant, easy of determination, will have to be added.

Ex. 2. $$1^2+2^2+3^2+\ldots n^2.$$

Here $S_{n+1}-S_n=(n+1)^2=(n+1)(n+2)-(n+1)$;

$$\therefore \quad S_n=\frac{n(n+1)(n+2)}{3}-\frac{n(n+1)}{2}=\frac{n(n+1)(2n+1)}{6}.$$

Ex. 3. $$1^4+2^4+3^4+\ldots n^4$$
$$S_{n+1}-S_n=(n+1)^4$$

Let
$$(n+1)^4=(n+1)(n+2)(n+3)(n+4)+A(n+1)(n+2)(n+3)+B(n+1)(n+2)+C(n+1).$$

Dividing by $n+1$, and proceeding as in Art. 33, we get $A=-6$, $B=7$, $C=-1$.

$$\therefore \quad S_n=\frac{1}{5}n(n+1)(n+2)(n+3)(n+4)-$$
$$\frac{3}{2}n(n+1)(n+2)(n+3)+\frac{7}{3}n(n+1)(n+2)-\frac{1}{2}n(n+1)$$
$$=\frac{n(n+1)(2n+1)}{30}\left\{3n(n+1)-1\right\}.$$

On the Convergency and Divergency of Infinite Series.

143. *Def.* If the limit to which the sum of a series approaches, as the number of terms increases, is finite, the series is a converging series; if otherwise, diverging. For example, the sum of the series $1+r+r^2+\ldots$ to n terms is $\frac{1-r^n}{1-r}$ (Art. 52), which, when r is less than **1**, approaches to $\frac{1}{1-r}$, in which case the series is a converging series.

Prop. 1. It is necessary and sufficient for convergency that the remaining terms after the nth have zero for their limit, both individually and collectively, as n increases.

It is obviously necessary and sufficient for convergency that the sum of the series after the nth term shall have 0 as its limit; and consequently, when all the terms of the series are positive, the same must be true of each individual term. But when the terms are alternately positive and negative, though it is necessary for convergency that the sum of the consecutive terms with their proper signs should have 0 as its limit, this is not sufficient; for, were it so, the sum to n terms would depend on whether n is even or odd.

Ex. 1. $1+\frac{1}{2}+\frac{1}{3}+\ldots$ is not a converging series; for although each term after the nth tends to 0 as its limit—the sum of n terms after the nth, viz., $\frac{1}{n+1}+\frac{1}{n+2}+\ldots \frac{1}{2n}$, which is greater than $\frac{1}{2n}+\frac{1}{2n}+\ldots\frac{1}{2n}$ to n terms, *i.e.*, greater than $\frac{1}{2}$, does not tend to 0 as its limit.

Ex. 2. $1+\frac{1}{1}+\frac{1}{1.2}+\frac{1}{1.2.3}+\ldots$ the expression for e (Art. 129), is convergent.

The sum of the terms after the nth is

$$\frac{1}{\underline{|n}}\left(1+\frac{1}{n+1}+\text{\&c.}\right)$$
$$<\frac{1}{\underline{|n}}\left(1+\frac{1}{n}+\frac{1}{n^2}+\ldots\right)$$
$$<\frac{1}{\underline{|n}}\cdot\frac{1}{1-\frac{1}{n}}<\frac{1}{(n-1)\underline{|n-1}}$$

the limit of which as n increases is 0.

Prop. 2. If the limit of the nth term is 0, and the terms continually diminish; then when the signs of the terms are alternately + and −, the series is convergent.

Let $u_1-u_2+u_3-$ &c., be the series; the terms after the nth (+ or −) make up the series of positive groups

$$(u_{n+1}-u_{n+2})+(u_{n+3}-u_{n+4})+\text{\&c.}$$

But these terms may also be written $u_{n+1}-(u_{n+2}-u_{n+3})-$ &c., which, since the whole group is positive, must

be less than u_{n+1}, the only positive term in it. But u_{n+1} has 0 for its limit, therefore the series is convergent.

Ex. 3. $1-\frac{1}{2}+\frac{1}{3}-\ldots$ is convergent, for the sum of the series after the nth term is less than $\frac{1}{n+1}$, which has 0 as its limit.

Prop. 3. If the terms of the series are all positive, and the limit of the nth term is 0; then if the limit of the quotient of the $(n+1)$th term by the nth be less than 1, the series is convergent; but if the limit be greater than 1, the sum is divergent.

1. Let k be the greatest value of $\frac{u_{n+1}}{u_n}$, after a certain value of n, and $k<1$; then,

$$u_{n+1}+u_{n+2}+\ldots<u_{n+1}(1+k+k^2+\ldots),$$
$$<\frac{u_{n+1}}{1-k},$$

which has 0 for its limit. Hence the series is convergent (Prop. 1).

2. Let k, the least value of $\frac{u_{n+1}}{u_n}$ after a certain finite value of n, be greater than 1; then

$$u_{n+1} = \text{ or } >ku_n$$
$$u_{n+2} = \text{ or } >k^2u_n$$
&c. &c.

$$\therefore \quad u_{n+1}+u_{n+2}+\text{\&c.} = \text{ or } >ku_n(1+k+k^2+\text{\&c.}),$$

which is infinite. Hence the series is divergent.

Prop. 4. If $\frac{u_{n+1}}{u_n}$ be less than 1; then the two series

$$u_1+u_2+u_3+u_4+\ \ldots\ldots \quad (1)$$
$$u_1+2u_2+4u_4+8u_8+\ \ldots\ldots \quad (2)$$

are both convergent, or both divergent together.

Series $(2)+u_1=2(u_1+u_2+2u_4+4u_8+\ldots)$, which is equal to or less than the following, term by term, viz.:—

$$2\{u_1+u_2+(u_3+u_4)+(u_5+u_6+u_7+u_8)+\ldots\},$$

i.e., twice series (1).

Hence if the one series be convergent, the other will be also convergent; and if series (2) be divergent, series (1) is also divergent.

Again, series (2) is equal to or greater than the following, term by term,

$$u_1+(u_2+u_3)+(u_4+u_5+u_6+u_7)+\ldots$$

which is series (1).

Hence if series (1) be divergent, series (2) is also divergent.

Ex. 1. The series $\frac{1}{1^r}+\frac{1}{2^r}+\frac{1}{3^r}+\ldots$ is convergent if $r>1$, but divergent if $r=$ or <1.

The two series (1) and (2) now become

$$\frac{1}{1^r}+\frac{1}{2^r}+\frac{1}{3^r}+\ldots$$
$$\frac{1}{1^r}+\frac{2}{2^r}+\frac{4}{4^r}+\ldots$$

the latter of which is the geometric series

$$1+\frac{1}{2^{r-1}}+\frac{1}{4^{r-1}}+\ldots,$$

which is convergent or divergent according as $r>1$ or the contrary. Hence the same is true of the given series.

Ex. 2. The binomial series $1+nx+$ &c., is convergent when $x<1$, divergent when $x>1$.

Ex. 3. To find when the binomial series $1-n+\frac{n(n-1)}{1.2}-$ &c., is convergent.

Let $n<1$; the $(r+1)$ term may be written

$$\frac{n}{r}\cdot\frac{r-n-1}{r-1}\cdot\frac{r-n-2}{r-2}\ldots$$
$$=\frac{n}{r}\left(1-\frac{n}{r-1}\right)\left(1-\frac{n}{r-2}\right)\ldots$$
$$<\frac{n}{r}\left(1+\frac{1}{r-1}\right)^{-n}\left(1+\frac{1}{r-2}\right)^{-n}\ldots \text{ (Art. 122, Ex. 7)}$$
$$<\frac{n}{r}\left(\frac{r}{r-1}\right)^{-n}\cdot\left(\frac{r-1}{r-2}\right)^{-n}\ldots$$
$$<\frac{n}{r^{n+1}},$$

whence (Prop. 4, Ex. 1) the series is convergent. Similarly in other cases. (P. K.)

ALGECIRAS, or ALGEZIRAS, a seaport of Spain, in the province of Cadiz, 6 miles W. of Gibraltar, on the opposite side of the bay. The town is picturesquely situated, and its name, which signifies in Arabic the *island*, is derived from a small islet which forms one side of the harbour. It is supplied with water by means of a beautiful aqueduct. It has a dilapidated fortress, and also a military hospital. Though the harbour is bad, and the commerce of the town has considerably declined, there is still a good coasting trade; the exports and imports averaging about £60,000 annually. Charcoal and tanned leather are the chief articles of export. Algeciras was the *Portus Albus* of the Romans, and the first place in Spain taken by the Moors. It remained in their possession from 713 till 1344, when it was taken by Alphonso XI. of Castile after a celebrated siege of twenty months, which attracted crusaders from all parts of Europe, among whom was the English earl of Derby, grandson of Edward III. It is said that during this siege gunpowder was first used by the Moors in the wars of Europe. The Moorish city was destroyed by Alphonso, and the modern town was not erected till 1760. During the siege of Gibraltar in 1780–82, Algeciras was the station of the Spanish fleet and floating batteries. Near Algeciras, on 6th July 1801, the English admiral Saumarez attacked a Franco-Spanish fleet, and sustained a reverse; but on the 12th he again attacked the enemy, whose fleet was double his own strength, and inflicted on them a complete defeat. Population, 14,000.

ALGER OF LIÉGE, known also as ALGER OF CLUGNY and ALGERUS MAGISTER, a learned French priest who lived in the first half of the 12th century. He was first a deacon of the church of St Bartholomew at Liége, his native town, was afterwards translated to the cathedral church of St Lambert, and finally retired to the monastery of Clugny, where he died not later than 1145, though the precise date is uncertain. His *History of the Church of Liége*, and many of his other works are lost. The most important of his still extant works are:—1. *De Misericordia et Justitia*, a collection of extracts from Fathers, with reflections, which is to be found in the *Anecdota* of Martène, vol. v. 2. *De Sacramento Corporis et Sanguinis Domini*; a treatise, in three books, against the Berengarian heresy, highly commended by Peter of Clugny and Erasmus. 3. *De Libero Arbitrio*; given in Pez's *Anecdota*, vol. iv. 4. *De Sacrificio Missæ*; given in the *Collectio Scriptor. Vet.* of Angelo Mai, vol. ix.

ALGERIA, or ALGIERS (French, *L'Algérie*), the largest and most important of the French colonial possessions, is a country of Northern Africa, bounded on the N. by the Mediterranean, W. by the state of Marocco, S. by the

desert of the Sahara, and E. by Tunis. The boundaries, however, are in many parts not accurately determined. It extends for about 550 miles along the coast, and stretches inland from 320 to 380 miles; lying between 2° 10′ W. and 8° 50′ E. long., and 32° and 37° N. lat. The area is estimated at about 150,500 English square miles.

Surface. The country is generally mountainous, being traversed by lofty ranges of the Atlas system, which run nearly parallel to the coast, and rise in some places to the height of upwards of 7000 feet. These are commonly divided into two leading chains, which are distinguished as the Great and Little Atlas. The former, which is the more southern and bordering on the Sahara, contains some of the highest points in the country. The Little Atlas or Maritime Atlas, as it is sometimes called, lies between the sea and the Great Atlas, and is composed of numerous diversified ranges generally of no great elevation. A number of smaller chains lie between these principal ones, and also between the latter and the sea, forming so many ascending steps or degrees. These principal ranges are connected by numerous transverse ones, thus forming extensive table-lands and elevated valleys, with no connection between them but the intervening heights. Occasionally the principal ranges are broken by deep defiles and narrow valleys. The maritime region presents numerous narrow valleys, each carrying down to the sea its mountain stream. In some parts the mountains rise abruptly from the sea, in others a tract of flat land intervenes between the mountains and the coast, and this is usually marshy, but sometimes fertile and well cultivated. There are a number of extensive plains near the coast, one of the most important of which is that of Metidja, commencing on the eastern side of the bay of Algiers, and stretching thence inland to the south and west. It is about 60 miles in length by 10 or 12 in breadth. Another great alluvial plain extends south and west for many miles from the vicinity of Bona. A third similar plain lies to the south-east and south-west of Oran, and south of Mostaganem is the plain of Shellif. The coast is generally steep and rocky, abounding in capes and gulfs, but very deficient in good harbours, and even in secure roadsteads, in consequence of its exposure to the north winds.

Rivers. The rivers are numerous, but the majority of them have short courses. They mostly rise in the mountains near the coast, and rush down with great impetuosity through deep and rocky channels, presenting the character of mountain torrents. During the rainy season they are much swollen, so as to render communication with different parts of the country extremely difficult. The most important river, both from the length of its course and the volume of its waters, is the Shellif, which, rising in the northern slopes of the Djebel Amur, flows first north and then west till it empties itself into the Mediterranean near Mostaganem after a course of 370 miles, during which it receives numerous tributary streams. The Seybouse is formed by the union of several small streams in the interior of the province of Constantine, south-east of the town of that name, and after a course of about 120 miles falls into the Mediterranean near Bona. The Summam, which contains the greatest body of water after the Shellif, rises in the interior of the province of Algiers near Aumale, and pursues a generally north-east direction to its mouth near Bougie. The Rummel, formed of several small streams south of the town of Constantine, passes that town and pursues a north-west direction to the sea. Among the less important rivers which empty themselves into the Mediterranean are the Harrach, Isser, Mazefran, Tafna, and Macta. Besides these, there are a number of streams in the interior, but they are less known and are generally dry except in the rainy season.

Algeria abounds in extensive lakes and marshes. Of the lakes in the northern part of the country, near the coast, the principal are,—the Fezara 14 miles south-west of Bona; the two lakes Sebkha and El Melah south of Oran; the three small lakes in the immediate vicinity of Calle, and several others. In the southern parts of the country are the extensive lakes of Chott-el-Harbi or Western Chott; the Chott-el-Chergui or Eastern Chott; the Zarhez-Gherbi and the Zarhez-Chergui; the Grand Sebkha-el-Chott, and a number of others. These are mostly dried up in summer, leaving a thick stratum of salt. Many of the marshes, especially in the neighbourhood of the larger towns, have been drained by the French, and the climate has thus been rendered more salubrious. There are also a number of warm mineral springs, containing principally salts of lime which are used with success by the Arabs in several kinds of disease. Some of these are in the vicinity of Calle Bougie, Milianah, &c. Lakes.

Natural Divisions. Algeria is divided by a line running nearly east and west into two distinct zones, called by the natives the *Tell* and *Sahara*. The Tell constitutes the zone bordering upon the Mediterranean, and is the cultivated land—the land of corn. It consists of a series of fertile basins, yielding almost exclusively corn of different kinds, especially wheat and barley. Some parts of it are extremely fertile, but at the same time flat and uniform. The chains separating the basins are clothed with timber, and peopled by the Kabyles. The Sahara lies to the south of the Tell, and is the region of pastures and of fruits. Hence, while the inhabitants of the Tell are agriculturists, those of the Sahara are shepherds and gardeners. The Sahara is sometimes spoken of as a desert, at other times as the country of dates. It may properly be divided into two regions; the northern is mountainous, but at the same time more fertile, better watered, and more populous than the other, which, bordering on the Great Desert, consists chiefly of oases of greater or less extent. The villages of the Sahara are surrounded by belts of fruit trees, of which the palm is the chief, though there are also pomegranate, fig, apricot, peach, and other trees, and vines. On the mountain ranges near the coast are extensive forests of various species of oak, pine, cedar, elm, ash, maple, olive, &c. The cork tree is also very common. The trees, especially the cedars and oaks, are frequently of gigantic size. Great injury is often done to the forests by the people annually burning up the grass of their fields. In this way extensive forests are sometimes consumed. The want of roads and navigable rivers has prevented the French from deriving much benefit as yet from the forests. Besides wheat and barley, the cotton plant, sugar-cane, and tobacco are extensively cultivated.

Animals. The animal kingdom presents little calling for notice. Lions, formerly very plentiful, are now extremely rare; leopards, panthers, jackals, and hyænas are still common; and monkeys and apes are numerous. The wild boar is found in the oak forests, and the brown bear in the higher parts of the country. There are also various species of antelope. Of the feathered tribes, eagles, vultures, hawks, and owls are common; snipes, curlews, plovers, storks, and herons frequent the marshy parts; and the ostrich has its habitat in the desert. Among the reptiles are various species of serpents, tortoises, turtles, lizards, &c. Locusts are common, and sometimes do great damage to the crops. One of the severest invasions of these pests ever known occurred in 1866, when the crops were nearly all destroyed, and the loss sustained by the colonists was estimated at £800,000. The coast is rich in coral and sponges, and the obtaining of these forms a considerable branch of industry. The chief wealth of most of the Arab tribes consists in their sheep, of which they frequently possess immense flocks; camels are also common, but the horses and mules are more esteemed, and are noted for their excellence.

only by the Arabs and Moors, but also by the maritime Christian powers, particularly the Spaniards. At length Pope Paul III. induced Charles V. to undertake an expedition to suppress these depredations, and issued a bull offering remission of sins and the crown of martyrdom to all who either fell in battle or were made slaves. The emperor set sail with 120 ships and 20 galleys, having on board 30,000 chosen men. They landed in safety, and were proceeding to attack the town of Algiers when a fearful storm arose, and in one night (28th Oct. 1541) destroyed 86 ships and 15 galleys with all their crews and military stores, so that the army on shore was deprived of the means of subsistence. This was then fallen upon by the Algerines, when many were killed and a great number taken prisoners, Charles himself and the remains of his army escaping with difficulty.

Algiers continued to be governed by viceroys or pashas appointed by the Porte till the beginning of the 17th century, when the janissaries solicited and obtained the right to choose their own dey or governor from among themselves. This subsequently led to frequent altercations between the pashas and the deys, the former seeking to recover their lost power, the latter to reduce it. In 1609, the Moors being expelled from Spain, flocked in great numbers to Algiers, and, as many of them were very able sailors, they contributed to raise the power of the Algerine fleet. In 1616 it consisted of forty sail of ships, of between 200 and 400 tons, their flagship having 500 tons. The Algerine pirates now became so formidable to the European powers, that in 1617 the French sent against them a fleet of fifty sail, under Beaulieu, who defeated their fleet and took two of their vessels. In 1620 the English sent out a squadron under the command of Sir Robert Mansel on the same errand, but it returned without effecting anything. Their depredations becoming still more frequent and troublesome, the Venetians equipped a fleet of twenty-eight sail, under the command of Admiral Capello, with orders to burn, sink, or take all the Barbary corsairs he should meet. In an engagement which speedily took place he signally defeated them, and took and destroyed sixteen of their galleys. They soon, however, regained their former strength; and at length Louis XIV., provoked by the outrages committed by them on the coasts of Provence and Languedoc, ordered, in 1681, a considerable fleet to be fitted out against them, under the command of Vice-admiral Duquesne. He attacked them near the island of Scios, and destroyed fourteen of their ships. This, however, had little effect upon them, and the following year he bombarded the town of Algiers and nearly reduced it to ashes. The Algerines, by way of reprisal, sent a number of galleys to the coast of Provence, where they committed great ravages. In May 1683, Duquesne with his fleet again cast anchor before Algiers, and proceeded to bombard the town. The dey and the people sued for peace; but Mezomorto, the Algerine admiral, who was to have been delivered up as one of the hostages, violently opposed coming to terms, stirred up the soldiery against the dey, and caused him to be murdered, and was himself chosen as his successor. The bombardment was renewed, and Mezomorto, reduced to extremities, caused all the French in the city to be cruelly murdered, and the French consul to be tied to the mouth of a mortar and shot off in the direction of the bombarding fleet. Duquesne was so exasperated by this piece of cruelty that he did not leave Algiers till he had utterly destroyed the fortifications, shipping, almost all the lower, and about two-thirds of the upper part of the town. The Algerines, now thoroughly humbled, sent an embassy to France to sue for peace, which was readily granted them. In 1686 the English concluded a treaty with the Algerines on favourable terms, and this was several times subsequently renewed; but it was not till the taking of Gibraltar and Port Mahon that England had sufficient check upon them to enforce the observance of treaties. From that time England was treated with greater deference than any other European power. In 1710 the Turkish pasha was expelled and his office united to that of dey. The dey thus became the supreme ruler in the country. He had the charge of the Turkish militia, recruited from Constantinople and Smyrna, because their children by native mothers could not be allowed to enjoy the same privileges as themselves in consequence of former rebellions against the government. Under the dey there was a divan or council of state, chosen from the principal civic functionaries.

Matters continued very much in the same state, and the history of Algiers presents little calling for special notice down to the expedition of Lord Exmouth. The principal States of Europe had had their attention taken up with weightier matters; but on the establishment of the peace of 1815 the English sent a squadron of ships, under Lord Exmouth, to Algiers, to demand the liberation of all slaves then in bondage there, and the entire discontinuance of piratical depredations. Afraid to refuse, the Algerines returned a conciliatory answer, and released a number of their slaves; but no sooner had the ships left than they redoubled their activity and perpetrated every sort of cruelty against the Christians. Among other acts of cruelty, they attacked and massacred a number of Neapolitan fishermen who were engaged in the pearl-fishery at Bona. The news of this excited great indignation in England, and Lord Exmouth was again despatched with five ships of the line and eight smaller vessels, and at Gibraltar he was joined by a Dutch fleet of six frigates, under Admiral Capellen. They anchored in front of Algiers on the 26th August 1816. Certain terms, which were extremely moderate, were proposed to the dey; but these not meeting with acceptance, a fierce bombardment was at once commenced. At first the assailants were subjected to a heavy fire from the enemy's batteries; but after a time these were one by one silenced, and ship after ship caught fire, till the destruction of the Algerine naval force was complete. Next day the terms proposed to the dey were accepted; Christian slaves to the number of 1211 were set at liberty, and a promise was given that piracy and Christian slavery should cease for ever. The Algerines, however, did not long adhere to the terms of the treaty. They lost no time in putting their city in a more formidable state of defence than before, and this done, they considered themselves in a condition to set the great powers of Europe at defiance.

Various injuries had from time to time been inflicted on the French shipping, but that which more directly led to a declaration of war was an insult offered to the French consul by the dey. A debt had been contracted by the French government to two Jewish merchants of Algiers at the time of the expedition to Egypt, and the dey having a direct interest in the matter, had made repeated applications for payment, but without success. Annoyed at this and at what he considered insulting language on the part of the consul, he struck the latter on the face in public. In consequence of this, a French squadron was sent to Algiers which took the consul on board, and for three years maintained an ineffective blockade. At length war on a great scale was resolved on, and a fleet was equipped at Toulon in May 1830 under the command of Admiral Duperré. It had also on board a land force, under the command of General Bourmont, consisting of 37,000 infantry, 4000 cavalry, and a proportionate number of artillery. The troops began to land on the 14th June upon the western side of the peninsula of Sidi Ferruch, in the bay of Torre

Chica. They did not meet with much opposition till the 19th, when a general attack was made upon them by a force of from 40,000 to 50,000 men. These, after a fierce conflict, were completely routed. They renewed their attack on the 24th and 25th, but were on both occasions repulsed. The French then advanced upon Algiers, and on the 29th the trenches were opened. On the morning of the 4th of July the bombardment commenced, and before night a treaty was concluded for the entire surrender of Algiers. The next day the French took possession of the town; and 12 ships of war, 1500 brass cannon, and over £2,000,000 sterling came into their hands as conquerors. The Turkish troops were permitted to go wherever they pleased, provided they left Algiers, and most of them were conveyed to Asia Minor. The dey himself, with his private property and a large body of attendants, retired to Naples.

When the French undertook the expedition against Algiers a pledge was given to the English government that they did not aim at the permanent possession of the country, but only at obtaining satisfaction for the injuries and insults that they had received, and putting down that system of piracy which had so long outraged Europe. The French government engaged that these objects being accomplished, the final settlement and government of the country should be arranged in concert with the other European powers for the general advantage. Notwithstanding this, the French ministry in 1833 publicly declared that it was the intention of their government to retain possession of Algiers and to colonise it. Subsequently, the English government acquiesced in this, on receiving an engagement that the French would not extend their conquests beyond Algeria either on the side of Tunis or of Marocco.

The capture of Algiers was celebrated in France with great demonstrations of joy. General Bourmont was raised to the rank of marshal, and Admiral Duperré was promoted to the peerage. The revolution of 1830 followed, when Bourmont was deposed, and General Clausel appointed to succeed him. The conquerors, instead of attempting to gain the good-will of the natives, destroyed a number of their mosques, seized upon lands set apart for religious purposes, and attempted to introduce their own laws and usages in place of those of the country, the consequence of which was that the natives entertained the greatest abhorrence for their oppressors, whom they regarded as the enemies of God and their prophet. General Clausel incensed them still more by seizing upon the possessions of the dey, the beys, and the expelled Turks in direct opposition to the conditions on which the capital had been surrendered. Bona was taken possession of, and an incursion was made into the southern province of Titterie, when the troops of the bey were defeated and Mediah taken. The beys of Titterie and Oran were deposed, and tributary rulers set up in their room. Still the war continued. The French were incessantly harassed by irruptions of hordes of the Arabs, so that no Frenchman was safe, even in the vicinity of the town; and little reliance could be placed on the fidelity of the beys who governed the provinces. Mediah was evacuated, and Oran abandoned. In February 1831 General Berthezene was appointed commander-in-chief, and undertook several expeditions into the interior to chastise the hostile tribes, but met with little success. In October Bona was surrounded and taken by the Kabyles. There was now no safety but in the town of Algiers; agriculture was consequently neglected, and it was necessary to send to France for supplies of provisions and for fresh troops. In November 1831 General Savary, Duc de Rovigo, was sent out with an additional force of 16,000 men. The new governor sought to accomplish his ends by the grossest acts of cruelty and treachery. One of his exploits was the massacre of a whole Arab tribe, including old men, women, and children, during night, on account of a robbery committed by some of them. He also treacherously murdered two Arab chiefs whom he had enticed into his power by a written assurance of safety. These proceedings exasperated the natives still further against the French, and those tribes that had hitherto remained quiet took up arms against them.

About this time Abd-el-Kader first appears upon the field. His father, a Marabout, had collected a few followers, and attacked and taken possession of the town of Oran. On this they wished to elect him as their chief, but he declined the honour on account of his great age; and recommended his son who, he said, was endowed with all the qualities necessary to success. Abd-el-Kader was born about the beginning of 1807, and had early acquired a great reputation among his countrymen for learning and piety, as he was also distinguished among them for skill in horsemanship and other manly exercises. He had made two pilgrimages to Mecca in company with his father, once when a child and again in 1828, by which he obtained the title of *Hadji*. At this time he was living in obscurity, distinguished by the austerity of his manners, his piety, and his zeal in observing the precepts of the Koran. He collected an army of 10,000 horsemen, and, accompanied by his father, marched to attack Oran, which had been taken possession of by the French. They arrived before the town about the middle of May 1832, but after continuing their attack for three days with great bravery they were repulsed with considerable loss. This was followed by a series of conflicts, more or less severe, between the parties, but without any permanent or decided advantage to either side. In March 1833 the Duc de Rovigo was obliged, on account of his health, to return to France, and General Avizard was appointed interim governor; but the latter dying soon after, General Voirol was nominated his successor. Abd-el-Kader was still extending his influence more and more widely among the Arab tribes; and the French at last considered it to be their interest to offer him terms of peace. A treaty was accordingly concluded with him by General Desmichels, governor of Oran, in February 1834, in which he acknowledged the supremacy of France, and was recognised by them as emir of the province of Mascara. One of the conditions of the treaty was that the emir was to have a monopoly of the trade with the French in corn. This part of the treaty was regarded with great dissatisfaction at home, and the general was removed from his post. In July General Drouet d'Erlon was sent out as governor-general of the colony. An intendant or head of the civil department was also appointed, as well as a commissary of justice at the head of the judicature. Tribunals of justice were also established, by which both French and natives were allowed to enjoy their respective laws. From the tranquil state of the country at this time the new governor was enabled to devote his attention to its improvement. The French, however, soon became jealous of the power of the emir, and on the pretence that he had been encroaching on their territory, General Trezel, who had succeeded Desmichels in the governorship of Oran, was sent against him with a considerable force. The armies met at the river Makta, and the French were routed with great slaughter on the 28th of June 1835. On the news of this defeat Marshal Clausel was sent to Algiers to succeed Count d'Erlon. In order effectually to humble the emir, he set out for his capital, Mascara, accompanied by the Duke of Orleans, at the head of 11,000 men. On reaching the town the French found it deserted, and, having set it on fire, they returned without having effected anything of consequence. In January 1836 Marshal Clausel undertook an expedition against Tlemcen, which he took and garrisoned. Soon

after this the emir attacked and put to flight a body of 3000 men under Count d'Arlanges on the Tafna. General Bugeaud, who had succeeded Marshal Clausel, attacked the Arabs under Abd-el-Kader on the Sikak river, 6th July 1836, and gained a complete victory over them. An expedition against the bey of Constantine was next resolved on, and Marshal Clausel, at the head of 8000 men, set out from Bona for this purpose in November 1836. They encountered on their march a severe storm of hail and snow, followed by a sharp frost, so that many of them died; and when they arrived before the walls of the town they were unable to undertake the siege, and effected their retreat with difficulty. The French were now anxious to conclude a peace with Abd-el-Kader, and with this view General Bugeaud arranged a meeting with him on the banks of the Tafna, and a treaty was signed, 30th May 1837. They were then free to turn their strength against the bey of Constantine, and an army of 20,000 men set out from Bona with this object under the command of General Damrémont early in October. The town was, after a very gallant defence, taken by storm on the 12th of that month by General Valée, General Damrémont having been killed by a cannon-ball the previous day. On the capture of the city the neighbouring tribes hastened to make their submission to the conquerors, and a strong garrison being left to defend the town, the army returned to Bona. As a reward for his services, General Valée was made a marshal and appointed governor-general of the colony. Disputes with the emir as to the boundaries of his territory were frequent, and at length war was again declared between the parties. The immediate cause of war on this occasion was the marching of an armed force of French troops through the emir's territory. This the latter looked upon as an infringement of the treaty, and consequently declared war. In October 1839, he suddenly fell upon the French troops in the plain of Metidja, and routed them with great slaughter, destroying and laying waste the European settlements. He surprised and cut to pieces bodies of troops on their march; outposts and encampments were taken by sudden assault; and at length the possessions of the French were reduced to the fortified places which they occupied. On the news of these events reaching France, reinforcements to the amount of 20,000 men were sent out. The spring campaign was vigorously opened on both sides, and numerous skirmishes took place, but without decisive results to either party. The French were, indeed, everywhere successful in the field, but the scattered troops of the enemy would speedily reassemble and sweep the plains, so that there was no safety beyond the camp and the walls of the towns. The fort of Masagran, near Mostaganem, with a garrison of only 123 men, gallantly withstood a fierce attack by 12,000 to 15,000 Arabs, which lasted for three days. Marshal Valée was now recalled, and General Bugeaud appointed to succeed him. The latter arrived at Algiers on the 22d of February 1841, and adopted a new system, which was completely successful. He made use of movable columns radiating from Algiers, Oran, and Constantine, and having from 80,000 to 100,000 troops at his disposal, the result soon told against the emir. Many of the Arab tribes were thus intimidated or brought under subjection, hard pressed garrisons were relieved and victualled, and town after town taken. Tekedemt, the principal stronghold of Abd-el-Kader, was destroyed, and the citadel blown up; Mascara was taken; and Saida, the only remaining fortress in the possession of the emir, was entirely demolished. In January 1842 the town of Tlemcen was taken, and ten days afterwards the fort of Tafna, which was demolished. The terrified Arabs submitted on all sides, and now almost the entire country was subdued. The emir himself, driven to extremities, was compelled to take refuge in Marocco. Here he succeeded in raising a considerable force, and returned to Algeria. He made up for the want of troops by the rapidity of his movements, and would suddenly make an attack on one place when he was supposed to be in quite an opposite quarter. In November 1842 the Duke of Aumale arrived in Algiers to take part in the operations against the emir; and in the spring of the following year he suddenly fell upon the camp of Abd-el-Kader while the great body of his troops were absent, and took several thousand prisoners and a large booty, the emir himself making his escape with difficulty. Not long afterwards the latter again took refuge in Marocco, and so excited the fanatical passions of the people of that country that their ruler was forced into a war with France. The army which was sent into Algeria was attacked and defeated by Bugeaud at the river Isly, 14th August 1844. The emperor of Marocco soon afterwards sued for peace, which was granted him on condition that he should no longer succour or shelter the emir, but aid in pursuing him. Abd-el-Kader was now reduced to great extremities, and obliged to take refuge in the mountain fastnesses, whence he would from time to time come down to annoy the French. In June 1845 a tribe of Arabs, who were being pursued by a body of French troops under General Pelissier, took refuge in a cave. As they refused to surrender, the general ordered a fire to be kindled at the mouth of the cave, and the whole of those within, men, women, and children, to the number of 500, were suffocated. The emir at length was brought to such straits that he agreed to deliver himself up to the French on being allowed to retire to Alexandria or St Jean d'Acre. Notwithstanding this promise, which was given by General Lamoricière, and ratified by the governor-general, he was taken to France, where he arrived on the 29th of January 1848; and was imprisoned first in the castle of Pau, and afterwards in that of Amboise, near Blois. In October 1852 Louis Napoleon, then president of the French Republic, gave him his liberty on condition that he should not return to Algeria, but reside at Brousso in Asia Minor. Here he remained till 1855 when, in consequence of the destruction of that town by an earthquake, he obtained permission to remove to Constantinople, and afterwards to Damascus. At the latter place he rendered valuable aid to the Christians by protecting them during the massacre by the Turks in Syria in 1860.

On the revolution in France of 1848, General Cavaignac was appointed governor-general of the colony; and the National Assembly, wishing to establish a closer connection between the country and France, offered to incorporate it with the republic. This proposal, however, met with considerable opposition, and Algeria was simply declared a permanent possession, with the right to send four deputies to the National Assembly, to be heard on all matters affecting the interests of the colony. Colonists were also sent out to settle there, and other means taken to further its prosperity. Still the republic did not seem to be more successful in the administration of affairs than the monarchy had been. The colonists died off or left in disgust, the natives were not more reconciled to the French yoke, and many of them rose in open rebellion. The Kabyles, in particular, the most intelligent and industrious of the native population, manifested the greatest repugnance to the imposition of taxes and of the usages of civilisation. In 1849 General Pelissier marched against several of the rebellious tribes, and reduced them to subjection. Generals Canrobert and Herbillon were sent into the district of Zaab to quell an insurrection excited by the Marabout Bon-Zian. The latter was driven to take refuge in Zaatcha, which resisted the utmost efforts of the French to take it for fifty-one days, but at last it was carried by storm. In 1850 there

were several expeditions sent out against the natives, and in 1851 General St Arnaud succeeded in reducing to subjection Little Kabylia. In 1852 General M'Mahon set out against Eastern Kabylia, and Pelissier, in the south, took Laghouat by storm. The next few years present us with several expeditions against the Kabyles, but these were not productive of very marked results. In 1854 there was an expedition against certain Arab tribes in the south, who were reduced to subjection. In 1856 a great expedition, under the command of General Randon, was organised against the tribes of Great Kabylia that had not yet submitted to the French; and after many months' fighting they were brought under subjection. The authority of France was now undisputed over the country, and peace for a time was established.

In 1858 the administration of the colony was confided to a special minister, the first nominated being Prince Napoleon; but he only held office for a short time; and soon after, the special ministry was abolished. In October 1859 certain Arab tribes rose in rebellion, but were speedily subdued. In 1860 Marshal Pelissier was made governor-general, with a vice-governor, a director-general of civil affairs, and a council of thirty members. In the beginning of 1863 the emperor promised to Algeria a constitution, with a representative assembly for provincial matters; and said that it was not a colony properly so called, but an Arab kingdom, and that the natives had an equal right to his protection with the colonists. In April 1864 a formidable insurrection of the Arabs broke out in the south, in consequence of an insult offered to one of their chiefs in a court of justice, and they suddenly fell upon and cut to pieces a detachment of French troops. A large force was speedily assembled and sent against them, and after they had been beaten in several encounters the insurrection was at length put down. Marshal Pelissier died in May, and Marshal M'Mahon was appointed to succeed him. A fresh insurrection of the Arabs broke out in October, but after several defeats they were brought to subjection. In May 1865 the Emperor Napoleon visited Algeria, and was everywhere received with the greatest demonstrations of joy. After his return to France he wrote a letter to Marshal M'Mahon respecting the future government of the colony. He particularly pointed out the necessity of seeking to gain the good-will of the natives by permitting them to enjoy their territories unmolested, and to maintain their own customs, and that they should be held as equal with the colonists before the law. He further directed him to seek to stimulate the industry of the colonists, and to strive to develop the resources of the country. In October a fresh insurrection broke out in the province of Oran. It commenced with an attack upon a friendly tribe, but was at length put down by a body of troops under the command of Colonel de Colomb. It again broke out in March 1866, and Colonel de Colomb was a second time sent out against the insurgents. He encountered them on the 16th, and, after a fierce engagement, put them to flight with great loss. In the beginning of 1867 a new expedition was organised against the refractory Arabs in the south, and these being effectually put down, a period of comparative peace followed. The crops in 1866 were almost entirely destroyed by an invasion of locusts, and in January 1867 a violent earthquake destroyed several villages in the vicinity of Blidah. A prolonged drought followed, which dried up the sources of the springs and produced a famine, from which the natives suffered much. A visitation of cholera succeeded, which is estimated to have carried off not less than 50,000 persons. In January 1868 a fresh revolt broke out among the Arabs, instigated by Si-Hamed, who had led on more than one of the previous revolts. They assailed and plundered some of the friendly tribes, and being pursued and attacked by a body of French troops, a fierce engagement took place, in which Si-Hamed was killed and his followers put to flight. Peace was enjoyed for the rest of that year; but towards the end of January 1869 several large bands of insurgent Arabs in the extreme south marched northward, took by surprise Tagguin, and being joined by others, in a short time they numbered 3000 horse. A body of French troops was sent out against them from Laghouat, under the command of Colonel Sonis, and after two and a half hours' hard fighting the insurgents were put to flight with great slaughter. In 1871 a widespread insurrection of Arab and Kabyle tribes broke out, stimulated no doubt by a knowledge of the weakened condition of France at home. It commenced with El-Mokrani, the hereditary bach-agha of the Medjana, attacking and burning the village of Brody-Bon-Arreredy, destroying isolated houses and posts throughout the district subject to his influence, the colonists who did not succeed in reaching a place of safety being massacred. All his attacks against the fortified places, however, failed; and as soon as the French were able to assume the offensive he was beaten in every engagement, and subsequently killed in action. When this rebellion appeared almost overcome, the whole of Kabylia rose in arms at the command of the sheikh El-Haddad, one of the most powerful chiefs in Kabylia, and head of an influential religious confraternity. The Kabyles, for the first time in history, descended from their mountain fastnesses, and attempted to invade the plains of the Metidja. The most horrible massacres were perpetrated, and all the principal ports on the coast were strictly blockaded on the landward side. It was not till after the fall of the commune in Paris that troops could be spared in sufficient numbers to suppress the insurrection. But this was at length effected, and a war contribution of £1,200,000 imposed upon the rebels, whose lands were also sequestrated, but the owners were permitted to resume possession on comparatively easy terms. The greater part of the sum recovered was distributed among the colonists who had suffered during the insurrection, and a considerable portion of it has been allotted for public works. The sequestration has also opened up much valuable territory for European colonisation. Since the insurrection many new colonists have arrived here, and among them many from Alsace and Lorraine. A law passed by the French Chamber, 15th September 1871, authorises, on certain conditions, the gratuitous concession of 247,000 acres of land to such natives of Alsace and Lorraine as might desire to preserve their French nationality. A more favourable era, it is believed, has now dawned for the colony. Down to 1871 it had continued under military rule, and this, it was thought, had had not a little to do with the frequent insurrections that had broken out in the country. Accordingly, in October of that year, a civil government was established, as has been already noticed, and since that time the colony has continued in a more peaceable and flourishing condition. (D. K.)

ALGHERO, a seaport of Italy, in the province of Sassari, Sardinia, situated on the west coast of the island, 14 miles S.W. of Sassari. It was founded by the Genoese, and was afterwards taken by the Catalonians, whose language is still spoken. Though strongly fortified towards the sea, the landward side of the town is commanded by the overhanging hills. Alghero is an episcopal see, and has a cathedral, erected in 1517, several monasteries, convents, and public schools. Many of the houses are of antique architecture. Near the town are some fine stalactite grottoes. The neighbourhood produces oil and fruit, and the best wine of the island; and the corals of Alghero are the most beautiful found in the Mediterranean.

The other exports include grain, wool, tobacco, bones, skins, and anchovies. Porte Conte, 9 miles to the N.W., is the roadstead frequented by the largest vessels, and is a secure and fortified anchorage, capable of accommodating a large fleet. Population of commune (1865), 8419.

ALGIERS (Fr. *Alger*, Arab. *Al-Jezair*, *i.e.*, The Islands), a city and seaport of Northern Africa, and capital of Algeria, is situated on the west side of a bay of the same name in the Mediterranean. Lat. (of lighthouse), 36° 47′ 20″ N., long. 3° 4′ 32″ E. It is built, in the form of an amphitheatre, on the northern slope of a steep hill rising abruptly from the coast. It ascends the side of the hill in the form of an irregular triangle, the apex of which is occupied by the Casbah, or ancient fortress of the deys, which is about 500 feet above the level of the sea. As seen from a distance, the city presents a very imposing and picturesque appearance; and the houses rising one above the other, and being all built of white stone, it has been compared to a ship under sail. It consists of two towns—the new, which is entirely European in its character, and is built on the lower part of the slope and along the shore; and the old town, which occupies the higher region, and is entirely Oriental in its character. The new town consists of handsome streets and squares, and contains the government houses, hotels, warehouses, barracks, &c. In the centre of the new town is the *Place du Gouvernement*, a large and handsome square in the European style, with a fountain, and planted with orange and lime trees. The streets are regular, spacious, and handsome, and adorned with arcades. In the Arab or old town the streets are narrow, winding, and dirty. The houses are square substantial-looking buildings, presenting to the street bare walls, with only a few slits protected by iron gratings in place of windows. Each house has a quadrangle in the centre, into which it looks, and which is entered by a low narrow doorway. Algiers is surrounded by walls and otherwise fortified, but its landward defences are weak and exposed, while the batteries which defend it towards the sea are very strong. It has two handsome suburbs, and numerous elegant villas are scattered over the vicinity. The town is the residence of the governor-general of Algeria, of the prefect of the department of Algiers, and of the chiefs of the different administrative services. It is also the seat of a bishop and of the supreme courts of justice, and has a chamber and tribunal of commerce, a royal college, various schools, a bank, public library, and museum. Among the principal buildings are a cathedral and several Roman Catholic churches, a Protestant church, several synagogues, and a number of mosques. The town is well supplied with water, and there are numerous public and private fountains and baths. Various markets are held here, and horse-racing is a favourite amusement. Algiers has of late come to be noted as a winter residence for invalids. The French have spent large sums of money in the improvement of the port of Algiers. It has an area of 220 acres, and it is calculated that when a rock near the centre, called *Roche Sans Nom*, is removed, it will be capable of accommodating 40 vessels of war and 300 trading vessels. It has two docks, capable of containing the largest vessels. The lighthouse has a revolving light visible at the distance of 15 miles. Population (1866), 52,614. (For the trade and climate of Algiers, see ALGERIA.)

ALGOA BAY, an inlet in Cape Colony, on the S.E. coast of Africa, 425 miles east from the Cape of Good Hope. Lat. of Croix Island, in the bay, 30° 47′ N., and long. 25° 46′. Algoa Bay lies between capes Recife and Padrone, on the former of which there is a lighthouse. It receives the rivers Sunday and Baasher. The best anchorage is on the west side of the inlet, near Port Elizabeth, which is the most important seaport on the south coast of Africa. Here the holding ground is good, and the anchorage is sheltered, except from the south-east winds. Fort Frederick stands on a hill overlooking Port Elizabeth. Algoa Bay was the first landing-place of the British emigrants to the eastern province of the Cape Colony, and as the harbour of that province it enjoys a rapidly increasing trade.

ALHAMA, a city of Spain, in the province of Granada, 24 miles S.W. of Granada. It is very picturesquely situated on the edge of a gorge in the hills of the Sierra de Alhama, the streets rising in terraces one above another. The river Marchan flows through the chasm, and the mountains behind the town reach a height of 8000 feet. The name Alhama signifies in Arabic "the bath," and is derived from the hot mineral springs in the neighbourhood. These springs, which have a temperature of 118° Fahr., are considered beneficial in cases of dyspepsia and rheumatism, and in former times had as many as 14,000 visitors annually. Alhama was a most important fortress while the Moors ruled in Granada, and its capture by the Marquis of Cadiz in 1482 was the most decisive step in the reduction of their power. Remains of the Moorish castle and walls are still to be seen, as well as an aqueduct of Roman or Moorish origin. Many of the houses are of Moorish architecture, and the antiquities of the town, the mineral springs, and the wild scenery of the environs attract numerous visitors. Population, about 7000.

ALHAMA, a town in Spain, in the province of Murcia, 13 miles S.W. of the town of that name. It is celebrated for its sulphur springs, which have a temperature ranging from 91° to 113° Fahr., and attract numerous visitors. The town has a hospital and the ruins of an ancient castle. Population, about 6500.

ALHAMBRA, the ancient fortress and residence of the Moorish monarchs of Granada, lies on a hill overlooking the city of Granada, on the north. The name, signifying in Arabic "the red," is derived from the colour of the sun-dried *tapia*, or bricks made of fine gravel and clay, of which the outer walls are built. This famous Moorish palace was erected at various dates, chiefly between 1248 and 1354, under the reigns of Ibn-l-Ahmar and his successors. The splendid decorations, and in particular the exquisite painting of the interior, are ascribed to Yusuf I., who died in 1354. Immediately after the expulsion of the Moors in 1492, their conquerors began, by innumerable acts of vandalism, to spoil the marvellous beauty of the Alhambra. The open work was filled up with whitewash, the painting and gilding effaced, the furniture soiled, torn, or removed. Charles V. rebuilt portions in the modern style of the period, and destroyed the greater part of the Winter Palace to make room for a modern structure which has never been completed. Philip V. Italianised the rooms, and completed the degradation by running up partitions which blocked up whole apartments, gems of taste and patient ingenuity. In subsequent centuries the carelessness of the Spanish authorities permitted this pearl of Moorish art to be still further defaced; and in 1812 some of the towers were blown up by the French under Sebastiani, while the whole buildings narrowly escaped the same fate. In 1821 the ancient pile was shattered by an earthquake. Directions were given in 1862, by Isabella, then queen of Spain, for the restoration of the Alhambra to its original condition. The work has been carried on with considerable skill, but the sums devoted to it have been too small for its satisfactory accomplishment.

The hilly terrace on which the Alhambra stands is about 2430 feet in length by 674 in breadth at the widest part. A strongly-fortified wall, flanked by thirteen square towers, encloses an area of 35 acres, within which the palace is built. Approaching from the city, the visitor passes

through the Gate of Pomegranates and enters the grounds of the Alhambra, which are well wooded, and in spring are covered by sweet-scented wild flowers. The gardens, though weedy and ravined, are a charming resort, adorned by beautiful waterfalls and sparkling fountains, and enlivened by the song of the nightingale. Passing the pillars of Charles V., a steep ascent leads to the chief entrance to the Alhambra, the Gate of Judgment—a massive archway, surmounted by a square tower 62 feet high, which, while serving as an outwork of the fortress and as an entrance-hall to the palace, was principally used as an open-air court of justice, according to the patriarchal custom of the east. The pillars of the gate are of sculptured marble, and the horse-shoe arch is 28 feet high. A narrow passage leads to the *Plaza de los Algibes*, the Place of the Cisterns, so called from the tanks underneath filled with water from the Darro, which foams through the ravine to the north of the hill. The Plaza is about 225 feet long by 187 wide. To the left rises Alcazaba, the ruined fortress of the Alhambra, with the *Torre de la Vela* or Watch Tower, where the Christian flag was first hoisted on the expulsion of the Moors in 1492. It commands a noble prospect. Below lies the city of Granada, with its hundred churches; and above rise overhanging heights, with white houses glancing out from the green foliage, reminding one of the saying of the Arabic poet, that Granada is like a pearl set round with emerald. In the Place of the Cisterns stands an isolated Moorish tower, the *Torre del Vino*, erected in 1345; and to the right lies the palace of Charles V., displacing so much that was curious in Moorish art. It is a majestic but cold-looking structure in the Renaissance style, unfinished and roofless, and presenting a desolate and ruinous aspect. Behind this edifice lies the Moorish palace, the exterior being severe, plain, and almost forbidding in appearance, according to the peculiarity of Moorish architecture, by which they contrived to heighten the splendour of the interior by contrast with the bare and unadorned structure of the outer walls. But within, the palace stands unrivalled in the gorgeous splendour of its halls and the exquisite beauty of its decorations. Everywhere are seen evidences of the delicate taste and the artistic luxury of the Moors. Spacious courts, with marble pillars and fretted ceilings, partitions coloured and gilt like the sides of a Stamboul casket, and filagree stuccos of veil-like transparency, all distinguished by airy lightness and grace, are among the main features of this palace of the voluptuous caliphs of Granada, who held dominion over that sunny land which their poets described as a terrestrial paradise. The colours chiefly employed are blue, red, and a golden yellow. In the hey-day of Moorish prosperity the palace must have been the most delicious of royal residences. Odoriferous gardens, in which the orange and the myrtle bloomed, alternated with sparkling fountains and soft couches, inviting to a luxurious repose. Everything contributed to render the whole the most splendid abode of Oriental magnificence, to which only the fantastic creations of the *Arabian Nights* can be fitly compared.

The present entrance is by a small insignificant door, from which a corridor conducts to the *Patio de la Berkàh*, the Court of the Blessing. This court is 140 feet long by 74 broad; and in the centre there is a large pond set in the marble pavement, full of gold-fish, from which some have called this the Court of the Pond. It is also known as the Court of the Myrtles, from the myrtles which grow along its sides. There are galleries on the north and south sides; that on the south 27 feet high, and supported by a marble colonnade. Underneath it, to the right, was the principal entrance, and over it are three elegant windows with arches and miniature pillars. The columns supporting the galleries are light in structure, and arches, slender and bending gracefully like palms, spring from the capitals and meet overhead. From this court the walls of the *Torre de Comares* are seen rising over the roof to the north, and its tower and colonnades are reflected in the crystal mirror of the pond.

The Hall of Ambassadors (*Sala de Ambajadores*) is the largest in the Alhambra, and occupies all the Tower of Comares. It is a square room, the sides being 37 feet in length, while the centre of the dome is 75 feet high. This was the grand reception-room, and the throne of the sultan was placed opposite the entrance. The azulejos are nearly 4 feet high all round, and the colours vary at intervals. Over them is a series of oval medallions with inscriptions, interwoven with flowers and leaves. There are nine windows, three on each façade, and the ceiling is admirably diversified with inlaid work of white, blue, and gold, in the shape of circles, crowns, and stars—a kind of imitation of the vault of heaven. The walls are covered with varied stucco-work of most delicate pattern, surrounding many ancient escutcheons.

Another of the more celebrated courts of the palace is the *Patio de los Leones*, the Court of the Lions. This is an oblong court, 116 feet in length by 66 in breadth, surrounded by a low gallery supported on 124 white marble columns. A pavilion projects into the court at each extremity, with filigree walls and light-domed roof, elaborately ornamented. The square is paved with coloured tiles, and the colonnade with white marble; while the walls are covered 5 feet up from the ground with blue and yellow tiles, with a border above and below enamelled blue and gold. The columns supporting the roof and gallery are irregularly placed, with a view to artistic effect; and the general form of the piers, arches, and pillars is most graceful. They are adorned by varieties of foliage, &c.; about each arch there is a large square of arabesques; and over the pillars is another square of exquisite filigree work. In the centre of the court is the celebrated Fountain of Lions, a magnificent alabaster basin supported by the figures of twelve lions in white marble, not designed with sculptural accuracy, but as emblems of strength and courage. When the fountain was in good order a great volume of water was thrown up, which fell into the basin, passed through the lions, and issued from their mouths.

The Hall of the Abencerrages derives its name from a legend according to which Boabdil, the last king of Granada, having invited the chiefs of that illustrious line to a banquet, massacred them here. This room is a perfect square, with a lofty dome, and trellised windows at its base. The roof is exquisitely decorated in blue, brown, red, and gold, and the columns supporting it spring out into the arch form in a remarkably beautiful manner. Opposite to this hall is the Hall of the Two Sisters, so called from two very beautiful white marble slabs laid as part of the pavement. These slabs measure 15 feet by 7½, and are without flaw or stain. There is a fountain in the middle of this hall, and the roof is composed of stalactites, nearly 5000 pieces entering into its construction. The whole decorations here are of the most exquisite description.

Among the other wonders of the Alhambra are the Hall of Justice; the mosque; the *Mirador de Lindaraja*, or boudoir of the sultana; the *Patia de la Reja*; the *Tocador de la Reina*, or queen's boudoir; and the *Sala de los Banos*, in all which are to be seen the same delicate and beautiful architecture, the same costly and elegant decorations. There must also be noticed the celebrated vase of the Alhambra, a splendid specimen of Moorish ceramic art, dating from 1320, and belonging to the first period of Moorish porcelain. It is 4 feet 3 inches high; the ground is white, and the enamelling is in blue, white, and gold.

A new hall, called the Hall of the Shields or Escutcheons, has recently been discovered; and the palace contains, besides the more important halls already mentioned, ranges of bed-rooms and summer-rooms, a whispering gallery and labyrinth, and vaulted sepulchres.

The towers of the fortress have also much of the ornamented character of the palace. Separated from the Alhambra by a ravine lies *Generalife*, the Garden of the Architect, probably in the first instance an outwork of the fortress, afterwards the summer villa of the sultans of Granada. It is impossible to conclude the description of the Alhambra without remarking how admirably every thing was planned to render this palace the most voluptuous of all retreats—the numerous fountains which cooled the air, the judicious disposition of doors and windows securing a free ventilation, the shady gardens, and the noble views of the hills and plains around. Some idea of the beauty of the original is afforded by the Alhambra Court in the Crystal Palace at Sydenham, imitating the Moorish palace in gorgeousness of colouring, elaborateness of ornamentation, and quaint grace of architectural style.

One of the most striking features of the Alhambra is the appliance of poetical conceits and passages from the Koran to enhance and form part of the ornamentation. "There is no God but Allah," "There is no conqueror but God," "Glory be given to our Lord," and other similar inscriptions are everywhere to be observed.

(See Mr Owen Jones's *Plans, Elevations, and Sections of the Alhambra*, 2 vols. fol., 1848.)

ALHAZEN (full name, Abu Ali al-Hasan Ibn Al-hasan), a mathematician of the 11th century, was born at Bassora, and died at Cairo in 1038. He is to be distinguished from another Alhazen who translated Ptolemy's *Almagest* in the 10th century. Alhazen having boasted that he could construct a machine for regulating the inundations of the Nile, was summoned to Egypt by the caliph Hakem; but, aware of the impracticability of his scheme, and fearing the caliph's anger, he feigned madness until Hakem's death in 1021. Alhazen was, nevertheless, a diligent and successful student, being the first great discoverer in optics after the time of Ptolemy. His researches were prosecuted under the greatest disadvantages, as he was compelled to eke out a livelihood by copying his own works and selling them. To him, and not to Ptolemy, is due the explanation of the apparent increase of heavenly bodies near the horizon. He correctly attributed the phenomenon to the fact that the eye compares these bodies with intervening terrestrial objects. He taught, previous to Vitello, that vision does not result from the emission of rays from the eye, and wrote also on the refraction of light, especially on atmospheric refraction, showing, *e.g.*, the cause of morning and evening twilight. He solved the problem of finding the point in a convex mirror at which a ray coming from one given point shall be reflected to another given point. As a writer, Alhazen is remarkable for prolixity and scholastic subtilty. Only two of his works have been printed—his *Treatise on Twilight*, and his *Thesaurus Opticæ*. (See Casiri, *Bibl. Arab. Hisp. Escur.*)

ALI, the fourth in order of the caliphs or successors of Mahomet, was born at Mecca, about the year 600 A.D. His father, Abu Taleb, was an uncle of the prophet, and Ali himself was adopted by Mahomet and educated under his care. While he was still a mere boy he distinguished himself by being the first to declare his adhesion to the cause of Mahomet, who in return made him his vicegerent, and some years after gave him his daughter Fatima in marriage. Ali proved himself to be a brave and faithful soldier; and when Mahomet died without male issue, he seemed to have the best claims to become the recognised head of Islamism. Three other companions of Mahomet, however, Abubekr, Omar, and Othman, occupied this position before him, and it was not until 656, after the murder of Othman, that he assumed the title of caliph. Almost the first act of his reign was the suppression of a rebellion under Telha and Zobeir, who were instigated by Ayesha, the widow of Mahomet, a bitter enemy of Ali, and hitherto one of the chief hindrances to his advancement to the caliphate. The rebel army was defeated at Kharibah, near Bassorah, the two generals being killed, and Ayesha taken prisoner. Ali's next care was to get rid of the opposition of Moawyah, who had established himself in Syria at the head of a numerous army. A bloody battle took place in the plain of Suffein, near the Euphrates, which seemed at first to be going in favour of Ali; when suddenly a number of the enemy, fixing copies of the Koran to the points of their spears, exclaimed that "the matter ought to be settled by reference to this book, which forbids Mussulmans to shed each other's blood." On hearing this the superstitious soldiers of Ali refused to fight any longer, and demanded that the matter should be referred to arbitration. Abu Musa was appointed umpire on the part of Ali, and Amru, one of the shrewdest men in the kingdom, on the part of Moawyah. Amru persuaded Abu Musa that it would be for the advantage of Moslemism that neither candidate should reign; and also, with a pretence of deference, asked him to give his decision first. Abu Musa, falling into the snare, proclaimed that he deposed both Ali and Moawyah; thereupon Amru declared that he also deposed Ali, but that he invested Moawyah with the caliphate. This treacherous decision greatly injured the cause of Ali, which was still further weakened by the loss of Egypt, Syria, and Persia, including the sacred cities of Mecca and Medina. Ali, however, resolved to make a final effort, and collected a large army for that purpose. He was not destined to see the result of his plans. Three of the fanatic sect of the Karigites made an agreement to assassinate Ali, Moawyah, and Amru as the authors of disastrous feuds among the faithful. The only victim of this plot was Ali, who died at Kufa in 661, of the wound inflicted by a poisoned weapon. He had eight wives besides Fatima, and in all, it is said, thirty-three children, one of whom, Hassan, a son of Fatima, succeeded him in the caliphate. Ali is described as a bold, noble, and generous man, "the last and worthiest of the primitive Moslems, who imbibed his religious enthusiasm from companionship with the prophet himself, and who followed to the last the simplicity of his example." He was also remarkable for learning and wisdom, and there are still extant collections of proverbs, verses, &c., which bear his name, especially the *Sentences of Ali*, an English translation of which, by William Yule, was published at Edinburgh in 1832. The question of Ali's right to succeed to the caliphate is an article of faith which divided the Mahometan world into two great sects, the Sunnis and the Shiahs, the former denying and the latter affirming his right. The Turks, consequently, who are usually Sunnis, hold his memory in abhorrence; whereas the Persians, who are generally Shiahs, venerate him as second only to the prophet, and celebrate the anniversary of his martyrdom.

ALI BEY (1728–73), an adventurer, said to have been a native of the Caucasus, and to have been sold about the age of twelve or fourteen for a slave in Cairo. The two Jews who became his masters presented him to Ibrahim, then one of the most influential men in the kingdom. In the family of Ibrahim he received the rudiments of a literary education, and was also instructed in the military art. He gradually gained the affection of his patron to such a degree that he gave him his freedom, permitted him to marry, and promoted him to the rank of governor of a

district. Afterwards he was elected to the elevated station of one of the governors of provinces. Deprived of his protector by death, and engaging in the dangerous intrigues that pave the way to power in an unstable government, he procured his own banishment to Upper Egypt. Here he spent two years in maturing his schemes for future greatness; and in 1766, returning to Cairo, he either slew or expelled the beys, and seized the reigns of government. Emboldened by success, he rescued himself from the power of the Porte, coined money in his own name, and assumed the rank of sultan of Egypt. Occupied in more important concerns, the Porte made no vigorous opposition to his measures, and Ali seized the opportunity to recover a part of the Said, or Upper Egypt, which had been taken possession of by an Arab sheik. He next sent out a fleet from Suez, which, seizing upon Djedda, entered the port of Mecca; while a body of cavalry, commanded by Mahomet Bey, his favourite, took and plundered Mecca itself. Having formed an alliance in 1770 with the Sheik Daher, a rebel against the Porte in Syria, he aimed at the conquest of all Syria and Palestine. He first endeavoured to secure Gaza; then his army, forming a junction with that of Daher at Acre, advanced to Damascus. There, on the 6th of June 1771, a battle was fought with the Turkish pashas, and Mahomet and Daher, Ali's generals, routed them with great slaughter. The latter instantly took possession of Damascus, and the castle itself had also capitulated, when Mahomet unexpectedly hastened back to Egypt with all his Mamelukes. Some ascribe this strange conduct to an impression made upon Mahomet by the Turkish agents, and others to a report of the death of Ali Bey.

Although unsuccessful, Ali never lost sight of his favourite object; and Mahomet, losing his confidence, was forced to save his life by exile. Mahomet, however, quickly returned with an army, and drove Ali Bey from Cairo. In this unfortunate state of affairs Ali fled to Daher, and, combining their forces, they attacked the Turkish commander at Sidon, and came off victorious, although the Turkish army was three times their number. After a siege of eight months, they next took the town of Jaffa. Deceived by letters from Cairo, which were only intended to ensnare him, and stimulated by his recent victories, Ali returned to Cairo. Entering the deserts which divide Gaza from Egypt, he was furiously attacked by a thousand chosen Mamelukes led on by Murad Bey, who was enamoured of Ali's wife, and had obtained the promise of her, provided that he could take Ali captive. Ali was wounded, made prisoner, and carried to Mahomet. He died three days after, from the effects either of poison or of his wounds.

ALI PASHA, surnamed *Arslan* or "The Lion," was born at Tepelini, a village of Albania, on the Voyutza, at the foot of the Klissoura Mountains, in 1741. He belonged to the Toske tribe, and his ancestors had for some years held the title of Bey of Tepelini, this dignity having become hereditary in his family. His grandfather fell in 1716 at the siege of Corfu, which was then held by the Venetians. His father, who died when Ali was in his fourteenth year, is represented by most authorities as a man of amiable character and peaceful habits, who was despoiled of his territories by the chiefs that lived around him; but his mother was a woman of fierce and unyielding disposition. Inciting her son to recover the possessions of his father, she roused in him a spirit of cruelty and aggression, tempered, however, by a considerable amount of cunning and foresight, which bore bitter fruit in his riper years. Many romantic stories are told of Ali's adventures at the outset of his career, but the only facts that are known with certainty are, that after living in the mountains as a robber for some years, and enduring great privations, he made himself master of his beylik of Tepelini by the aid of his associates. He is said to have then murdered his brother and imprisoned his mother, who died shortly after, on a charge of attempting to poison him. In order to increase and establish his power, he then made overtures to the Turkish government, by whose orders he attacked and defeated the pasha of Scutari, then in rebellion against the sultan, and put to death Selim, pasha of Delvino. For these acts he was rewarded by being placed in possession of the whole of his father's territories, and he was appointed lieutenant to the Derwend-pacha of Rum-ili, an officer who was charged with the suppression of brigandage and highway robbery in the district. Ali, however, by permitting the robbers to go unchecked in return for a share of the spoil, brought his superior to disgrace and death, but escaped himself by sending bribes to the ministers of the sultan. For his services in the field in the war between Prussia and Turkey in 1787 he was appointed pasha of Trikala in Thessaly, and Derwend-pasha of Rum-ili. He soon cleared the country of robbers, mainly by summoning to his standard all who were willing to serve under him, and by their aid he took forcible possession of Joannina in 1788. By means of the powerful body of troops at his command, and the wise measures that he introduced, he wrought considerable amelioration in the districts under his charge, and the Porte seeing this, confirmed him in the pashalik of Joannina. His whole attention was now turned to the aggrandisement of his territory and personal power. He obtained possession of the western part of Northern Greece, or Livadia as it was then called; but was baffled for many years in his attempts to occupy the country of the Suliotes in the south-west of Epirus. These brave and hardy mountaineers at last, in 1803, agreed to evacuate their country, and were treacherously massacred by Ali while on their way to the coast to embark for Corfu. When the French took Venice in 1797, Ali, by pretending admiration for the principles of the revolution, induced Napoleon to send him engineers, by whose aid he fortified Joannina; but failing to obtain from him, as he had hoped, the Venetian ports on the seaboard of Epirus, he took occasion, after the defeat of Napoleon in Egypt, to lay siege to Prevesa, which was surrendered by the French troops. Ali had now a difficult part to play, but he succeeded so well with his master the sultan, that he was confirmed in the possession of the whole of Albania northwards from Epirus to Montenegro, over which he had asserted his authority, partly by intrigue and partly by force of arms. He also held the high position of governor of Rum-ili for a brief period (1799), during which he amassed a large sum of money by his extortions. The cruel massacre of the inhabitants of Gardiki, for an alleged insult to his mother and sister about forty years previously, was perpetrated about this time. He contrived to make his peace with the French in spite of the capture of Prevesa, and in 1807 once more entered into alliance with them, with the view of obtaining Parga, which he had attempted to capture, but without success, in 1800. Napoleon, however, neglected to secure Parga for him at the peace of Tilsit, and the fortress remained in the hands of the French until it was taken in 1814 by the English, who gave it up in 1817, ostensibly to the sultan, but in reality to Ali. Ali was now at the height of his power: he was almost supreme over Albania, Epirus, part of Thessaly, and the western part of Northern Greece; while one of his sons held the pashalik of the Morea. So powerful was he that, though he was nearly eighty years of age, the Porte feared and hated him, and desired his death, but could find no good pretext for taking measures against him until

1820, when Ali procured the assassination of an officer who had left him and taken service under the sultan at Constantinople. For this daring act the sultan proscribed Ali, and ordered all the European pashas to march against him. He resisted every effort to capture him, but was at last induced by Kourschid Pasha to surrender in January 1822 on promise of a pardon from the sultan. On 5th February, on pretence of handing him the necessary document, Kourschid Pasha procured an interview with him, and then produced the firman authorising his execution. The brave old despot defended himself with his usual resolution and courage, but was overpowered by numbers, and his head was struck from his body and sent to Constantinople.

ALIAS, signifying *at another time*, is used in judicial proceedings to connect the several names of a person who attempts to conceal his true name, or to pass under a feigned one; as Smith alias Jones, James alias John.

ALIBI, in *Law*, denotes the absence of the accused from the place where he is charged with having committed a crime; or his being *elsewhere*, as the word imports, at the time specified.

ALICANTE, a province of Spain, bounded on the N. by Valencia, on the W. by Albacete and Murcia, on the S. by Murcia, and on the S.E. and E. by the Mediterranean Sea. It was formed in 1834 of districts taken from the ancient provinces of Valencia and Murcia, the former contributing by far the larger portion. Its length is about 73 miles, its breadth 68 miles, and the area 2090 square miles. The surface of the province is extremely diversified. In the north and west there are extensive mountain ranges of calcareous formation, intersected by deep ravines; while farther south the land is more level, and there are many fertile valleys. On the Mediterranean coast, salt marshes, exhaling an insalubrious miasma, alternate with rich plains and pleasant and productive huertas or gardens, such as those of Alicante and Denia. There is no considerable river in the province, but a few rivulets flow east through the valleys into the Mediterranean. The sky is clear, the climate temperate, and the rainfall very slight. Notwithstanding the want of rivers and of rain, agriculture is in a very flourishing condition. The inhabitants possess a spirit of steady industry uncommon in Spain, and by means of wells and canals they have to a large extent succeeded in overcoming the disadvantages of nature. Many tracts originally rocky and sterile have been levelled, and now present terraces covered with the vine and with useful trees. Cereals are grown, but the inhabitants prefer to raise such articles of produce as are in demand for export, and consequently part of the grain supply of the province has to be imported. Esparto grass, rice, the sugar-cane, and tropical fruits and vegetables are largely produced. Great attention is given to the rearing of bees and silk-worms; and the wine of the province is held in high repute throughout Spain, while some inferior kinds are sent to France to be mixed with claret. Cattle are not extensively reared. The most important minerals of the province are lead, copper, iron, and coal. There are about twenty lead and copper mines; and mineral springs are found at various places. The manufactures consist of fine cloths, silk, cotton, woollen and linen fabrics, girdles and lace, paper, hats, leather, earthenware, and soap. There are numerous oil-mills and brandy distilleries. Many of the inhabitants are engaged in the carrying trade, while the fisheries on the coast are also actively prosecuted, tunny and anchovies being caught in great numbers. Barilla is obtained from the sea-weed on the shores, and some of the saline marshes yield large supplies of salt by spontaneous evaporation. The province is divided into 16 judicial divisions and 206 parishes. Alicante is the chief town, and the other places of importance are Denia and Villajoyosa on the coast; and Orihuela, Elche, Villena, and Alcoy in the interior. Education is in a low state; of the criminals arrested it is found that 14 in 15 can neither read nor write. The people are of a lively and irascible temperament, and offences against the person are frequent. Population (1870), estimated at 440,000.

Alicante, the capital of the above province, and, after Cadiz and Barcelona, the most considerable seaport of Spain. It is situated at the head of the bay of Alicante, in the Mediterranean Sea, in 38° 20′ N. lat., and 0° 30′ W. long. The city is built on the bay in the form of a half-moon, and is overlooked by a rock 400 feet high, surmounted by a castle, which has been suffered to fall into decay. There is good anchoring-ground in the bay, but only the smaller vessels can come up to the mole or pier. The bay is protected by batteries, and there is a fixed light on the mole, 95 feet high, and visible for a distance of 15 miles. Alicante was the *Lucentum* of the Romans; but notwithstanding its antiquity, the town presents a modern appearance, and has few remains of Roman, mediæval, or Moorish times. It is the seat of a bishop, and has a cathedral and episcopal palace. It has also a good town-house, an orphanage, a lyceum, a public library, and a school of navigation. Cotton, linen, and woollen goods, cigars, and confections are manufactured. There is a considerable trade in the fruit and other produce of the surrounding plain; and the *vino tinto*, or dark red wine, produced in the vicinity, is sent to France for mixing purposes. At the island of Plana, on the coast, very beautiful marble is procured. The foreign trade of the port, though still considerable, has greatly declined on account of the imposition of an excessive import tariff. In 1871, besides coasting traders, 372 Spanish and foreign vessels, with a tonnage of 62,546, entered the port. Of these vessels, 78 were British, measuring 29,021 tons. The value of the imports under foreign and native flags was £542,526, and the duties paid were £90,421, without reckoning duties corresponding to material and fuel for railways, which are admitted free. The chief imports are coals, iron, machinery, and guano; and the chief exports esparto—of which 11,000 tons were shipped in 1871—raisins, almonds, oranges, olive oil, silk, saffron, wine, lead, salt, and soda. There are here English and other European consuls. Alicante was besieged by the Moors in 1331, and again by the French in 1709, when the English commandant and his staff were killed by the explosion of a mine. Population, 31,500.

ALICATA, or Licata, a seaport of Italy, in the province of Girgenti, Sicily, situated on the south coast, at the mouth of the Salso, the largest river in the island. It is supposed to occupy the site of the ancient *Phintias*, built by Phintias, tyrant of Agrigentum, in 280 B.C., after the destruction of Gela. The neighbourhood was the scene of many of the most memorable events of the Punic wars. On the hill overlooking the modern town there are extensive ancient remains. Alicata is now the most important commercial town on the south coast of Sicily, though the port is only an open shallow roadstead. The larger vessels lie a mile off shore, and are laden and discharged by means of barges. The chief trade is in sulphur, and the other exports include corn, fruit, macaroni, soda, and excellent wine. Population, 16,000.

ALICUDI, one of the Lipari Islands. See Lipari Islands.

ALIEN, obviously derived from the Latin *alienus*, is the technical term applied by British constitutional law to any one who does not enjoy the privileges of a British subject. The jealousy which has generally existed against communicating the privileges of citizenship to foreigners

has its foundation in mistaken views of political economy. It arose from the impression that the produce of the energy and enterprise of any community is a limited quantity, of which each man's share will be the less the more competitors there are; superseding the just view that the wealth of a state depends on the number and energy of the producers. Thus the skilled workmen who would increase its riches have often been jealously kept out of a country. But, on the other hand, special temptations, including the gift of citizenship, have often been offered to skilled foreigners by states desiring to acquire them as citizens. Britain has occasionally received industrious and valuable citizens, driven forth by the folly or tyranny of other powers, as in the memorable instance of the revocation of the edict of Nantes, which sent the Spitalfields colony and many other Frenchmen to this country. Looking on the full benefit of British citizenship as a transcendent boon, the principle of our older legislation on the subject has been to allow friendly aliens to possess at least a portion of it. There never existed in Britain a law so harsh as the *Droit d'Aubaine* of France, which confiscated to the crown all the property of a deceased alien. The courts of justice have ever been opened to them, and they have thus been entitled to protect themselves from any inequalities which do not apply to them by special law. It seems to be a rule of the general public law that an alien can be sent out of the realm by exercise of the crown's prerogative; but in modern practice, whenever it has seemed necessary to extrude foreigners, a special Act of Parliament has been obtained for the purpose. (See Phillimore's *Internat. Law*, vol. i., p. 133; Forsyth's *Cases and Opinions on Const. Law*, p. 181.)

Our law, save with the special exceptions mentioned afterwards, admits to the privileges of subjects all who are born within the British dominions. In the celebrated question of the *post-nati* in the reign of James I. of England, it was found, after solemn trial, that natives of Scotland born before the union of the crowns were aliens in England, but that those born subsequently enjoyed the privileges of English subjects. A child born abroad, whose father or whose grandfather on the father's side was a British subject, may claim the same privilege, unless at the time of his birth his father was a traitor or felon, or engaged in war against the British empire (4th Geo. II. c. 22). Owing to this exceptional provision, some sons of Jacobite refugees, born abroad, who joined in the rebellion of 1745, were admitted to the privilege of prisoners of war, because, as the conduct of their fathers deprived them of the privileges of citizenship, they were held not to be liable to its burdens.

It has been enacted with regard to the national status of women and children that a married woman is held to be a citizen of the state of which her husband is for the time being a subject; that a natural-born British woman, having become an alien by marriage, and thereafter being a widow, may be rehabilitated by certificate of the Secretary of State; that where a father or a widow becomes an alien, the children in infancy becoming resident in the country where the parent is naturalised, and being naturalised by the local law, are held to be subjects of that country; that those of a father or of a widow readmitted to British nationality become British subjects also; and that the children of a father or of a widow who obtains a certificate of naturalisation, becoming resident with such parent in the United Kingdom, become naturalised (33 and 34 Vict. c. 14, s. 10). The same statute provides that a declaration of alienage before a justice of peace or other competent judge, having the effect of divesting the declarant of the character of a British subject, may be made by a naturalised British subject desiring to resume the nationality of the country to which he originally belonged, if there be a convention to that effect with that country; by natural-born subjects who were also born subjects of another state according to its law; or by persons born abroad having British fathers.

The main characteristic disabilities to which aliens have been subjected are incompetency to exercise political privileges, such as that of electing or being elected to sit in Parliament, and incapacity to hold landed property. The privilege of sitting on a jury was also counted among the political rights from which they are excluded; but when a foreigner is on trial, he had in England the privilege of the jury *de medietate linguæ*, in which half the panel consisted of foreigners, a privilege which was taken away in 1870, and never existed in Scotland. An alien enemy can neither by himself nor assignee sue for the recovery of a debt due to him in this country, unless by the Queen's special licence. But his right to do so revives when the war is terminated. (See Mr Justice Story's judgment in *Society for Propagation of the Gospel* v. *Wheeler*, 2 Gallison's Reports, 127, and Phillimore's *International Law*, iii. 121).

Many of the special disabilities to which aliens were subject under the Navigation Act and other laws connected with our old restrictive commercial policy, have been removed or neutralised by the free trade measures of later years; but it is still impossible for an alien to be the owner of a British ship. In other respects the tendency has been to communicate some of the rights of citizenship to aliens, and to widen the definition of subjects.

Most of the acts of Parliament passed with regard to aliens during the last and the present centuries have been repealed by 33 & 34 Vict. c. 14—the Naturalisation Act, 1870. It enables aliens to take, acquire, hold, and dispose of real and personal property of every description (except British ships), and to transmit a title to land, in all respects as natural-born British subjects. But the act expressly declares that this relaxation of the law does not qualify aliens for any office or any municipal, parliamentary, or other franchise, or confer any right of a British subject other than those above expressed in regard to property, nor does it affect interests vested in possession or expectancy under dispositions made before the act, or by devolution of law on the death of any one dying before the act.

The Act 6 & 7 Will. IV. c. 11 has not been repealed by the Act of 1870. It requires masters of vessels to intimate the arrival of all aliens, who are thereby bound to have their names registered and to obtain certificates of registration. It is believed that these conditions have seldom been complied with or enforced.

It may be remarked that the repealed Act of 1864 (7 & 8 Vict. c. 66) was the first considerable relaxation of the alien law. It communicated to the children born abroad of a British mother the privilege of acquiring land by purchase or succession. It gave friendly aliens the privilege of holding leases for any time not exceeding twenty-one years. Before this act the rights of citizenship could only be conferred on aliens by statute; and it was enacted at the commencement of the Hanover succession, that no private naturalisation bill should be brought in unless it contained a clause disqualifying the person it applied to from being a privy councillor or a member of Parliament, and from holding any office, civil or military, and from being a freeholder; but this restriction is repealed by the act of 1844. Limited privileges could formerly be given by the sovereign's letters of denization; but by the act of 1844 an alien intending to reside and settle in Britain was enabled, by application to the Home Secretary, to obtain a certificate giving him all the rights of a natural-born subject, with certain exceptions. Naturalisation,

which is accompanied by political and other rights, privileges, and obligations, may now, under the act of 1870, be obtained by applying to the Home Secretary and producing evidence of having resided for not less than five years in the United Kingdom, or of having been in the service of the crown for not less than five years, and of intention to reside in the United Kingdom or serve under the crown. Such a certificate may be granted by the Secretary of State to one naturalised previously to the passing of the act, or to a British subject as to whose nationality a doubt exists, or to a statutory alien, *i.e.*, one who has become an alien by declaration in pursuance of the act 1870. The laws of a British colony with regard to naturalisation have effect only within the limits of that colony. Naturalisation is also effected by the operation of the law upon the acts of individuals, as a woman by marriage acquires the nationality of her husband. The naturalisation of a father carries with it that of his children in minority; and Fœlix holds that that of a widow has the same effect upon her minor children. (See Fœlix, *Traité de Droit Internat. Priv.*, l. i. t. 2, s. 2; Savigny, *Priv. Internat. Law*, translated by Guthrie, pp. 26, 31, 32; Phillimore's *Internat. Law*, vol. i.; Bar, *Das Internat. Privat und Strafrecht*, § 30; Gand, *Code des Etrangers;* Hansard *on Aliens;* Heffter, *Europ. Völkerrecht*, § 59 sqq.; Sir A. E. Cockburn *on Nationality*, Lond. 1869; Cutler *on Naturalisation*, Lond. 1871).

In the United States an alien desiring to be naturalised must declare on oath his intention to become a citizen of the United States; two years afterwards must declare on oath his intention to support the constitution of the United States and renounce allegiance to every foreign power, including that of which he was before a subject; must prove residence in the United States for five years, and in the state where his application is made for one year, as a good citizen; and must renounce any title of nobility. In France an alien desiring naturalisation must obtain permission to establish his domicile in France; three years after (in special cases one year) he is entitled to apply for naturalisation, which involves the renunciation of any existing allegiance. (See further, ALLEGIANCE and INTERNATIONAL LAW.)

ALIGARH, a district of British India, in the Meerut division, and under the jurisdiction of the Lieutenant-Governor of the North-West Provinces, lies between lat. 27° 29′ and 28° 10′ 30″ N., and between long. 77° 32′ 30″ and 78° 42′ 30″ E. It contains an area of 1954 square miles, of which upwards of two-thirds, or 884,060 acres, are under cultivation. Population in 1865 returned at 925,538 souls, and by the census of 1872 ascertained to be 1,073,108. Alígarh is bounded on the N. by the Bulandshahr district and a portion of Budáon; on the E. by Etah district; on the S. by Mathurá district; and on the W. by Gurgáon and Mathurá districts. The district is nearly a level plain, but with a slight elevation in the centre, between the two great rivers, the Ganges and Jamná. The only other important river is the Kálí Nadí, which traverses the entire length of the district from north-west to south-east.

The civil station and principal town is Koel, situated a short distance to the south of Alígarh Fort. The chief products are wheat, barley, joár, bajrá, pulses, oil-seeds, gram, and indigo. There are no manufactures. In 1870–71 the total net revenue of the district was returned at £233,709, and the expenditure at £45,488; the land revenue in the same year amounted to £196,655, or 84 per cent. of the total net revenue. Nine towns are returned as containing a population of upwards of 5000 souls, as follows:—Koel, the civil station and principal city, population within municipal limits, 55,228; Hátrás, population, 33,100; Atraulí, population within municipal limits, 15,895; Sikandrá Ráo, population within municipal limits, 11,988; Jalálí, population, 7516; Mursán, population, 6113; Tapal, population, 6031; Bíjaigarh, population, 5779; and Hardeoganj, population, 5202. There are five municipal towns in the district, the revenue raised being derived from octroi duties. The following was the municipal revenue and its incidence per head in 1871–72:—Koel (Alígarh), municipal revenue, £5467; incidence, 1s. 11¾d. per head of the municipal population. Hátrás, municipal revenue, £5221, 16s.; incidence per head, 3s. 1¾d. Sikandra Ráo, municipal income, £505, 12s.; incidence, 10d. per head. Atraulí, municipal income, £709; incidence, 10¾d. per head. Hardeoganj, municipal income, £462, 18s.; incidence, 1s. 9¼d. per head. In 1871–72, the district contained 370 schools, attended by a total of 7939 pupils, of whom 6766 were Hindus and 1173 Mahometans. For the protection of person and property, a regular police force is maintained, consisting of 1056 men of all grades, equal to one man to every 1·85 square mile of area, or one to every 1016 of the population. The Village Watch or rural police numbered 2000 in 1871, equal to one man to every ·67 square miles, or one to every 536 inhabitants.

ALÍGARH FORT, in the district of the same name, is situated on the Grand Trunk Road, in lat. 27° 56′ N., and long. 78° 8′ E. The fort consists of a regular polygon, surrounded by a very broad and deep ditch. It was captured from the Marhattás under the leadership of Perron, a French officer, by Lord Lake's army, in September 1803, since which time it has been much strengthened and improved. In the rebellion of 1857 the troops stationed at Alígarh mutinied, but abstained from murdering their officers, who, with the other residents and ladies and children, succeeded in reaching Hátrás.

ALIMENT, in the *Law of Scotland*, is the sum paid or allowance given in respect of the reciprocal obligation of parents and children, husband and wife, grandparents and grandchildren, to contribute to each other's maintenance. The term is also used in regard to a similar obligation of other parties, as of creditors to imprisoned debtors, the payments by parishes to paupers, &c. Alimentary funds, whether of the kind above mentioned, or set apart as such by the deed of a testator, are intended for the mere support of the recipient, and are not attachable by creditors.

ALIMONY is, in *English Law*, the allowance for maintenance to which a wife is entitled out of her husband's estate on a decree, obtained at the wife's instance, for judicial separation or for the dissolution of the marriage. It is settled by the judge of the Divorce Court on a consideration of all the circumstances of the case.

ALISON, REV. ARCHIBALD, an author of great reputation in his own day, was born on the 13th November 1757 at Edinburgh, of which his father was for a time lord provost. After studying at the university of Glasgow and at Balliol college, Oxford, he took orders in the Church of England, and was appointed in 1778 to the curacy of Brancepeth, near Durham. In 1780 he married Dorothea, youngest daughter of Professor Gregory of Edinburgh. The next twenty years of his life were spent in Shropshire, where he held in succession the livings of High Ercall, Roddington, and Kenley. In 1800 he removed to Edinburgh, having been appointed senior incumbent of St Paul's chapel in the Cowgate. For thirty-four years he filled this position with great acceptance, his preaching attracting so many hearers that a new and larger church was built for him. His last years were spent at Colinton, near Edinburgh, where he died on the 17th May 1839. Mr Alison published, besides a Life of Lord Woodhouselee, a volume of sermons, which passed through several editions, and a work entitled *Essays on the Nature and Principles of Taste*, which received a very laudatory criticism from Lord Jeffrey in the *Edinburgh Review* for May 1811. His theory of the beautiful, which is based on the principle of association, is incomplete and unsatisfactory, and his work is now only of historical importance. Two sons of Mr Alison attained distinction. The elder, Dr William Pulteney Alison, born in 1790, was from 1820 until within a few years of his death, in 1859, a prominent member of the medical faculty in the university

of Edinburgh. The younger son is the subject of the following notice.

ALISON, SIR ARCHIBALD, Bart., the celebrated historian, younger son of the preceding, was born at Kenley, Shropshire, on the 29th December 1792. He studied at the university of Edinburgh, distinguishing himself especially in the classes of Greek and mathematics. In 1814 he passed at the Scotch bar, but he did not at once enter on the regular practice of his profession. The close of the war had opened up the Continent, and Alison, sharing with many of his countrymen the desire to witness the scene of the stirring events of the previous twenty years, set out in the autumn of 1814 for a lengthened tour in France. It was during this period, as he tells us in a characteristic passage of the work itself, that he "conceived the first idea" of writing his History, and "inhaled that ardent spirit, that deep enthusiasm," which enabled him to accomplish his self-imposed task. A more immediate result of the tour was his first literary work of any importance, *Travels in France during the Years* 1814–15, which appeared in the latter year. On his return to Edinburgh, Mr Alison practised at the bar for some years with but very moderate success. In 1822, however, he became one of the four advocates-depute for Scotland. The extensive and varied experience gained in this office, which he held until 1830, gave him the necessary qualifications for writing his *Principles of the Criminal Law of Scotland* (1832), and *Practice of the Criminal Law of Scotland* (1833), works that are still of standard authority. It was the acknowledged merit of these treatises that chiefly induced Sir Robert Peel, during his brief administration of 1834, to confer on Mr Alison the important judicial office of sheriff of Lanarkshire, which ranks next in dignity and emolument to a judgeship in the supreme court. The office, though by no means a sinecure, afforded considerable leisure, which Mr Alison employed in not only making frequent contributions to periodical literature, but also writing the long-projected *History of Europe*, for which he had been collecting materials for more than fifteen years. The history of the period from the commencement of the French revolution till the restoration of the Bourbons in 1815 was completed in ten volumes in 1842, and met with a success almost unexampled in works of its class. Within a few years it ran through ten editions, and was translated into most of the languages of Europe, as well as into Arabic and Hindustani. At the time of the author's death it was stated that 108,000 volumes of the library edition and 439,000 volumes of the popular edition had been sold. A popularity so wide-spread must almost of necessity have had some basis of real merit on which to rest, and the good qualities of Mr Alison's work lay upon the surface. It brought together, though not always in a well-arranged form, an immense amount of information that had before been practically inaccessible to the general public. It made an attempt at least to show the organic connection in the policy and progress of the different nations of Europe; and its descriptions of what may be called external history—of battles, sieges, and state pageants—were always spirited and interesting. On the other hand, the faults of the work were so numerous and glaring as to prevent it from ever taking rank as a classic. The general style was prolix, involved, and vicious; inaccurate statements and fallacious arguments were to be found in almost every page; and the constant repetition of trite moral reflections and egotistical references seriously detracted from its dignity. A more grave defect resulted from the author's strong political partisanship, which entirely unfitted him for dealing with the problems of history in a philosophical spirit. In the position of unbending Toryism which he occupied it was impossible for him to give any explanation of so complex a fact as the French revolution that would be satisfactory to reflective minds. Accordingly, his treatment of what may be called the inner history of those forces hidden in the French revolution which have made modern Europe what it is, was meagre and incomplete in the last degree.

A continuation of the History, embracing the period from 1815 to 1852, which was completed in four volumes in 1856, did not meet with the same success as the earlier work. The course of events did not afford the same material for the exercise of the author's powers of description, and the period being so near as to be almost contemporary, there was a stronger temptation, which he seems to have found it impossible to resist, to yield to political prejudice. Three great measures of English legislation—the Act restricting the paper currency, the Reform Act of 1832, and the Act abolishing the corn laws—were the object of his special aversion; and, with little regard for consistency, he was in the habit of tracing, now to one and now to another of these measures, all the real and many imaginary evils in the state of the nation. On the currency question, in regard to which he stood from the first almost alone in opinion, he has inserted several tedious dissertations in the continuation of his History, besides publishing a separate pamphlet in 1847. On the two other great measures he clung tenaciously to his opinion long after the more intelligent of his party had admitted the necessity, if not the justice, of the concessions that had been made. The use which Mr Alison made of statistics in the continuation of his History to support his peculiar political and economic theories was little short of astounding. He will be acquitted of intentional unfairness only by those who are aware, not merely how easy it is to make figures yield any result that may be wished, but also how difficult it is to bring out the correct result, even with the most honest purpose, unless there be special aptitude and special training on the part of the investigator.

Mr Alison's successful literary career received from time to time due recognition in the form of public honours. In 1845 he was chosen rector of Marischal College, Aberdeen, and in 1851 he was raised to the same honourable position by the students of Glasgow University. In 1852 the dignity of baronet was conferred upon him by Lord Derby, and in the following year he was made a D.C.L. of Oxford. His literary activity continued till within a short time of his death, the chief works he published in addition to his History being the *Principles of Population* (1840), in answer to Malthus; a *Life of Marlborough* (1847); and the *Lives of Lord Castlereagh and Sir C. Stewart* (1861). Three volumes of his political, historical, and miscellaneous essays were reprinted in 1850. Sir Archibald died at Possil House, Glasgow, on the 23d May 1867.

ALIZARIN, the principal colouring matter of madder, may be obtained by subliming on paper an alcoholic extract of madder, or by exhausting the root with water, precipitating with sulphuric acid, dissolving the moist precipitate in a solution of chloride of alumina, and separating the impure alizarin by the addition of hydrochloric acid. The impure alizarin is dissolved in alcohol, and separated as a lake on treating with hydrate of alumina, which is now boiled with carbonate of soda to separate another colouring matter called purpurin, and is finally treated with hydrochloric acid, which dissolves the alumina and leaves the pure substance.

Alizarin in the anhydrous state forms red prisms, and in the hydrated condition crystals like mosaic gold. It dissolves sparingly in water even at the boiling point, but is soluble in alcohol or ether. Mineral acids do not decompose the colouring matter at ordinary temperatures. Caustic alkalis or alkaline carbonates dissolve alizarin.

forming deep purple solutions, from which acids precipitate in orange-coloured flakes. Alizarin has the atomic composition $C_{14}H_8O_4$, and has recently been made synthetically from the hydrocarbon $C_{14}H_{10}$ called anthracene, which occurs among the products of the destructive distillation of coal. This is the first example of the artificial formation of a natural colouring matter. For further details see CHEMISTRY.

ALKALI, a term originally applied to the ashes of plants, now employed in inorganic chemistry as a generic name given to the group of compounds that have the property of neutralising acids. The use of the term is, however, generally confined to such members of the group as are soluble in water. The most soluble alkaline bodies are the oxides of potassium (potash), sodium (soda), lithium (lithia), and ammonium (aqueous ammonia); and next in order the oxides of calcium (lime), barium (baryta), and strontium (strontia). The solutions of these bodies exert a caustic or corrosive action on vegetable and animal substances, and precipitate the oxides of the heavy metals from solutions of their salts. Many vegetable colouring matters are changed in tint by alkaline solutions—for instance, reddened litmus becomes blue, yellow turmeric brown, and syrup of violets and infusions of red cabbage green.

ALKALOIDS, the name of a group of organic bodies that possess alkaline properties. They are characterised by the property of combining with acids to form salts, and many have the power of giving an alkaline reaction with vegetable colours. All the natural alkaloids contain nitrogen as an essential constituent, and they are especially marked by possessing great medicinal power. Many artificial alkaloids have been made of recent years in which phosphorus, arsenic, and antimony occupy the place of nitrogen. For the individual properties, tests, &c., of different alkaloids, see CHEMISTRY.

ALKANET (*Alkanna tinctoria*, or *Anchusa tinctoria*), a plant of the order *Boraginaceæ*, indigenous to the south of France and the shores of the Levant. It is extensively cultivated on the Continent for the sake of the root, which yields a fine colouring matter, imparting a beautiful carmine tint to oils, wines, wax, and all unctuous substances. Being perfectly harmless, alkanet is much used for colouring in pharmacy. Some of the mixtures styled port wine owe their colour to this dye, and it is also employed in staining furniture.

AL-KINDI, ABU YUSUF, &c., styled by pre-eminence "The Philosopher of the Arabs," flourished during the first half of the 10th century, and died at some unknown date posterior to 961. His literary activity was encyclopædic, and spread itself over all the sciences. The titles of his works number nearly 200 in the catalogue of Casiri, and amount to 265 in that of Flügel; but the latter appears in some cases to have enumerated the same works under two divisions, and it is doubtful whether the philosopher has not been confounded with another writer of the same name. His treatises are arranged under the following heads, which throw some light on his classification of the sciences :—Philosophy in general, logic, politics, ethics, arithmetic (under which he discusses the unity of God), spherology, theory of music (which was closely connected with all primitive speculation from its religious character), astronomy, meteorology, geometry, cosmology (the form, &c., of the heavens), astrology, medicine, and on various arts, besides his commentaries and controversial writings. Of all these, none except some treatises on medicine and astrology remain. Others of them must have been known in the Middle Ages, for Al-Kindi is placed by Roger Bacon, along with Alhazen, in the first rank after Ptolemy as a writer on perspective (optics). Some of them were certainly translated by Gerard of Cremona. Whatever his influence may have been on the Schoolmen, he was undoubtedly a great initiator as regards his countrymen. He was one of the earliest translators and commentators of Aristotle, but he appears to have been, like Al-Farabi, superseded by Avicenna. He marks the first philosophic revolt against Islamism, and his doctrine on the simplicity and unity of the Deity was apparently equally Aristotelian and un-Mahometan. See Flügel, *Abhandlungen für die Kunde des Morgenlandes*, erster Band, 1859.)

ALKMAAR, a town of the Netherlands, in the province of North Holland, situated on the Helder canal and on the railway between Haarlem and the Helder, about 20 miles N.N.W. of Amsterdam. The streets of Alkmaar are extremely neat and regular, and are intersected by canals lined with trees, while the ramparts of the town have been converted into beautiful boulevards. Many of the public buildings are elegant, especially the church of St Lawrence, a Gothic edifice of the 15th century. Alkmaar is the seat of a court of primary jurisdiction and of a tribunal of commerce, and possesses good schools as well as several literary and scientific societies. Its principal article of commerce is cheese, for which it is said to be the chief market in the kingdom, if not in the world. Besides cheese, it has a good trade in butter, corn, and cattle, and manufactures of salt, sailcloth, soap, vinegar, and leather. Alkmaar successfully sustained a siege by the Duke of Alba in 1573, and in 1799 gave its name to a convention signed by the Duke of York and the French general Brune, in accordance with which the Russo-British army evacuated Holland. Population, 12,000.

ALKMAAR, HEINRIK VON, the German translator of the celebrated satirical poem *Reineke de Vos*, flourished in the latter half of the 15th century. In the preface to his work, which is the only source of information as to his life, he states that he was tutor to the Duke of Lorraine, and that he translated the poem from the Walsch. In spite of the latter statement, many have attributed the authorship to him; but it is now known that the story had a much earlier origin. Some have supposed the name Alkmaar to be a pseudonym.

ALL-SAINTS DAY, ALL-HALLOWS, or HALLOWMAS, a festival, first instituted about 610 A.D., on the 1st of May, in memory of the martyrs, and celebrated since 834 on the 1st of November, as a general commemoration of all the saints. As the number of saints increased, it became impossible to dedicate a feast-day to each. Hence it was found expedient to have an annual aggregate commemoration of such as had not special days for themselves. The festival is common to the Roman Catholic, English, and Lutheran churches. See BELTANE.

ALLAH, the Arabic name for the one true God which is employed in the Koran, and has been adopted into the language of all Mahometan nations. It is compounded of *al*, the definite article, and *ilah*, meaning *worthy to be adored*. See MAHOMETANISM.

ALLAHÁBÁD, a division, district, and city of British India, under the jurisdiction of the lieutenant-governor of the North-Western Provinces. The ALLAHABAD DIVISION comprises the six districts of Allahábád, Cawnpur, Fathipur, Hamírpur, Bándá, and Jaunpur. It is bounded on the north and east by the Etáwah and Farrakhábád districts and the province of Oudh; on the south by the Benares division and the Rewah state; and on the west by the states of Bandelkhand and the Jhánsí division. Total population (1872), 5,466,116.

ALLAHÁBÁD DISTRICT lies between 24° 49′ and 25° 44′ N. lat., and between 81° 14′ and 82° 26′ E. long. In shape the district is that of an irregular oblong; and it is difficult accurately to describe its boundaries, as at one extremity it wanders into Oudh, while on the south the villages

of the state of Rewah and those of this district are hopelessly intermingled. Roughly speaking, however, the boundaries may be described as follows:—On the north by the district of Jaunpur and by the Ganges; on the west by the districts of Fathipur and Bándá; on the south by the independent state of Rewah; and on the east by the districts of Mirzápur and Jaunpur. The settlement of the district is at present undergoing revision; and as the measurements are still incomplete, it is impossible to state the exact area. For practical purposes, it may be estimated at 2802 square miles, or 1,793,906 acres, of which 1,065,990 acres are cultivated, and 727,916 acres are uncultivated; of this latter, however, there are about 250,000 acres capable of being brought under tillage, although not actually cultivated. The census of 1872 returned the population of the district at 1,394,245 souls, of whom 1,211,778 are Hindus, 181,574 Mussulmans, and 893 Christians. There is, however, a manifest error in these figures, as the European and Eurasian population of Allahábád city alone cannot be set at a lower figure than 3500. The census returns are in consequence undergoing revision. Of the Hindu population, 173,916 are returned as Bráhmans.

The Jamná and the Ganges meet at Allahábád city, and enclose within their angle a fertile tract, well irrigated by means of tanks and wells. The East Indian Railway and the Grand Trunk road afford the principal means of land communication. The former enters the district from the east, crosses the Jamná at Allahábád city, and travels westward, leaving the district near Khágá station. The Grand Trunk road enters Allahábád from the north-east, meets the railway at Allahábád city, and thence runs almost parallel with it till it leaves the district. Only three towns are returned as containing a population of over 5000 souls—viz., Allahábád, population 144,464; Manaimá, population 6146; and Chizwá, population 5791. Rice is the principal crop, the area under it being returned at 139,000 acres, and the average produce at 5¼ cwt. per acre. A little more than half of the total rice crop is retained for local consumption, and the remainder exported. The average price of common rice in February 1873 was 6s. 9d. per cwt. Pulses are also grown in large quantities, the area under the various sorts being about the same as rice, and the yield also about the same. Joár and bajrá cover as large an area as either rice or pulses, but the yield is neither so large nor of such value. About half the crop is said to be annually exported. Wheat is cultivated to the extent of about 150,000 cwt. per annum, of which about one-half is exported; the average yield is said to be about 6¼ cwt. per acre, and the average price from 6s. 2d. to 6s. 9d. per cwt. Mustard, tobacco, opium, linseed, and indigo are also cultivated largely, with cotton and sugar-cane in small quantities. Indigo stands first among the manufactures of the district, and large factories exist at Alamchánd, Sarái Salem, Gadúpur, Kansaridh, Thardai, and Dum-duma. These are generally under the supervision of European managers, and the produce is forwarded direct to the Calcutta market. Next to indigo, the most important industry is stone-cutting. The stone is chiefly quarried from a low range of hills near Shiorájpur, whence it is carried in country carts to the Jamná river; and after crossing it in flat-bottomed boats, it is finally landed at Balwá Ghát. Here the stone-masons take it in hand. The gross income of the Balwá Ghát stone traders is estimated at £2000 per annum. A brisk trade is also carried on in hides, the principal mart being the village of Karwá, in Aráil fiscal division, where it is estimated that the sale of skins amounts to upwards of £10,000 per annum for the Mirzápur and Calcutta hide markets. Paper is manufactured in the fiscal division of Karrá, and a considerable quantity exported to Oudh. Several villages in the fiscal divisions of Karrá and Chail are noted for the manufacture of brass and copper vessels; and iron vessels are largely manufactured in Khairágarh, Karrá, and Phulpur. The East India Railway Company have a large castor-oil manufactory at the village of Manauri. The total net revenue of the district in 1871-72 is returned at £244,537, and the total net civil expenditure at £51,770. The district passed into the hands of the English in 1801, by a treaty between the Vazír of Oudh and the East India Company.

Allahábád City, the capital of the North-Western Provinces, is also the administrative headquarters of the Allahábád division and of the district of the same name. It is situated at the confluence of the Ganges and Jamná rivers, in 25° 26′ N. lat., and 81° 55′ E. long. Its most conspicuous feature is the fort, which rises directly from the banks of the confluent rivers, and completely commands the navigation of both streams. Within the fort are the remains of a splendid palace, erected by the Emperor Akbar, and once a favourite residence of his. A great portion of it has been destroyed, and its hall is converted into an arsenal. Outside the fort, the places most of importance are the Sarái and garden of Khasrú, the son of the Emperor Jahángír, and the Jumá Masjid, or great mosque. When the town first came into the hands of the English this mosque was used as a residence by the military officer commanding the station, and afterwards as an assembly-room. Ultimately it was returned to its former owners, but the Mahometans considered it desecrated, and it has never since been used as a place of worship. Allahábád is one of the most noted resorts of Hindu pilgrimage. It owes its sanctity to its being the reputed confluence of three sacred streams—the Ganges, the Jamná, and the Saraswatí. This last stream, however, is not visible. It leaves the Himálayas to the west of the Jamná, passes close to Tháneswar in the Panjáb, and loses itself in the sands of Sirhind, 400 miles north-west of Allahábád. The Hindus, however, assert that the stream joins the other two rivers under ground, and in a subterraneous temple below the fort a little moisture trickling from the rocky walls is pointed out as the waters of the Saraswatí. An annual fair is held at Allahábád, at the confluence of the streams, on the occasion of the great bathing festival, at the full moon of the Hindu month of Mágh. Allahábád was taken by the British, in the year 1765, from the Vazír of Oudh, and assigned as a residence for Sháh Alam, the titular Emperor of Dehli. Upon that prince throwing himself into the hands of the Marhattás, the place was resumed by us in 1771, and again transferred to the Nawáb of Oudh, by whom it was finally ceded, together with the district, to the British in 1801, in commutation of the subsidy which the Vazír had agreed to pay for British protection. The population and trade of Allahábád city have rapidly increased of late years. According to the census of 1853, the city and suburbs contained 72,098 inhabitants. Before 1872 the population had exactly doubled, the census returns for that year exhibiting a total population of 144,464. The municipal income and expenditure of Allahábád city in 1871–72 were as follows:—Income—Octroi duties, £13,676, 14s.; tax on professions, £220, 10s.; carriage tax, £1264, 4s.; proceeds of the Hindu fair and ground rents, £5364: total municipal income, £20,525, 8s.; incidence of taxation, 2s. 11d. per head of the population. Expenditure—Establishment, including cost of collection, police, conservancy, and lighting, £9906, 4s.; street watering, £1002, 12s.; new works, £7677, 16s.; repairs, £1088, 2s.; vaccination, £20; dispensary, £330; charities, £250; Alfred Park, £800; other items, £223, 2s.: total, £21,297, 16s. Allahábád forms the junction of the great railway system which unites Bengal with Central India and Bombay, and it is rapidly developing into a great centre of inland and export trade.

ALLAMAND, Jean Nicolas Sebastian, natural philosopher, born at Lausanne in 1713, was educated for the church, and held for a short time a clerical appointment at Leyden. Here he enjoyed the patronage and friendship of the celebrated S'Gravesende, who made him his literary executor. In 1747 he was appointed professor of philosophy and natural history at Franeker, and two years later he was transferred to a similar chair at Leyden, which he occupied until his death in 1787. Allamand's chief service to science consisted in translating and editing the scientific works of others, but he also made some original discoveries of importance, especially in connection with electricity. He was the first to explain fully the phenomena of the Leyden jar, and he made a near approach to the discovery of negative electricity. He greatly enriched

the botanical garden and natural history museum at Leyden by specimens from all quarters of the globe. His translation of Buffon's works was published at Amsterdam, in thirty-eight quarto volumes, between 1766 and 1779. Allamand was a member of the Royal Society of London and of the Academy of Sciences at Haarlem.

ALLAN, David, a Scottish historical painter of considerable celebrity, was born at Alloa on the 13th February 1744. At a very early age he gave such proofs of natural artistic talent as led to his being placed under the care of the Messrs Foulis, who some time before had instituted an academy in Glasgow for painting and engraving. On leaving the academy (1762), after seven years' successful study, he obtained the patronage of Lord Cathcart and of Erskine of Mar, on whose estate he had been born. The latter furnished him with the means of proceeding to Rome (1764), where he remained for a number of years engaged principally in copying the old masters. Among the original works which he then painted was the "Origin of Portraiture"—representing a Corinthian maid drawing her lover's shadow—well known through Cunego's excellent engraving. This gained for him the gold medal given by the Academy of St Luke in the year 1773 for the best specimen of historical composition. Returning from Rome in 1777, he resided for a time in London, and occupied himself in portrait-painting. In 1780 he removed to Edinburgh, where, on the death of Alexander Runciman in 1786, he was appointed director and master of the Academy of Arts. There he painted and etched in aquatint a variety of works, those by which he is best known—as the *Scotch Wedding*, the *Highland Dance*, the *Repentance Stool*, and his *Illustrations of the Gentle Shepherd*—being remarkable for their comic humour. He has had frequently applied to him the name of the "Scottish Hogarth;" but his drolleries are not to be compared for a moment with the productions of the great English satirist. Allan died at Edinburgh on the 6th August 1796.

ALLAN, Sir William, R.A., and president of the Royal Scottish Academy, was born at Edinburgh in 1782. At an early age he was entered as a pupil in the School of Design established in Edinburgh by the Board of Trustees for Arts and Manufactures, where he had as companions, Wilkie, Burnet the engraver, and others who afterwards distinguished themselves as artists. Here Allan and Wilkie were placed at the same table, studied the same designs, and contracted a friendship which terminated only with their lives. Leaving the Edinburgh school, Allan prosecuted his studies for some time in London; but his attempt to establish himself there was unsuccessful, and, after exhibiting at the Royal Academy (1805) his first picture, *A Gipsy Boy and Ass*, an imitation in style of Opie, he determined, in spite of his scanty resources, to seek his fortune abroad. He accordingly set out the same year for Russia, but was carried by stress of weather to Memel, where he remained for some time, supporting himself by his pencil. At last, however, he reached St Petersburg, where the kindness of Sir Alexander Crichton, the court physician, and other friends procured him abundant employment. The emoluments of his profession enabled him by and by to make excursions into southern Russia, Turkey, the Crimea, and Circassia, where he filled his portfolio with vivid sketches, of which he made admirable use in his subsequent pictures. In 1814 he returned to Edinburgh, and in the two following years exhibited at the Royal Academy *The Circassian Captives* and *Bashkirs conducting Convicts to Siberia*. The former composition, which united graceful forms and powerful expression with novel and picturesque costumes, established his reputation as a master in the highest walk of art; but the picture remained so long unsold in the studio of the artist, that, thoroughly disheartened, he threatened to retire to Circassia when, through the kindness of Sir Walter Scott, a subscription of 1000 guineas was obtained for the picture, which fell by lot into the possession of the Earl of Wemyss. About the same time the Grand Duke Nicholas, afterwards emperor of Russia, visited Edinburgh, and purchased his *Siberian Exiles* and *Haslan Gheray crossing the River Kuban*, giving a very favourable turn to the fortunes of the painter, whose pictures were now sought for by collectors. From this time to 1834 we find him pursuing his art in the sphere in which he achieved his greatest success and firmly established his fame, the illustration of Scottish history. His most important works of this class were *Archbishop Sharpe on Magus Moor; John Knox admonishing Mary Queen of Scots* (1823), engraved by Burnet; *Mary Queen of Scots signing her Abdication* (1824); and *Regent Murray shot by Hamilton of Bothwellhaugh*. The last procured his election as an associate of the Royal Academy (1825). Later Scottish subjects were *Lord Byron* (1831), portraits of Scott, and *The Orphan* (1834), which represented Anne Scott seated near the chair of her deceased father. In 1830 he was compelled, on account of an attack of ophthalmia, to seek a milder climate, and visited Rome, Naples, and Constantinople. He returned with a rich store of materials, of which he made excellent use in his *Constantinople Slave Market* and other productions. In 1834 he visited Spain and Morocco, and in 1841 went again to St Petersburg, when he undertook, at the request of the Czar, his *Peter the Great teaching his Subjects the Art of Shipbuilding*, exhibited in London in 1845, and now in the Winter Palace of St Petersburg. His *Polish Exiles* and *Moorish Love-letter*, &c., had secured his election as a Royal Academician in 1835; he was appointed president of the Royal Scottish Academy (1838), and limner to Her Majesty for Scotland, after Wilkie's death (1841); and in 1842 received the honour of knighthood. His later years were occupied with battle-pieces, the last he finished being the second of his two companion pictures of the *Battle of Waterloo*. He died on the 22d February 1850, leaving a large picture unfinished—*Bruce at Bannockburn*—which exhibits no traces of impaired power.

ALLEGHANY, Allegheny, or Allegany Mountains, is the name often given to the Appalachian Mountains in the United States. A more exact use of the name restricts it to the portion of the system that lies west of the Hudson river, and forms the watershed of the Mississippi basin on the south-east. See Appalachian Mountains.

ALLEGHANY, a river of the United States, which rises in the north of Pennsylvania, and after flowing about 300 miles, first in a northerly, but for the greater part of its course in a westerly direction, during which it passes for a short distance into the state of New York, unites with the Monongahela at Pittsburg to form the Ohio. The country through which it flows is mostly hilly, and large numbers of pines, white oaks, and chestnuts grow upon its banks. It is navigable for small steamers for about 200 miles above Pittsburg.

ALLEGHENY, a large suburb of Pittsburg (*q.v.*) In 1870 it contained 53,180 inhabitants.

ALLEGIANCE, either derived from the French *allegeance* or taken from the same Latin source, has been used to express that duty which a person possessing the privileges of a citizen owes to the state to which he belongs, and is technically applied in law to the duty which a British subject owes to the sovereign as representing the state. It has been divided by the English legal commentators into natural and local; the latter applying only to the deference which a foreigner must pay to the institutions of the country in which he happens to live; but it is in its wider sense that the word is important, as representing a condition attached to mankind of which it is

very difficult in theory, and still more in practice, to adjust the true character and limits. For a state to decide what persons are bound to it by allegiance may be easy, but for a man to know where his allegiance lies when two or more states claim him—and hence for jurists to decide what is the reasonable extent to which any state ought to make such a claim—is often involved in difficulty. The English doctrine, which was also adopted in the United States, asserted that allegiance was indelible. *Nemo potest exuere patriam* (Forsyth's *Cases and Opinions in Constitutional Law*, pp. 257, *sqq.*, 333, *sq.*) Accordingly, as the law stood before 1870, every person born within the British dominions, though he should be removed in infancy to another country where his family resides, owes an allegiance to the British crown which he could never resign or lose, except by Act of Parliament or by the recognition of the independence or the cession of the portion of British territory in which he resided. By the Naturalisation Act, 1870, 33 & 34 Vict. c. 14 (see ALIEN), it was made possible for British subjects to renounce their nationality and allegiance, and the ways in which that nationality is lost are defined. So British subjects voluntarily naturalised in a foreign state are deemed aliens from the time of such naturalisation, unless, in the case of persons naturalised before the passing of the Act, they have declared their desire to remain British subjects within two years from the passing of the Act. Persons who, from having been born within British territory are British subjects, but who at birth became under the law of any foreign state subjects of such state, and also persons who, though born abroad are British subjects by reason of parentage, may by declarations of alienage get rid of British nationality.

ALLEGIANCE, *Oath of*, an oath of fidelity to the sovereign taken by all persons holding public office. By ancient common law it might be required of all persons above the age of twelve, and it has repeatedly been used as a test for the disaffected. It was first imposed by statute in the reign of Elizabeth (I. c. 1), and its form has more than once been altered since. Up to the time of the Revolution the promise was "to be true and faithful to the king and his heirs, and truth and faith to bear of life and limb and terrene honour, and not to know or hear of any ill or damage intended him without defending him therefrom." This was thought to favour the doctrine of absolute non-resistance, and accordingly the Convention Parliament enacted the form that has been in use since that time—"I do sincerely promise and swear that I will be faithful and bear true allegiance to Her Majesty Queen Victoria." These words are included in the form prescribed by 21 & 22 Vict. c. 48, which substitutes one oath for the oaths of allegiance, supremacy, and abjuration.

ALLEGORY (ἄλλος, other, and ἀγορεύω, to speak), a figurative representation conveying a meaning *other* than and in addition to the literal. It is generally treated as a figure of rhetoric, but the medium of representation is not necessarily language. An allegory may be addressed to the eye, and is often embodied in painting, sculpture, or some form of mimetic art. The etymological meaning of the word is wider than that which it bears in actual use. An allegory is distinguished from a metaphor by being longer sustained and more fully carried out in its details, and from an analogy by the fact that the one appeals to the imagination and the other to the reason. The fable or parable is a short allegory with one definite moral. The allegory has been a favourite form in the literature of nearly every nation. The Hebrew scriptures present frequent instances of it, one of the most beautiful being the comparison of the history of Israel to the growth of a vine, in the 80th psalm. In classical literature one of the best known allegories is the story of the stomach and its members in the speech of Menenius Agrippa (Livy, ii. 32); and several occur in Ovid's *Metamorphoses*. Perhaps the most elaborate and the most successful specimens of allegory are to be found in the works of English authors. Spencer's *Faerie Queene*, Swift's *Tale of a Tub*, Addison's *Vision of Mirza*, and, above all, Bunyan's *Pilgrim's Progress*, are examples that it would be impossible to match in elaboration, beauty, and fitness, from the literature of any other nation.

ALLEGRI, ANTONIO. See CORREGGIO.

ALLEGRI, GREGORIO, musical composer, probably of the Correggio family, was born at Rome about 1580. He studied music under Nanini, the intimate friend of Palestrina. Being intended for the church, he obtained a benefice in the cathedral of Fermo. Here he composed a large number of motetts and sacred pieces, which, being brought under the notice of Pope Urban VIII., obtained for him an appointment in the choir of the Sistine chapel at Rome. He held this from Dec. 1629 till his death on the 18th Feb. 1652. His character seems to have been singularly pure and benevolent. Among the musical compositions of Allegri were two volumes of Concerti, published in 1618 and 1619; two volumes of Motetts, published in 1620 and 1621; besides a number of works still in manuscript. He was one of the earliest composers for stringed instruments, and Kircher has given one specimen of this class of his works in the *Musurgia*. But the most celebrated composition of Allegri is the *Miserere*, still annually performed in the Sistine chapel at Rome. It is written for two choirs, the one of five and the other of four voices, and has obtained a celebrity which, if not entirely factitious, is certainly not due to its intrinsic merits alone. The mystery in which the composition was long enshrouded, no single copy being allowed to reach the public, the place and circumstances of the performance, and the added embellishments of the singers, account to a great degree for much of the impressive effect of which all who have heard the music speak. This view is confirmed by the fact, that when the music was performed at Venice by permission of the pope, it produced so little effect that the Emperor Leopold I., at whose request the manuscript had been sent, thought that something else had been substituted. In spite of the precautions of the popes, the *Miserere* has long been public property. In 1769 Mozart was able to write it down after hearing it twice; and in 1771 a copy was procured and published in England by Dr Burney. The entire music performed at Rome in Holy Week, Allegri's *Miserere* included, has been issued at Leipsic by Breitkopf and Härtel. Interesting accounts of the impression produced by the performance at Rome may be found in the first volume of Mendelssohn's letters, and in Miss Taylor's *Letters from Italy*.

ALLEINE, JOSEPH, Nonconformist divine, the author of *An Alarm to the Unconverted*—a book which remains as potential as when first modestly sent forth, scarcely second to Richard Baxter's *Call to the Unconverted*—was otherwise noticeable. Baxter himself wrote a characteristic introduction to his Life fully two centuries ago (1672); while recently (1861) the Rev. Charles Stanford has retold his story and the story of his age with great fulness of knowledge and historical fidelity. The Alleines came out of Suffolk, and as early as 1430 some of them—sprung of Alan, lord of Buckenhall—settled in the neighbourhood of Calne and Devizes, whence descended the immediate ancestors of "worthy Mr Tobie Alleine of Devizes," father of our worthy. Joseph Alleine, fourth of a large family, was born at Devizes early in 1634. 1645 is marked in the title-page of a quaint old tractate, by an eye-witness, as his "*setting forth in the Christian race.*" His eldest brother Edward had been a clergyman, but in this year died, in his twenty-

seventh year; and Joseph entreated his father that he might be educated to succeed his brother in the work of the ministry. His father consented, and he was immediately sent to Poulshot, then under a fellow of Exeter College, Oxford (William Spinage). In April 1649 he set out for Lincoln College, Oxford, in the presidency of Dr Paul Hood, with Dr John Owen as the vice-chancellor of the university. A Wiltshire place becoming vacant in Corpus Christi College, on the 3d Nov. 1651 he was chosen scholar of that house. Of his student life it was written contemporaneously, "*He could toil terribly.*" On 6th July 1653 he took the degree of B.D., and thereupon became a tutor of his college. He became also chaplain of Corpus Christi, preferring this to a fellowship. In 1654 he had offers of high preferment in the state, which he declined. The succeeding year (1655) brought him another offer, which he did not decline. George Newton, of the great church of St Mary Magdalene, Taunton, sought him for assistant; and putting from him all other things, even forsaking further academical honours within his immediate grasp, he accepted the invitation by proceeding at once to Taunton, undergoing the accustomed probation, and at last being ordained as the associate of one of the most venerable of the later Puritan fathers. The ministry that resulted stands out lustrous and noble in the history of historical Taunton, and in the Life of the junior pastor, as told by Baxter and Stanford. Almost coincident with ordination came the marriage of the associate-pastor with Theodosia Alleine, daughter of Richard Alleine. Friendships among "gentle and simple"—of the former, with Lady Farewell, grand-daughter of Protector Somerset—bear witness to the attraction of Alleine's private life. His public life—in preaching after the intense, awakening, wistful type; in catechising with all diligence and fidelity; in visitation among the poor and mean and sad; in letter-writing, tender and sympathetic; in devotional intercession through long consecrated hours of day and night—was a model of pastoral devotion. This is all the more remarkable as the pastor continued the student-toil of Corpus Christi, one monument of which was his *Theologia Philosophica,* a lost MS., establishing the harmony between revelation and nature, and whose learning—classical, patristic, and recondite—drew forth the wonder of Baxter. Alleine was no mere scholar or divine, but a man who associated on equal terms with the patriarchs of the Royal Society, then laying those broad and deep foundations on which rests England's present scientific renown. These scientific studies and experiments, nevertheless, were ever kept in subordination to his proper work. The extent of his influence was, in so young a man, unique, resting fundamentally on the earnestness of his nature and the manifest power of his ministry. The year 1662 found senior and junior pastors like-minded, and both were of the Two Thousand. Alleine, when the Ejection blow fell, with John Wesley (grandfather of the celebrated John Wesley) for fellow-labourer, also ejected, carried on a kind of itineracy where-ever opportunity was found for preaching the gospel. For this he was cast into prison, indicted at sessions, and suffered as hundreds of England's noblest men have suffered. His *Letters from Prison* were an earlier *Cardiphonia.* He was released on 26th May 1664; and spite of the Conventicle Act (Five Mile Act), he returned to his beloved work as a preacher of the gospel. He found himself again in prison, and again and again a sufferer. Tempestuous and troubled were his remaining years. Now in hiding, now in great bodily weakness, now coming to the front in some act of charity or patriotism, now at the waters of Bath, slowly but serenely wearing out. He died November 17, 1668; and the mourners, remembering their beloved minister's words while yet with them, "If I should die fifty miles away, let me be buried at Taunton," found a grave for him in St Mary's chancel. Pilgrims from over the sea read with dim eyes the brief Latin inscription on his stone. No Puritan-Nonconformist name is so affectionately cherished as is that of Joseph Alleine. "Being dead he yet speaketh" through his imperishable practical books. (*Life,* edited by Baxter; *Joseph Alleine: his Companions and Times,* by Charles Stanford, 1861; Wood's *Athenæ;* Palmer's *Nonc. Mem., s.v.;* Harleian MSS., and Williams MSS.) (A. B. G.)

ALLEINE, Richard, M.A., author of *Vindiciæ Pietatis,* was educated at St Albans Hall, Oxford, where Anthony à Wood states he was entered commoner in 1627, aged sixteen; and where, having taken the degree of B.A., he transferred himself to New Inn, and continued there until he proceeded M.A. He and the like-minded William Alleine were sons of Richard Alleine, rector for upwards of fifty years of Dichet, Somerset. The younger Richard being ordained, became assistant to his venerable father, and immediately stirred the entire county by his burning eloquence. In March 1641 he succeeded to many-sided Richard Bernard as rector of Batcomb (Somerset). He declared himself on the side of the Puritans by subscribing "The testimony of the ministers in Somersetshire to the truth of Jesus Christ" and "The Solemn League and Covenant." He continued for twenty years rector of Batcomb. On the Act of Uniformity being passed, he cast in his lot with the Two Thousand of the ejected. Upon the Five-Mile Act he removed to Frome Selwood, and preached there and around until his death on December 22, 1681. His works are all of the richest spiritual character, with a wistfulness of appeal that goes right to the heart. His *Vindiciæ Pietatis* (which appeared successively in 1660, 1663, and 1665) was refused licence by Sheldon, and was published, in common with other Nonconformist books, without it. It was rapidly bought up, and "did much to mend this bad world." Roger Norton, the king's printer, caused a large part of the first impression to be seized, on the ground of not being licensed, and to be sent to the royal kitchen. Glancing over its pages, he was struck with what he read, and on second thoughts it seemed to him a sin that a book so holy—and so saleable—should be destroyed. He therefore bought back the sheets, says Calamy, for an old song, bound them, and sold them in his own shop. This in turn was complained of against him, and the shrewd publisher had to beg pardon on his knees before the council-table; and the remaining copies were sentenced to be "bisk'd," or rubbed over with an inky brush, and sent back to the kitchen for lighting fires. Such "bisk'd" copies occasionally occur still. The book was not killed. It was reissued, with additions, and a contribution by Joseph Alleine, and went forth on a mission which has endured to our day. (Calamy, *s.v.;* Palmer's *Nonconf. Mem.* iii. pp. 167–8; C. Stanford's *Joseph Alleine; Researches at Batcomb and Frome Selwood;* Wood's *Athenæ, s.v.*) (A. B. G.)

ALLEN, Bog of, the name given to a congeries of morasses in Kildare and King's County, Ireland. Clane Bog, the eastern extremity, is within 17 miles of Dublin, and the morasses extend westward almost to the Shannon. Their total area is about 238,500 acres. They do not form one continuous bog, the tract of the country to which the name is given being intersected by strips of dry cultivated land. The rivers Brosna, Barrow, and Boyne take their rise in these morasses; and the Grand Canal crosses them. The Bog of Allen has a general elevation of 250 feet above the level of the sea, and the average thickness of the peat of which it consists is 25 feet. It rests on a subsoil of clay and marl.

ALLEN, John (1770–1843), was born near Edinburgh, and educated at the university of that city, where he took the degree of M.D. in 1791. With youthful enthusiasm, Allen joined the Scottish movement of that period for parliamentary reform. He was an acute metaphysician, and the prelections on physiology which he delivered in Edinburgh are distinguished by clearness and precise philosophical views. Leaving Edinburgh, he took up his abode at Holland House as the friend and private secretary of the late Lord Holland. In 1811 he was elected warden of Dulwich College; and in 1820 obtained the comfortable sinecure of master of that institution, where he died in 1843. Allen's detached publications, though well written, are not very important, if we except his valuable *Inquiry into the Growth of the Royal Prerogative* (1830), "a learned and luminous work;" but he was an able contributor to the *Edinburgh Review*, to which he is said to have furnished no less than forty articles, chiefly on physiological, metaphysical, and political subjects; and some of his contributions on French and Spanish history are very interesting. For this last department he was peculiarly fitted by his residence with Lord Holland in France and Spain; he had even collected materials for a history of Spain, but was hindered from fulfilling his purpose by his deep interest in politics. The latter portion of his life was divided between politics and the study of the history of the British constitution. Brougham, in his *éloge* of Allen (*Works*, vol. iv., 1872), has highly commended him for extensive learning and philosophical talent.

ALLEN, or Alleyn, Thomas (1542–1632), a famous English mathematician, was born at Uttoxeter in Staffordshire, 21st December 1542. He was admitted scholar of Trinity College, Oxford, in 1561; and in 1567 took his degree of master of arts. In 1580 he quitted his college and fellowship, and retired to Gloucester Hall, where he studied very closely, and became famous for his knowledge of antiquity, philosophy, and mathematics. Having received an invitation from Henry, Earl of Northumberland, a great friend and patron of men of science, he spent some time at the earl's house, where he became acquainted with Thomas Harriot, John Dee, and other famous mathematicians. He was also intimate with Cotton, Camden, and their antiquarian associates. Robert, Earl of Leicester, had a particular esteem for Allen, and would have conferred a bishopric upon him, but his love of solitude made him decline the offer. His great skill in mathematics earned him, as was usual in those times, the credit of being a magician; and the author of *Leicester's Commonwealth* accuses him of employing the art of "figuring" to further the Earl of Leicester's unlawful designs, and of endeavouring by the black art to bring about a match between his patron and Queen Elizabeth. Allen was indefatigable in collecting scattered manuscripts relating to history, antiquity, astronomy, philosophy, and mathematics. A considerable part of his collection was presented to the Bodleian library by Sir Kenelm Digby. He published in Latin the second and third books of *Claudius Ptolemy of Pelusium, Concerning the Judgment of the Stars, or, as it is commonly called, of the Quadripartite Construction, with an exposition.* He wrote also notes on some of Lilly's books, and on Bale's *De Scriptoribus M. Britanniæ.*

ALLENTOWN, formerly called Northampton, a thriving town of the United States, capital of Lehigh county. Pennsylvania, is pleasantly situated on a height on the western bank of the Lehigh River, 85 miles E.N.E. of Harrisburg. It is a well-built place, and contains a good court-house, a military institute, an academy, and a theological seminary. Most of the inhabitants are of German descent; the German language is commonly spoken, and is used along with English both in the newspapers and in the courts of law. The valley of the Lehigh is very rich in iron ore and anthracite, and in the town and neighbourhood extensive iron-works and anthracite furnaces are in operation. This trade is being rapidly developed, and is favoured by good railway communication, New York and Philadelphia being both within 100 miles of Allentown by rail. A tenth of the whole iron manufactured in the United States is said to be produced here. Population (1870), 13,884.

ALLESTRY, or Allestree, Richard, D.D., was born at Uppingtown in Shropshire in 1619, and educated in the grammar school of Coventry, and afterwards at Christ Church, Oxford. After passing as bachelor of arts he was made successively moderator in philosophy, canon of Christ Church, doctor of divinity, chaplain in ordinary to the king, and regius professor of divinity. His early studies, however, were interrupted by the hostilities of the times. In the year 1641 he and many other students of Oxford entered the royal service, and gave signal proofs of their courage and loyalty. A short interval of hostilities permitted Allestry to return to his literary pursuits; but soon after, he again took up arms, and was present at the battle of Keintonfield. On his way to Oxford to prepare for the reception of the king he was taken prisoner, but was released by the king's forces. A violent disease which then prevailed in the garrison of Oxford brought Allestry to the brink of the grave; but recovering, he again joined a regiment of volunteers, chiefly consisting of Oxford students. Here he served as a common soldier, and was often seen with the musket in one hand and a book in the other. At the close of the revolutionary struggle he returned to his favourite studies, but still continued true to his party. This occasioned his expulsion from the college; but he was provided with a comfortable retreat in the families of the Honourable Francis Newport and Sir Anthony Cope. Such was the confidence reposed in him that when the friends of Charles II. were secretly preparing the way for his restoration, they entrusted him with personal messages to the king. In returning from one of these interviews he was seized at Dover, and upon examination committed a prisoner to Lambeth House. The Earl of Shaftesbury obtained his release in a few weeks. His valuable library was bequeathed to the university. He died in January 1681. He erected at his own private expense the west side of the outward court of Eton College, and the grammar school in Christ Church College; besides settling several liberal pensions upon individual persons and families. His only extant work is a volume of sermons, printed at Oxford in 1684.

ALLEYN, Edward, eminent as a stage-player in the reigns of Elizabeth and James I., but better remembered in after-times as the founder of Dulwich college, was born in London, in the parish of St Botolph, Bishopsgate, on the 1st of September 1566. When he was only four years old, his father, an innkeeper, died, and his mother soon afterwards married an actor named Browne. This change in his domestic surroundings brought young Alleyn into early and close association with the stage, for which he possessed great natural aptitude. Thus it chanced that "he was bred a stage-player," as stated by Fuller (*Worthies*). A tenacious memory, a polished elocution, a stateliness of figure and countenance, and a genial temperament, were among the natural and acquired accomplishments that he brought to bear on his chosen pursuit. He gained distinction in his calling while yet quite a young man, and by common consent was eventually rated as the foremost actor of his time. Several prominent dramatists and other writers of the period have left forcible testimony to his

rare excellence in the histrionic art. Ben Jonson, a critic nowise prone to exalt the merits of men of mark among his contemporaries, but addicted rather to disparagement, and even, as Drummond of Hawthornden tells, to bitterest detraction, bestowed, nevertheless, unstinted praise on Alleyn's acting (see Jonson's *Epigrams*, No. 89). Nash, in *Pierce Pennyless, his Supplication to the Devil*, expresses in prose the same eulogy that Jonson renders in verse. Heywood calls Alleyn "inimitable," "the best of actors," and

"Proteus for shapes and Roscius for a tongue."
—(Prologue to Marlowe's *Jew of Malta*.)

Peele's letter to Marlowe, quoted by several of Alleyn's biographers, telling of a merry meeting at which Shakespeare, Ben Jonson, and Alleyn figure in the front rank of a group of choice spirits, has long been numbered among literary forgeries. (See the Life prefixed to Dyce's *Peele's Works*, 1829.)

But ample and clear evidence remains to show his great celebrity as an actor. His professional earnings as a player formed, however, one only, and not the chief, among several sources from which he drew the wealth that afterwards sustained his great foundation; and his fame as an actor must long since have faded into a dim tradition, of little or no concern to present times, but for the association of his name with an institution around which cluster interesting historic reminiscences, and whose future is fraught with high promise. He inherited house property in Bishopsgate from his father. His marriage, in 1592, with Joan Woodward, stepdaughter to Henslowe, a successful speculator in theatrical and kindred enterprises, brought him eventually much wealth. He became successively part owner in Henslowe's ventures, and in the end sole proprietor of sundry play-houses and other resorts for the diversion of pleasure-seekers. Among these were the Rose Theatre at Bankside, in close contiguity to Shakespeare's Globe Theatre; the Paris Garden, in the same vicinage, where were enacted such pastimes as bear-baiting, bull-baiting, and other sports of the period; and the Fortune Theatre in St Luke's. He filled, too, in conjunction with Henslowe, the post of "master of the king's games of bears, bulls, and dogs." He continued to discharge the duties of this office long after he had relinquished his other professional work.

Alleyn's ownership in Dulwich lands began in 1606, and further acquisitions, made in the course of the next five years, during which he was gradually breaking away from the actual practice of the histrionic art, though not from theatrical speculations or kindred enterprises, increased his holding to more than 1300 acres. His residential connection with Dulwich began in 1607. He occupied the manor-house, a mansion even then very ancient, but which is still tenanted, after many additions and alterations. The priors and abbots of Bermondsey owned and occupied it through the four centuries preceding their expulsion in 1537, when Henry VIII. assigned their house and adjacent church lands to Thomas Calton, grandfather to the Calton who sold his heritage to Alleyn. Some details respecting this and other purchases of neighbouring estates are set forth in Alleyn's own writing, in a small thick memorandum-book which, with other Alleyn papers preserved at Dulwich, has been carefully scrutinised by the writer of this notice.

The landed property stretches from the crest of that range of Surrey hills on whose summit rests the Crystal Palace, to the crest of the parallel ridge, three miles nearer London, known in its several portions as Herne Hill, Denmark Hill, and Champion Hill. Alleyn acquired this large suburban property for little more than £10,000, which may be estimated as equivalent to £50,000 in the present day. But the present value of the lands which he bought for such a price is hardly under a million and a-half sterling, so enormous has been the rise in the value of land in and near London. Alleyn had barely got full possession of this property before the question how to dispose of it began to press upon him. He was still childless, after twenty years of wedded life. Then it was that the prosperous player—the man "so acting to the life that he made any part to become him" (Fuller, *Worthies*)—began "playing the last act of his life so well" (Bacon's Letter to the Marquis of Buckingham, dated 18th August 1618), as to gain the general applause of his own age, and a large measure of admiration in after times. He built and endowed in his own lifetime the College of God's Gift at Dulwich. All was completed in 1617, except the charter or deed of incorporation for setting his lands in mortmain. Tedious delays occurred in the Star Chamber, where Lord Chancellor Bacon was scheming to bring the pressure of kingly authority to bear on Alleyn with the aim of securing a large portion of the proposed endowment for the maintenance of lectureships at Oxford and Cambridge. Alleyn finally carried his point, and the College of God's Gift at Dulwich was founded, and endowed under letters patent of James I. dated 21st of June 1619. The college, as thus incorporated, consisted of twelve "poor scholars" and as many pensioners, the latter comprising equal numbers of men and women—"poor brethren" and "poor sisters,"—together with a teaching and governing staff of six higher officials. These latter included a master and a warden, who were always to be of the founder's surname, and four fellows, all "graduates and divines," among whom were apportioned the ministerial work of the chapel, the instruction of the boys, and the supervision of the almspeople or pensioners. The scholars and pensioners were to be drawn in equal numbers from the four London parishes out of which the founder drew his wealth. A curious legend, dating from the time of the founder, and always current afterwards among the pensioners on his bounty, tells that he was scared into his generous and charitable scheme by an apparition of the devil, *in propria persona*, among some theatrical demons in a drama in which he was acting. In the fright thus occasioned he was said to have made a vow, which he redeemed in the founding of Dulwich College.

Alleyn was never a member of his own foundation, as stated by Heywood, and copied by succeeding writers. The college records clearly set this point at rest. But he continued to the close of his life to guide and control the affairs of his foundation, under powers reserved to himself in the letters patent. His diary shows that he mixed much and intimately in the daily life of the college. Many of the jottings in that curious record of daily doings and incidents favour the inference that he was genial, kind, amiable, and withal a religious man. His fondness for his old professional work is indicated by the fact that he engaged the boys in occasional theatrical performances. At a festive gathering on the 6th of January 1622 "the boyes play'd a playe."

Shakespeare's name is interwoven with local traditions bearing on Alleyn's life at Dulwich, and the links of association between these famous contemporaries afford strong antecedent probability that the tradition sprang from something more solid than "such stuff as dreams are made of." Each began and closed his professional career as a stage-player in nearly the self-same period and in neighbouring theatres. During several years they were near neighbours in their homes at Bankside, then the headquarters of players and play-houses. Leading actors then, as afterwards, came much in contact with the living authors whose creations they personated. Alleyn performed in "Leir," the "Moore of Venis," "Romeo,"

"Pericles," and "Henry VIII," as appears from his inventory of his own theatrical wardrobe. Among the intimate friends of both were Ben Jonson, Michael Drayton, and other members of the goodly company of poets and dramatists whose genius shed a lustre on their day. Shakespeare had not finally betaken himself to the retirement of Stratford-on-Avon until seven years after Alleyn took up his abode at Dulwich. In the face of all these facts, it can hardly be said the local tradition is groundless, though no direct proof has yet been brought to bear on the point.

Alleyn's first wife died in the summer of 1623. In December of the same year he married Constance Donne, who survived him. This lady was a daughter of Dr Donne, dean of St Paul's. Her maiden name was misquoted by an early biographer. This mistake gave rise to the further error which attributes to Alleyn a third wife. He died in November 1626, in the sixty-first year of his age. His gravestone at Dulwich fixes the date of his death on 21st November, but there are grounds for the belief that the true date is the 25th of the same month.

Besides dispensing bounties within the bounds of his college, Alleyn provided, by an after-thought, some years later than his deed of foundation, for certain extensions of the benefits of his endowment. But successive actions at law, carried on at various periods, resulted in the ruling that it was not within the competence of the founder to divert any portion of the revenues of his foundation to the use of others than the members thereof, as specified in the letters patent. Chief among the good intents on the part of the founder that were thus frustrated was his scheme for embracing in the school work within the college as many outsiders as would bring the total number to eighty boys, inclusive of the twelve foundationers. But as this was not within the bond, his successors in the administration of the trust, for more than two centuries after his death, declined the work. In the latter part of that period, decay, and not development, fixed on the time-honoured memorial of Alleyn's high but thwarted purposes the stigma of a public scandal. Then came, in 1842, a grudging and partial, rather than a full and loyal, concession towards the realisation of the founder's aims. Finally, however, an Act of Parliament, in 1857, extinguished the stagnant and unprogressive corporation. Alleyn's College of God's Gift at Dulwich entered thenceforward on that prosperous career which already links its name with the front rank of institutions doing good service in the educational work of the day. (J. GO.)

ALLIANCE, a league between independent states for the purpose of combined action, defensive or offensive, or both—a subject which falls to be treated under the heading LAW OF NATIONS. The alliances of greatest historical importance are the Triple Alliance (1688) of Great Britain, Sweden, and the Netherlands against France; the Grand Alliance (1689) of the Emperor Leopold I. and Holland, subsequently joined by England, Spain, and Saxony, against Louis XIV.; the Quadruple Alliance (1718) of Great Britain, France, Austria, and Holland, against Spain; the Holy Alliance (1815) of Russia, Austria, and Prussia, for the maintenance of peace and the establishment of the existing dynasties; and the alliance (1854) of Great Britain, France, and Turkey, against Russia.

ALLIER, a department in the centre of France, so called from the river of the same name; bounded on the N. by the department of Cher and Nièvre, on the E. by those of Saône-et-Loire and Loire, on the S. by that of Puys de Dôme, and on the W. by those of Creuse and Cher; extending at the widest points 82 miles from E. to W., and 55 from N. to S.; and containing an area of 2821 square miles. Its surface is in general undulating, rising to considerable elevations among the mountains of Forez on the south-east, and among those of Auvergne towards the west. The river Allier flows northward between these ranges, receiving the Andelot, the Sioule, and the Bioudre, all from the left; east of the Allier is the Bèbre, which joins the Loire within the limits of the department; and on the west the Cher, with its tributary the Aumance. The soil is for the most part fertile, especially in the valleys of the Allier, the Sioule, and the Bèbre, yielding wheat, oats, barley, rye, fruits, and potatoes, in quantities exceeding what is required for home consumption, as well as some red and white wines. Good timber is grown, and cattle, sheep, goats, and horses are reared in large numbers; but agriculture is on the whole in a backward condition, owing to the inhabitants' aversion to change. The mineral wealth of the department is very considerable, including iron, coal, antimony, marble, and manganese—the coal mines of Commentry being among the most important. The chief manufactures are of cutlery, earthenware, glass, cloth, leather, and paper. The climate is healthy, but is liable to sudden variations of temperature. The mineral waters at Vichy, Nèris, and Bourbon l'Archambault, in the department, are in much repute. Allier comprehends the greater portion of the old province of Bourbonnais, and is at present divided into four arrondissements—Moulins, Gannat, La Palisse, and Montluçon, which are subdivided into 28 cantons and 317 communes. Moulins is the capital, and the seat of a bishop whose diocese is co-extensive with the department. The other important towns are La Palisse, Cusset, Vichy, Gannat, Saint Pourçain, Montluçon, and Commentry. Population in 1871, 390,812; of whom 196,831 were males, and 193,981 females. Of the total population, 223,374 could neither read nor write, and 36,786 could read but could not write.

ALLIER, the ancient *Elaver*, a river of France, which rises in the department of Lozère, among the Margeride mountains, a few miles east of the town of Mende, and, after traversing Haute Loire, Puys de Dôme, and Allier, forms the boundary between Cher and Nièvre, until it falls into the Loire four miles west of Nevers. Its length is 200 miles, for a considerable portion of which it is navigable, and its chief tributaries are the Dore and the Sioule.

ALLIGATOR, (probably derived from the Spanish *el lagarto*, the lizard), an animal so closely allied to the crocodile that some naturalists have classed them together as forming one genus. It differs from the true crocodile principally in having the head broader and shorter, and the snout more obtuse; in having a large canine tooth of the under jaw received, not into an external furrow, but into a pit formed for it within the upper one; in wanting a jagged fringe which appears on the hind legs and feet of the crocodile; and in having the toes of the hind feet webbed not more than half-way to the tips. The principal species, all found in America only, are the common alligator (*Alligator Mississippiensis* or *Crocodilus Lucius*), occurring in the southern United States; the caiman or cayman (*A. palpebrosus*), in Surinam and Guiana; and the spectacled alligator or jacaré (*A. sclerops*), principally in Brazil. The names *alligator* and *crocodile* are often confounded in popular speech; and the structure and habits of the two animals are so similar that both may be conveniently considered under the heading CROCODILE.

ALLITERATION. As Milton defined rhyme to be "the jingling sound of like endings," so alliteration is the jingle of like beginnings. All language has a tendency to jingle in both ways, even in prose. Thus in prose we speak of "near and dear," "high and dry," "health and wealth." But the initial form of jingle is much more common—"safe and sound," "thick and thin," "weal or

woe," "fair or foul," "spick and span," "fish, flesh, or fowl," "kith and kin." The poets of nearly all times and tongues have not been slow to seize upon the emphasis which could thus be produced. Accordingly we read in Shakespeare:—

"Full fathom five thy father lies:
Of his bones are corals made."

In Pope:—

"Here files of pins extend their shining rows
Puffs, powders, patches, bibles, billet-doux

In Gray:—

"Weave the warp and weave the woof,
The winding-sheet of Edward's race."

In Coleridge:—

"The fair breeze blew, the white foam flew,
The furrow followed free;
We were the first that ever burst
Into that silent sea."

Churchill describes himself as one

"Who often, but without success, had prayed
For apt alliteration's artful aid,—"

an example which is itself a proof of his failure; for alliteration is never effective unless it runs upon consonants.

As thus far considered, alliteration is a device wholly dependent on the poet's fancy. He may use it or not, or use it much or little, at his pleasure. But there is an extensive range of poetry whose metrical laws are entirely based on alliteration. This, for example, is the principle on which Icelandic verse is founded; and we have a yet nearer interest in it, because it furnishes the key to Anglo-Saxon and a large portion of early English verse. For a specimen take the following lines, the spelling modernised, from the beginning of *Piers the Ploughman*:—

"But in a *M*ay *m*orning | on *M*alvern hills,
Me be*f*el a *f*erly | of *f*airy methought;
I was *w*eary of *w*andering | and *w*ent me to rest
Under a *b*road *b*ank | *b*y a *b*urn-side;
And as I *l*ay and *l*eaned | and *l*ooked on the waters,
I *s*lumbered in a *s*leeping | it *s*ounded so merry."

The rule of this verse is indifferent as to the number of syllables it may contain, but imperative as to the number of accented ones. The line is divided in the middle by a pause, and each half ought to contain two accented syllables. Of the four accented syllables, the first three should begin with the same letter; the fourth is free, and may start with any letter. Those who wish for a more minute analysis of the laws of alliterative verse, as practised by the Anglo-Saxon and early English poets, may consult an exhaustive essay on the subject by the Rev. W. W. Skeat, prefixed to vol. iii. of *Bishop Percy's Folio Manuscript;* only the reader must be on his guard against an error which pervades it, and which this able writer seems to have derived from Rask. The question arises—What is the nature of the cadence in alliterative verse? Now all metrical movement is of two kinds, according as the beat or emphasis begins the movement or ends it. If the beat is initial, we say in classical language that the movement is trochaic or dactylic, according to the number of its syllables; and if the beat is final, we in like manner say that the movement is iambic or anapæstic. Mr Skeat and many others object with some reason to use the classical terms, and therefore brushing them aside, let us put the question in the simplest form—Has the movement of alliterative verse got the initial or the final beat? In the middle of last century Bishop Percy decided this question with sufficient accuracy, though he mixed up his statement with a blunder which it is not easy to account for. He points out how the poets began to introduce rhyme into alliterative verse, until at length rhyme came to predominate over alliteration, and "thus was this kind of metre at length swallowed up and lost in our common burlesque Alexandrine or anapæstic verse, as

A cobbler there was, and he lived in a stall."

Percy made a serious mistake when he gave the name of Alexandrine to anapæstic verse; but he is quite right in his general statement that alliterative verse became lost in a measure, the movement of which had the final beat. Conybeare has stated the fact still more accurately. "In the Saxon poetry a trochaic character is predominant. In *Piers Plowman* there is a prevailing tendency to an anapæstic cadence." It is the result of a change in the language—the loss of inflection. Take the word *man*. The genitive in Saxon would be *mannes*, a trochee; in English, *of man*, an iambus. The tendency of the language was thus to pass from a metrical movement, in which the beat was initial, to one in which it was final. It may therefore be quite right to speak of Anglo-Saxon alliterative poetry as trochaic or dactylic, and quite wrong to apply the same terms to the cadence of our later alliterative verse. And this is precisely the error into which Mr Skeat has fallen. He says—"Lines do not always begin with a loud syllable, but often one or two and sometimes (in early English especially) even three soft syllables precede it. These syllables are necessary to the sense, *but not to the scansion of the line*." That is just the point at issue. By leaving out of account the light syllable or syllables at the beginning of a line, and taking his start from the first syllable that has the alliterative beat, Mr Skeat may certainly prove that all the later alliterative poetry has a movement of initial beat. But English ears will not submit to this rule. It is those light syllables of no account which have altered the rhythm of English descant from one of initial to one of final beat. (E. S. D.)

ALLIX, Pierre, a distinguished divine of the French Reformed Church, was born at Alençon in 1641. He was pastor first at St Agobile in Champagne, and then at Charenton, near Paris. The revocation of the Edict of Nantes in 1685 compelled him to take refuge in London, where, under the sanction of James II., he opened a church for the French exiles. His reputation for learning was such as to obtain for him, soon after his arrival, the degree of doctor of divinity from both universities, and in 1690 he received from Bishop Burnet the more substantial honour of the treasurership and a canonry in Salisbury cathedral. He died at London in March 1717.

The works of Allix, which are very numerous, are chiefly of a controversial and apologetic character, and, like most works of that class, are not thoroughly trustworthy. At the invitation of a number of English ministers, he is said to have written a history of the councils of the church, which, however, owing to want of support, never was published. In opposition to Bossuet he issued *Some Remarks upon the Ecclesiastical History of the Ancient Churches of Piedmont* (1690), and *Remarks upon the Ecclesiastical History of the Ancient Churches of the Albigenses* (1692), with the view of showing that the Albigenses were not Manichæans, but historically identical with the Waldenses. His *Dissertation on the First Rise of the Trisagium or Doxology* (1674), and *Reflections upon the Books of Holy Scripture* (1688), are of little present value.

ALLOA, a seaport town of Scotland, in the county of Clackmannan, situated on the north side of the Firth of Forth, 25 miles from Edinburgh, and 6 below Stirling, with which it is connected by railway. The town as a whole is irregularly built, although in the modern portions there are several spacious streets, with good shops and houses. The parish church, opened in 1819, is a fine Gothic edifice, with a handsome spire 200 feet high; there are also places of worship belonging to the other denomina-

tions, as well as the county court-house, a corn exchange, and schools of various grades. In the immediate vicinity of the town is an ancient tower, 89 feet high, with walls 11 feet in thickness, said to have been built about the year 1315, formerly the residence of the powerful family of Erskine, descendants of the Earls of Mar. Here many of the Scottish princes received their education as wards of the Lords Erskine and the Earls of Mar, the last of these educated here being Henry, the eldest son of James VI. Among the manufactures of Alloa are ale, whisky, iron goods, glass (especially bottles), bricks, yarns, shawls, and blankets. Shipbuilding is also carried on to some extent, and in the neighbourhood there are several collieries. The harbour is safe and commodious, having a depth of 16 feet at neap, and 22 at spring tides; adjoining it is an excellent dry dock, and a capacious wet dock was constructed in 1863. In 1872, 446 vessels of 49,941 tons entered, and 533 of 70,499 cleared the port of Alloa, in addition to coasting vessels in ballast; and in the same year £453 were derived from customs duties. The chief exports were pig-iron, ale, glass, and coals; the imports, timber, grain, iron, linseed, and flax. There is a ferry here across the Forth. Population in 1871, 9362.

ALLODIUM or ALODIUM denotes lands which are the absolute property of their owner, and not subject to any service or acknowledgement to a superior. It is thus the opposite of *fe-odum* or fief. The proper derivation of the word has been much discussed and is still doubtful, though it is probably compounded of *all*, whole or entire, and *odh*, property. Allodial tenure seems to have been common throughout northern Europe It exists in Orkney and Shetland, where the proprietor of an allodial estate was known until recently as an *udaller*. (See Sir Walter Scott's *Pirate.*) In England allodial tenure is unknown, the feudal system having been made universal by William the Conqueror.

ALLORI, ALESSANDRO, a painter of the Florentine school, was born at Florence in 1535, and died in 1607. Having lost his father in his fifth year, he was brought up and trained in art by his uncle, Angelo Bronzino, whose name he sometimes assumed in his pictures. Visiting Rome in his nineteenth year, he carefully studied the works of Michael Angelo; but having himself little genius and no originality, the influence of that great master can only be traced in the anatomical correctness of his drawing of nude figures. He was very successful as a portrait-painter.

ALLORI, CRISTOFANO, son of the preceding, was born at Florence on the 17th October 1577, and died in 1621. He received his first lessons in painting from his father, but becoming dissatisfied with the hard anatomical drawing and cold colouring of the latter, he entered the studio of Pagani, who was one of the leaders of that later Florentine school which endeavoured to unite the rich colouring of the Venetians with the correct drawing of Michael Angelo's disciples. Allori became one of the foremost of this school. His pictures are distinguished by their close adherence to nature and the delicacy and technical perfection of their execution. His technical skill is proved by the fact that several copies he made after Correggio have been taken to be duplicates by Correggio himself. His extreme fastidiousness limited his power of production, though the number of his works is not so small as is sometimes asserted. Several specimens are to be seen at Florence and elsewhere. The finest of all his works is his "Judith and Holofernes," in the Pitti palace. The model for the Judith was his mistress, the beautiful Mazzafirra, who is also represented in his Magdalene; and the head of Holofernes is generally supposed to represent himself, though this is questioned by the best authorities.

ALLOTROPY (from ἄλλος, other, and τρόπος, manner), a name applied to a property, whereby certain substances, chemically simple, assume different forms and conditions without undergoing chemical change. Sulphur and phosphorus, for instance, occur sometimes in crystals and sometimes in an amorphous state, being in the latter case sometimes translucent and sometimes opaque, and present very different properties under these different conditions. Ozone is an allotropic form of oxygen. The name *isomerism* is given to the similar by no means uncommon property whereby compound bodies, although entirely distinct, are made up of the same chemical elements in precisely the same proportions.

ALLOXAN, a product of the action of oxidising agents on uric acid, obtained by adding slowly, in small quantities, uric acid to strong nitric acid of specific gravity 1·4, kept cool, and stirring constantly. Carbonic acid and nitrogen are evolved during the action, and the alloxan crystallises out on standing. It is purified by recrystallisation from water, and then has the composition $C_4H_2N_2O_4 + aq$. The crystals of this compound are large and colourless, and when heated to a temperature of 150° C., lose the water of crystallisation, and acquire a red colour. Alloxan is readily soluble in water and alcohol, and its aqueous solution reddens litmus, has an astringent taste, and colours the skin purple after some time. It produces a great number of derivatives, for which see URIC ACID.

ALLOY, the name given to a combination obtained by fusing metals with each other. Few metals are employed in the pure state, with the exception of iron, copper, lead, tin, zinc, platinum, aluminium; metals are more frequently used in the forms of alloys for technical purposes. Every industrial application necessitates special qualities that may not occur in any isolated metal, but which may be produced by the proper mixture of two or more of these substances. Thus gold and silver, which in their pure state are too soft and flexible for the manufacture of plate, coin, trinkets, &c., are hardened by the addition of a tenth part of copper, while the colour and other valuable qualities are not materially impaired. Similarly copper is rendered hard by mixture with zinc, when we obtain brass, an alloy of a beautiful yellow colour, easier to work than the pure metal. If brass has to be used in turning operations it is found to tear under the action of the chisel, unless a small quantity of lead has been added. These examples are sufficient to show that an alloy is really an industrial metal, often of greater importance than the metals which compose it.

Alloys are equally interesting from a purely scientific point of view. They are not only mixtures of metals having certain particular qualities, but in reality are true chemical compounds, generally dissolved in an excess of one of the constituent metals. In the appearances which accompany the union of the metals, and in the properties of the resulting products, we observe that which characterises the manifestation of affinity, that is, an evolution of heat and light, resulting in the formation of substances having a definite composition, distinct crystalline form, and a variety of properties different from those of the constituents. If a piece of clean sodium is rubbed in a mortar with a quantity of dry mercury, the metal dissolves, producing a harsh sound resembling the immersion of red hot iron in water. This phenomenon is due to the large evolution of heat which accompanies the combination, as the mercury rises rapidly in temperature on the addition of each successive piece of sodium. If the mass is allowed to cool after the action, long needles of a white brilliant alloy of definite composition crystallise from the middle of the liquid, from which the excess of mercury may be separated by decantation. Platinum, iridium, gold, rhodium, ruthenium, and silver unite with tin, producing an evolution of heat; if

the tin is in excess after cooling, a metallic ingot is obtained resembling closely the original substance; but if the mass is treated with strong hydrochloric acid, the excess of tin is dissolved and crystals remain of a definite alloy of tin and the precious metal. These alloys are insoluble in strong hydrochloric acid, which dissolves tin so easily; but they are soluble in aqua regia, even when the precious metal contained therein (rhodium, ruthenium, iridium) is in the free state absolutely insoluble. This is no proof that the industrial alloys are always the result of one definite combination dissolved in excess of one of the metals, as many combinations are able to co-exist in the same alloy. This may be proved by taking an alloy of tin, lead, and bismuth, which melts below the boiling point of water, heating to a temperature of 25° C., and observing the rate of cooling by means of a thermometer. The thermometer falls at first regularly as far as a certain degree, where it remains stationary for some time, after which it descends to a lower temperature, where it is again similarly arrested. These two stoppages in the rate of cooling can only be explained by admitting the production of a less fusible alloy in the fluid mass, which solidifies with an evolution of heat, rendering the thermometer stationary for a time. Each successive arrest will therefore correspond to the formation of more fusible combinations. Thus the metals form amongst themselves true chemical combinations; and alloys are often formed by the mixture of one or more of these compounds with excess of one of the constituents.

Recently hydrogen, which, although a gaseous substance, has chemical properties resembling those of the true metals, has been combined with palladium, sodium, and potassium, producing compounds similar in properties to the recognised alloys.

Properties of Alloys. *Density.*—If the density of any alloy is calculated from that of the components—assuming that there is no condensation of volume—the resulting number is sometimes greater than, equal to, or less than, the experimental result. Thus the alloys of gold and silver are less dense than the theoretical mean density; whereas brass and the alloys of lead and antimony vary in the opposite direction. The former are therefore produced through an expansion, the latter through a condensation of their constituents. In the formation of many alloys there is no alteration of volume, and then the calculated density is correct. *Colour.*—This is generally grey, unless when we have a coloured metal like copper or gold present in sufficient quantity. *Hardness, Ductility, and Tenacity.*—Alloys are for the most part harder and more brittle, and are generally less ductile and possess less tenacity than the constituent metal that has these properties in excess. Aluminium bronze is an exception, as its tenacity is greater than that of either of the components. *Fusibility.*—This is always greater than that of the least fusible metal entering into the composition of the alloy, and is sometimes greater than in any of the components. Thus an alloy, composed of 5 parts of bismuth, 3 of lead, and 2 of tin, melts at 91° C. Alloys of lead and silver, containing a small quantity of the latter, are more fusible than lead, and potassium and sodium form an alloy fluid at the ordinary temperature of the air. *Liquation.*—The constituents of an alloy heated gradually to near its point of liquefication frequently unite anew in such proportions as to form a mass that is fusible at the given temperature. If the fluid portion is poured off, there remains a solid alloy less fusible than the original. Copper is separated from silver by this process. *Decomposition.*—When the alloy contains a volatile metal like zinc or mercury, heat decomposes it, but the temperature required to expel the last trace of the volatile metal must be considerably higher than that metal's normal temperature of ebullition. *Temper.*—The alloy of 94 parts of copper and 6 parts of tin forms a bronze so brittle that it may be pulverised with a hammer when it has been slowly cooled; but if, on the contrary, it is cooled rapidly by tempering it in cold water, it becomes malleable. *Influence of the Constituent Metals.*—Mercury, bismuth, tin, and cadmium give fusibility to alloys into which they enter; tin also gives hardness and tenacity if present in considerable quantity; lead and iron give hardness; arsenic and antimony render alloys brittle.

Composition of Alloys.—A statement of the average proportions in which the metals enter into the best known alloys, the composition of which is generally very variable, is given in the following table:—

Coinage of gold,.	Gold, 90. Copper, 10.	Specula of telescopes,...............	Copper, 67. Tin, 33.
Gold jewellery and plate,.......	Gold, 75 to 92. Copper, 25 to 8.	Pinchbeck,............	Copper, 90. Zinc, 10.
Silver coinage,.....	Silver, 90. Copper, 10.	Brass,.....................	Copper, 67 to 72. Zinc, 33 to 28.
Silver vessels,......	Silver, 95. Copper, 5.	German silver,........	Copper, 50. Zinc, 25. Nickel, 25.
Silver jewellery,..	Silver, 80. Copper, 20.	Type metal,............	Lead, 80. Antimony, 20.
Aluminium Bronze,..........	Copper, 90 to 95. Aluminium, 10 to 5.	English metal,........	Tin, 100. Antimony, 8. Bismuth, 1. Copper, 4.
Bronze. — Coins, Medals,..........	Copper, 94 to 96. Tin, 4 to 6. Zinc, 1 to 5.	Pewter,.................	Tin, 92. Lead, 8.
Bronze.—Cannon,	Copper, 90. Tin, 10.	Liquid measures,.....	Tin, 82. Lead, 18.
Bronze.—Bells,....	Copper, 78. Tin, 22.	Plumbers' solder,.....	Tin, 67. Lead, 33.
Bronze. — Cymbals,...............	Copper, 80. Tin, 20.		

Preparation of Alloys.—The metals are generally fused together under a layer of charcoal to prevent oxidation, thoroughly mixed by agitating, and the mass left to cool slowly. This process can only be employed when the constituent metals are all non-volatile at the temperature required for combination. If the mixture contains volatile metals, like sodium, potassium, magnesium, or zinc, they are added after the more refractory metal is fused.

ALLSTON, Washington, an eminent American historical painter and poet, was born 5th November 1779, at Waccamaw, in South Carolina, where his father was a planter. He early displayed a taste for the art to which he afterwards devoted himself. He graduated at Harvard in 1800, and for a short time pursued his artistic studies at Charleston with Malbone and Charles Fraser. He then removed to London, and entered the Royal Academy as a student of Benjamin West, with whom he formed a life-long friendship. In 1804 he repaired to Paris, and from that city, after a few months' residence, to Rome, where he spent the greater part of the next four years studying Italian art and Italian scenery. During this period he became intimate with Coleridge and Thorwaldsen. From 1809 to 1811 he resided in his native country, and from this latter date to 1817 he painted in England. After visiting Paris for a second time, he returned to the United States, and practised his profession at Boston (1818–30), and afterwards at Cambridge, Massachusetts, where he died on the 9th July 1843. He was elected an associate of the Royal Academy in 1819. The paintings of Allston are characterised rather by grandeur of conception than by skilful execution. In colour and the management of light and shade he closely imitated the Venetian school, and he has hence been styled "the American Titian." Many of his pictures have biblical subjects, and Allston himself had a profoundly religious nature. His first great painting, "The Dead Man Revived," executed shortly after his second visit to England, gained a prize of 200 guineas from the British Institution; in England he also prepared his "St Peter Liberated by the Angel," "Uriel in the Sun," "Jacob's Dream," and "Elijah in the Wilderness." To the period of

his residence in America belong "The Prophet Jeremiah," "Saul and the Witch of Endor," "Miriam," "Beatrice," "Rosalie," "Spalatro's Vision of the Bloody Hand," and the vast but unfinished "Belshazzar's Feast," at which he was working at the time of his death. As a writer, Allston shows great facility of expression and imaginative power. His friend Coleridge said of him that he was surpassed by no man of his age in artistic and poetic genius. His literary works are—*The Sylphs of the Seasons and other Poems* (1813), where he displays true sympathy with nature and deep knowledge of the human heart; *Monaldi* (1841), a tragical romance, the scene of which is laid in Italy; and *Lectures on Art*, edited by his brother-in-law, R. H. Dana the novelist (1850).

ALLUVIUM, soil or land made up of the sediment deposited by running water. Rivers act on the rocks in their course both mechanically and chemically, and are in consequence always more or less loaded with detritus, which in its turn again aids the water in abrading other rocks. A great proportion of the matter with which rivers are thus charged is carried out to sea. But in level tracts, where the motion of a river is slow, it frequently overflows its banks, and leaves a sediment of earth, mud, gravel, &c., when it returns to its ordinary channel. The principal alluvial tracts are the deltas or deltoid formations at the mouths of large rivers. These vary in character very considerably. The Delta of the Nile is the best-marked specimen; the waters of the Rhine, Ganges, &c., arrested by the solid matter they have washed down, force their way through it in numerous smaller channels; the Mississippi has carried the solid matter it holds in suspension far into the Gulf of Mexico, forming long spits of land on the banks of the stream. The cognate term *diluvium* (now little used) has been applied to formations produced by extraordinary aqueous agencies.

ALMA, a river of Russia, in the S.W. of the Crimea, which falls into the sea about 16 miles N. of Sebastopol. It gives its name to a battle gained over the Russians, on the 20th September 1854, by the allied British, French, and Turkish armies. The British numbered 25,000 men, with 60 guns, and were commanded by Lord Raglan; the French force consisted of 30,000 men and 68 guns, to which were added 7000 Turkish infantry—all under the command of Marshal St Arnaud. To these were opposed 36,000 Russians, with 122 guns, under Prince Menschikoff, strongly posted on the heights on the left bank of the river. The victory was largely due to the determined advance of the British in face of the Russian fire.

ALMADEN, or ALMADEN DEL AZOGUE (in Arabic, the "Mine of Quicksilver"), a town of Spain, in the province of Ciudad Real, lies in the Sierra Morena, 55 miles S.W. of the town of Ciudad Real. It is the *Sisapon* of the Romans, and is famous for its quicksilver mines, which have been wrought extensively both in ancient and in modern times. They were the richest and most productive in the world until the discovery of quicksilver at New Almaden in California. The annual yield is about 1,400,000 ℔, and 4000 workpeople are employed. The principal vein is 25 feet thick; a depth of 1000 feet has been reached, and the ore increases in richness with the depth of the descent. These mines belong to the Spanish Government, and yield a large revenue. At various periods they have been leased to private speculators. The town has a good hospital and mining schools. Population, 9000.

ALMAGEST, compounded of the Arabic *al* and *μεγίστη*, the name applied by the Arabians to their translation of the Μεγάλη Σύνταξις of Claudius Ptolemy, which contains a large collection of problems in geometry and astronomy. The translation was made about the year 827 A.D. by order of the caliph Al-Mamun. The name is also applied to other editions and translations of the work, as well as to other scientific compilations. Thus Riccioli published a book of astronomy, the *New Almagest*, and Plukenet an *Almagestum Botanicum*.

ALMAGRO, a town of Spain, in the province of Ciudad Real, 12 miles E.S.E. of the town of that name. It stands in a fertile plain, and is a well-built town, with spacious streets and a fine square. It was once almost exclusively inhabited by monks and the Knights of Calatrava, and contains several ruined churches, monasteries, and convents. In the town and neighbourhood lace is extensively manufactured, as many as 9000 workmen being employed. Brandy, soap, earthenware, and leather are also made; and the surrounding district is famous for its breed of asses and mules, for the sale of which two great fairs are annually held. Excellent red wine is produced in the district. Population, 14,000.

ALMAGRO, DIEGO DE, a Spanish commander, the companion and rival of Pizarro, was born at Aldea del Rey in 1475. According to another account he was a foundling in the village from which he derived his name. Nothing is known of his life until 1525, when he joined Pizarro and Hernando de Luque at Panama in a scheme for the conquest of Peru. The details of his subsequent career are given at length in the article PERU. He was executed by order of his former associate Pizarro in 1538.

ALMALI, a prosperous town of Asiatic Turkey, situated on the river Myra, 25 miles from its mouth, and 50 miles W.S.W. of Adalia. It lies 5000 feet above the sea, in a valley at the extremity of an extensive plain, the neighbouring mountains rising to a height of 10,000 feet. The town is well built, with handsome houses, several mosques, and a bazaar; and its appearance is rendered very attractive by the lofty trees interspersed through the streets, and by the gardens of the environs. There are numerous mills and factories, tanyards and dyeworks; and the inhabitants are exceedingly industrious. The town is much frequented by merchants from Smyrna and other places, who purchase the produce of the district and send it to the coast for shipment. Population, 8000.

AL-MAMUN (also written AL-MAMOUN, AL-MAMON, and simply MAMUN), one of the most renowned of the Abbasside dynasty of caliphs, was born in 786 A.D. He was the son of Harun-al-Raschid, whose caliphate is the golden age of Mahometan history. Harun, dying in 808, left the supremacy to his son Al-Amin, Al-Mamun being at the time governor of Khorassan, and favourable to the succession of his brother. Irritated, however, by the treatment he received at the hands of Amin, and supported by a portion of the army, Mamun speedily betook himself to arms. The result was a five years' struggle between the two brothers, ending in the death of Amin, 4th October 813, and the proclamation of Al-Mamun as caliph at Baghdad. Various factions and revolts, which disturbed the first years of his reign, were readily quelled by his prudent and energetic measures. But a much more serious rebellion, stirred up by his countenancing the heretical sect of Ali and adopting their colours, soon after threatened his throne. His crown was actually on the head of his uncle Ibrahim ben Mahdi (surnamed Mobarek) for a short time, and a civil war with the orthodox Mussulmans was imminent, when the timely death of Mamun's vizier and of the imam Rizza removed his principal heretical advisers, and restored the people to their allegiance. This inaugurated a period of tranquillity, which Al-Mamun employed in patronising and fostering the cultivation of literature and science throughout his empire. He had already, while governor of Khorassan, founded a college there, and attracted to it the most eminent men of the

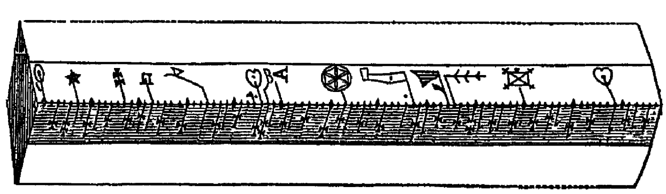
day; and now Baghdad became, under his auspices, the seat of academical instruction and the centre of intelligence. At his own expense he caused to be translated into Arabic many valuable books from the Greek, Persian, Chaldean, and Coptic languages; and he was himself an ardent student of mathematics and astronomy. The first Arabic translation of Euclid was dedicated to him in 813. Mamun founded observatories at Baghdad and Kassiun (near Damascus) for astronomical purposes, and he succeeded in determining the inclination of the ecliptic. He also caused a degree of the meridian to be measured on the plain of Shinar; and he constructed astronomical tables, which are said to be wonderfully accurate. The supposed antagonism of orthodoxy and science receives some support from the conduct of Mamun. A lover of philosophy and letters, he did not concern himself about the creed of the professors he appointed to his colleges, or the physicians he employed at his court; and on the occasion of his marriage he distributed largesses to Mussulmans, Jews, and Christians indiscriminately. These liberal measures culminated, however, in his becoming a convert in 827 to the heterodox faith of the Motasali, who asserted the free-will of man and denied the eternity of the Koran. The later years (829–830) of his reign were distracted by hostilities with the Greek emperor Theophilus, occasioned, it is said, by a dispute about an eminent Greek priest whom the caliph wished to attach to his college at Baghdad. A series of revolts in different parts of the Arabian empire betokened the decline of the military glory of the caliphs. Already had Spain and part of Africa asserted their independence, and Egypt and Syria were now inclined to follow. In 833, after quelling Egypt, at least nominally, Mamun marched into Cilicia to prosecute the war with the Greeks; but with this expedition the career of one of the most famous of the caliphs was to terminate. He died near Tarsus, leaving his crown to a younger brother, Motassem. The death of Al-Mamun ended an important epoch in the history of science and letters, and the period of Arabian prosperity which his father's reign had begun. The influence of these two sovereigns is sometimes exaggerated; but there can be no doubt we owe much to their exertions at a time when Europe was sunk in barbarism. Mamun was the author of *Inquiries into the Koran*, of a tract on the *Signs of Prophecy*, and of one on the *Rhetoric of the Priests and Panegyrists of the Caliphs*.

ALMANAC, a book or table, published from year to year, containing a calendar of the days, weeks, and months of the year, a register of ecclesiastical festivals and saints' days, and a record of various astronomical phenomena, particularly the rising and setting of the sun, the changes and phases of the moon, eclipses of the sun and moon, the times of high water at particular ports, &c. In addition to these contents, which may be regarded as essential to the almanac, it generally presents additional information, which is more or less extensive and varied according to the many different special objects contemplated in works of this kind. The derivation of the word is doubtful. The first syllable is the Arabic definite article; the rest of the word has been variously derived from the Greek μήν, a month; the Anglo-Saxon *mona*, the moon; and (which appears the most probable derivation) the Arabic *manah*, to reckon.

The CALENDAR will be treated of in a separate article (which see). Here we have to do with the publication which contains the calendar of any particular year, along with other matter, astronomical, statistical, political, &c. The *Ephemeris* again, it is to be observed, is a strict astronomical term, being a register from day to day of the places and motions of the heavenly bodies.

The attention given to astronomy by Eastern nations, and the practice that prevailed among them of divination by means of the stars, must have led to the early construction of such tables as are comprised in our almanacs. Our information respecting these is extremely scanty; but we are not left in the same ignorance with regard to the practice of the ancient Romans. The peculiar arrangement of their calendar is well known, and their *fasti sacri* or *kalendares* were very similar to modern almanacs. Originally knowledge of the calendar was confined to the class of pontifices or priests, whom the people had to consult not only about the dates of the festivals, but also regarding the proper times of instituting various legal proceedings. But about 300 B.C. one Cn. Flavius, the secretary of Appius Claudius, possessed himself of the secret, either by the stealthy use of documents in the possession of his master, or, according to Pliny, by repeatedly consulting the pontifices and jurists, and collating the particulars of the information he obtained from them. It was neither more nor less than publishing an almanac when, as Livy[1] relates, he exhibited the *fasti* on white tablets round the forum. From this time tablets containing the calendar, the festivals, astronomical phenomena, and sometimes historical notices, seem to have been common. The *Fasti* of Ovid is a poetical relation of incidents and traditions connected with the calendar. The researches of antiquaries have brought to light numerous *fasti* or *calendaria* cut on marble and other kinds of stone. Representations of several of these will be found in Gruter's *Inscriptiones*. One figured there, the Farnese rustic calendar, is a cubical block of stone, on each of the four vertical faces of which three columns are engraved, detailing for each different month the number of days, the date of the *nones*, the lengths of the day and night, the sun's place in the zodiac (which is also indicated by a representation of the sign at the top of the column), the tutelary deity of the month, the rural operations of the season, and the chief festivals.

Almanacs of a ruder kind, known as *clogg almanacs*, were in use in some parts of England as late as the end of the 17th century. Dr Robert Plot, keeper of the Ashmolean Museum and professor of chemistry at Oxford, gives a figure of one of these, with a very minute description, in his *Natural History of Staffordshire* (Oxford, 1686); and another is represented in Gough's edition of Camden's *Britannia* (1806, vol. ii. p. 499). The cloggs were square blocks of hard wood, about 8 inches in length, with notches along the four angles corresponding to the days of the year. The accompanying illustration shows the angle



on which is registered the almanac for the months of January, February, and March, taking it from left to right. The marks on the under side in the figure exhibit the primes or golden numbers of a cycle, which is fully described in Plot's work. They generally increase by 8, 19 being struck off when that number is exceeded; and the same number will be found to stand against all the dates (approximately) of new moon throughout the year. The cross mark is for X, and the hook at the end of a line for V. The weeks are indicated by a deeper notch for every seventh day, and a broadening stroke on the upper side in the figure represents the first day of each month.

[1] "Fastos circa forum in albo proposuit, ut quando lege agi posset, sciretur" (ix. 46).

The other characters on the upper side are for saints' days and festivals. Thus Epiphany (Jan. 6) is indicated by a star, St Hilary (Jan. 13) by a bishop's double cross, the conversion of St Paul (Jan. 25) by an axe, St Valentine (Feb. 14) by a true lover's knot, St Matthias (Feb. 24) by a battle-axe, &c. All the feasts of the Virgin, as the Purification (Feb. 2) and the Annunciation (March 25), are denoted by a heart—Dr Plot was greatly puzzled to know why. St Blaise (Feb. 3), St Agatha (Feb. 5), and others were indicated by their initials; and opposite the day (March 1) consecrated to David, the patron saint of Wales, is a symbol which some consider a harp and others a leek.

The earliest almanac regarding which Lalande (whose *Bibliographie Astronomique*, Paris, 1803, is the best authority on publications of this kind) could obtain any definite information belongs to the 12th century. Manuscript almanacs of considerable antiquity are preserved in the British Museum and in the libraries of Oxford and Cambridge. Of these the most remarkable are a calendar ascribed to Roger Bacon (1292), and those of Peter de Dacia (about 1300), Walter de Elvendene (1327), John Somers (1380), &c. It is to be remembered that early calendars (such as the *Kalendarium Lincolniense* of Bishop Robert Grosseteste) frequently bear the names, not of their compilers, but of the writers of the treatises on ecclesiastical computation on which the calendars are based. In 1812 there was printed at Hackney what purported to be a transcription of the greater part of an almanac for 1386. This, if it exists, must be one of the earliest, perhaps *the* earliest, in the English language that has been preserved. The earliest English calendar in the British Museum is one for the year 1431. The first printed almanac known is one for the year 1457; the first of importance is that of Joannes de Monte-Regio, better known as Regiomontanus, which appears to have been printed at Nuremberg in 1472. In this work the almanacs for the different months embrace three Metonic cycles, or the 57 years from 1475 to 1531 inclusive. The *Ephemerides* of Regiomontanus, which are to be distinguished from his almanac, were sold, it is said, for ten crowns of gold, considerably more than their own weight. The earliest almanac printed in England was *The Kalendar of Shepardes*, a translation from the French, printed by Richard Pynson about 1497.

The exclusive right to sell "almanacs and prognostications," enjoyed in the time of Elizabeth by two members of the Company of Stationers, was extended by James I. to the two universities and the Stationers' Company jointly; but the universities commuted their privilege for an annuity from the company. About a century ago one Thomas Carnan, a bookseller, conceiving that the company had no just title to its monopoly, published an almanac for three successive years, and was thrice imprisoned on that account by the company. In 1775 the case came before the Court of Common Pleas, and was decided in Carnan's favour. The question argued was, "Whether almanacs were such public ordinances, such matters of state, as belonged to the king by his prerogative, so as to enable him to communicate an exclusive right of printing them to a grantee of the crown?" and the judges were unanimously of the opinion that the crown had no such right. The minister, Lord North, made an attempt in 1779 to put the company in possession, by a parliamentary enactment, of what the judges had denied it; but the proposed monopoly was denounced by Erskine and others with such ability and severity that the bill was thrown out by a majority of forty-five. In consequence of this loss to the company of its exclusive right to issue almanacs, the universities lost their title to their annuity, and in lieu of it they received a parliamentary grant. The company continued, however, virtually to retain its monopoly by buying up as much as possible all the almanacs issued by other publishers, and by means of the great influence it possessed over the book trade. In more recent times the power to control the sale of this class of publications has altogether ceased, but a considerable proportion of the almanacs published in this country still issue from the hall of the Stationers' Company. A lively description of "Almanac Day" at Stationers' Hall will be found in Knight's *Cyclopædia of London* (1851), p. 588.

The influence of the heavenly bodies on the conditions and affairs of men has been believed in, and a superstitious importance has been attached to particular times and seasons by the credulous from the remotest times. As might be imagined, therefore, since the bases on which the whole system of judicial astrology rested all fall within the field of the almanac-makers' labours, great prominence was given to omens and predictions in many of these publications. The early almanacs had commonly the name of "prognostications" in addition, and what they professed to show may be gathered from titles like the following, which is quoted by Mr Halliwell:—"Pronostycacyon of Mayster John Thybault, medycyner and astronomer of the Emperyall Majestie, of the year of our Lorde God MCCCCCXXXIIJ., comprehending the iiij. partes of this yere, and of the influence of the mone, of peas and warre, and of the sykenesses of this yere, with the constellacions of them that be under the vij. planettes, and the revolucions of kynges and princes, and of the eclipses and comets." In 1579 Henry III. of France deemed it necessary to prohibit all almanac-makers from indulging in predictions. No such restriction, however, existed in this country; and it was to their prophesyings that the almanacs of the Stationers' Company were long indebted for much of their popularity. Among almanacs of this class published in England, and principally by the Stationers' Company, are Leonard Digges's *Prognostication Everlasting of Right Good Effect*, for 1553, 1555, &c.; William Lilly's *Merlinus Anglicus Junior*, for 1644, &c., and other almanacs and "prognostications;" Booker's *Bloody Almanac* and *Bloody Irish Almanac*, for 1643, 1647, &c.—the last attributed erroneously to Napier; Partridge's *Mercurius Cœlestis*, for 1681, *Merlinus Redivivus*, &c. The name of Partridge has been immortalised in Pope's *Rape of the Lock;* and his almanacs were very cleverly burlesqued by Swift, who predicted Partridge's own death, with all details of time and circumstance, in genuine prognosticator's style. The most famous of all the Stationers' Company's predicting almanacs was the *Vox Stellarum* of Francis Moore, dating from about 1680. Of a different but not a better sort was *Poor Robin*, dating from 1663, and published by the company down to 1828, which abounded in coarse, sometimes extremely coarse, humour.

On the 1st of January 1828 the Society for the Diffusion of Useful Knowledge issued the *British Almanac* for that year—a publication greatly superior in every way to the almanacs of the time. To quote the society's *Almanac* for 1829—

> "This was almost the first attempt in this country to produce an almanac that should not only be useful to all classes, and of which the information should be wholly of a popular character, but which should be purified from the superstitions, prejudices, and indecencies which have characterised some of the almanacs of which the circulation has been the most extensive. By a parliamentary return of the year 1828 we find that the stamp duty paid upon the almanacs of England exhibits a circulation of 451,593 annually. It may be safely asserted that two-thirds of these publications contain some large portion of the matter just described; and they thus keep alive a spirit of ignorance utterly opposed to the desire for sound and practical information which distinguishes our own times."

The success of the *British Almanac*, with its valuable

supplement, the *Companion to the Almanac*, led to a great improvement in this class of publications. The Stationers' Company issued the *English Almanac*, a work of a similar kind. The entire repeal in 1834, by the 3d and 4th Will. IV., c. 57, of the heavy stamp duty on all almanacs of fifteenpence per copy, gave an additional stimulus to the publication of almanacs of a better class, and from that time the number has greatly increased. It is interesting to remark that the *British Almanac* and *Companion* still exist, and retain their original form and character, and that this has from 1870 been the principal almanac published by the Stationers' Company.

The variety of extraneous matter included in almanacs, corresponding to the very numerous other objects to which the almanac proper is often only secondary, can be merely alluded to here. A number of publications, issued in Germany from the middle of the 18th to the middle of the 19th century, under such titles as *Musenalmanach*, or *Almanach des Muses*, contain some of the best works of some of the most celebrated German poets. The *Almanach de Gotha*, which has existed since 1764, and is published at present both in French and German, gives a particular account of all the royal and princely families of Europe, and ample details, compressed into little space, concerning the administration and the statistics of the different states of the world. As works of general statistical reference, the two national almanacs, *Oliver and Boyd's New Edinburgh Almanac* (from 1837) and *Thom's Irish Almanac* (from 1843), are of very great value.

The *Nautical Almanac* is a publication the object of which is to supply information that is indispensable to the navigator and the astronomer. It gives with the utmost precision the positions of the principal heavenly bodies at short intervals of time, and other important details of celestial phenomena. The moon's exact position is registered for every hour, and also the angular distances at noon and midnight daily of the moon from the sun and several fixed stars. By means of the data thus supplied, in connection with observations of the heavenly bodies, time, latitude, and longitude can be determined. The *Nautical Almanac* has been published regularly since the issue in 1766 of the Almanac for 1767. It was originated by Dr Maskelyne, the astronomer-royal, who conducted it for many years. About 1830 the Lords of the Admiralty were induced by complaints of its defects to bring the subject under the notice of the Royal Astronomical Society. The society appointed a committee to consider what changes seemed necessary, and, on the committee's recommendation, the form was adopted which has continued with little change from 1834 to the present time. During that period the Almanac has been published under the superintendence of the Admiralty. It is issued generally three years at least before it comes into use. The *Connaissance des Temps* (from 1679), the *Berliner Jahrbuch* (from 1776), and the *American Ephemeris* and *Nautical Almanack* (from 1855) are publications of a similar kind.

(See, in addition to works referred to above, interesting papers by Mr J. O. Halliwell and Professor De Morgan in the *Companion to the Almanac* for 1839, 1840, 1845, 1846.)

ALMANSA, a town of Spain, in the province of Albacete, 35 miles E.S.E. of the town of that name, on the Madrid and Alicante railway. The surrounding plain is very fertile, and irrigated by means of a large reservoir. There are manufactures of linen and cotton fabrics, and also of brandy, leather, and soap. A Moorish castle is to be seen on a hill to the north-west of the town. About a mile from Almansa stands an obelisk commemorating the decisive battle fought here on 25th April 1707, in which the French, under the Duke of Berwick, the natural son of James II. of England, completely defeated the allied English and Spanish armies. The French greatly outnumbered the opposing force. This battle hastened the conclusion of the war of the Spanish succession. Population of the town, about 8000.

ALME, or Almai (from *âlim*, wise, learned), the name of a distinct class of singing girls in Egypt. To be received into it, according to M. Savary, it is necessary to have a good voice, to understand the language well, to know the rules of poetry, and be able to compose and sing impromptu couplets adapted to the circumstances. The almai are present at all festivals and entertainments, and also at funerals, where they act the part of hired mourners. They are to be distinguished from the ghawazee, or dancing girls, who perform in the public streets, and are of a lower order.

ALMEIDA, a strongly-fortified town of Portugal, in the province of Beira, situated between the Coa and the Duas Casas, a branch of the Agueda, 95 miles N.E. of Coimbra, and 25 miles from the Spanish fortress of Ciudad Rodrigo. It was taken by the Spaniards in 1762, and again by the French in 1810. The recapture of it by the Duke of Wellington in 1811 was deemed one of the most brilliant exploits of the Peninsular war. It is well fortified, and contains an ancient church and two hospitals. Population, 6580.

ALMEIDA, Don Francisco de, the first viceroy of Portuguese India, was born at Lisbon about the middle of the 15th century. He was the seventh son of the second Count of Abrantes, and thus belonged to one of the most distinguished families in Portugal. In his youth he took part under Ferdinand of Aragon in the wars against the Moors (1485–92). In March 1505, having received from Emmanuel I. the appointment of viceroy of the newly-conquered territory in India, he set sail from Lisbon in command of a large and powerful fleet, and arrived in July at Quiloa, which yielded to him almost without a struggle. A much more vigorous resistance was offered by the Moors of Mombaza, but the town was taken and destroyed, and its large treasures went to strengthen the resources of Almeida. At other places on his way, such as the island of Angediva, near Goa, and Cananore, he built forts, and adopted measures to secure the Portuguese supremacy. On his arrival in India he took up his residence at Cochin, where a Portuguese fort had been built by Albuquerque in 1503. The most important events of Almeida's brief but vigorous administration were the conclusion of a commercial treaty with Malacca, and the discoveries made by his son Lorenzo, who acted as his lieutenant. The latter was probably the first Portuguese who visited Ceylon, where he established a settlement, and is also celebrated as the discoverer of Madagascar and the Maldive islands. In 1508 he was killed at Dabul in a naval engagement with the Moors. His father was preparing signally to avenge his death when Albuquerque arrived in Cochin, and presented a commission empowering him to supersede Almeida in the government. It was probably Almeida's unwillingness to be thwarted in his scheme of vengeance that chiefly induced him to refuse to recognise Albuquerque's commission, and to cast him into prison. (See Albuquerque.) The punishment he inflicted on the Moors was speedy and terrible. Sailing along the coast, he pillaged and burned various ports, including Goa and Dabul, and finally encountering the enemy's combined fleet off Diu early in 1509, he completely destroyed it. Returning immediately to Cochin, he held out for a few months against the claims of Albuquerque, but in November 1509 he was compelled to yield. On the 1st December he set sail for Europe with an escort of three vessels. On the voyage the fleet called at Saldanha Bay, in South Africa, to

procure water, and here Almeida was killed (March 1, 1510) in an unprovoked attack upon the Caffre natives, during which he showed great personal courage. His body was recovered on the following day, frightfully mutilated, and received a hasty burial.

ALMERIA, a modern province of Spain, comprehending the eastern portion of the ancient kingdom of Granada. It is bounded on the N. by Jaen and Murcia, on the E. and S. by Murcia and the Mediterranean, and on the W. by Granada; with an area of about 3300 square miles. The province is traversed by mountain ridges, some of them of considerable elevation, with corresponding valleys and plains of great fertility. The principal sierras are those of Maria, Almahilla, Cabrera, Almagrera, Gata, and Gador, and in the W. some offshoots of the Sierra Nevada. The most considerable rivers are the Almanzora, running from west to east, with a course of about 50 miles; the Almeria, flowing from north-west to south-east; and the Adra from north to south, watering the fertile district between the Sierra de Gador and the Alpujarras. On the S. coast is the Gulf of Almeria, a spacious bay, 25 miles wide at the entrance, and about 10 miles in depth. The climate of the province is mild, except in the interior, where the winter is cold. On the coast rain seldom falls, and south-west winds prevail. The inhabitants are principally engaged in mining and agriculture. Many of the proprietors farm their own land, the number of landed properties being 44,858, while the tenants are only 7365. Of the area of the province, 376,698 acres are arable and pasture land; 13,538 acres vineyards; 5360 acres olive plantations; 30,797 acres cultivated mountain and wood lands; and 1,686,738 acres uncultivated. There are 438,357 head of live stock. All kinds of grain are raised in abundance. The common fruits are plentiful, as well as oranges, lemons, and vines. Much excellent silk is produced in the western districts; cotton is raised to some extent along the coast, and the sugar-cane is also cultivated. Cattle are extensively bred; those of the valley of the Almeria are especially remarkable for their size and beauty. The province is one of the richest in minerals of all Spain, the mountains yielding silver, mercury, lead, antimony, copper, and iron. The silver mines of the Sierra de Almagrera, opened in 1839, produced in 1843 nearly 1,700,000 ounces; while the lead mines of the Sierra de Gador are computed to have yielded, from 1795 to 1841 inclusive, 11,000,000 quintals of lead, and the present annual output is from 30,000 to 40,000 tons of ore. In the Sierra de Gata, jaspers and agates are found; in the Sierra Nevada, to the west, are the celebrated quarries of Macael marble; and the Sierra Cabrera yields antimony, malachite, gypsum, magnetic iron, &c. The manufactures of the province consist chiefly of esparto cordage, white-lead, shot, saltpetre, soap, leather, and earthenware. The principal exports are lead, esparto, barilla, and soap; while the imports include coal and machinery from England, woollen and cotton stuffs from Catalonia, silk from Valencia and Malaga, and linen from Marseilles and Gibraltar. From the want of adequate facilities for communication, the development of the agricultural and mining resources of Almeria has not been so rapid as might have been expected. The disturbances attending the revolution of 1868 have also had a prejudicial effect. Education is in a backward state, the proportion of the population at school being only fifteen in the thousand. Crime, although great, is not excessive, offences against the person forming the greater number of the cases tried. The people generally are simple, sober, and religious. Population in 1870, estimated at 361,553.

ALMERIA, the capital of the above province, lies on the Gulf of Almeria, on the Mediterranean, 72 miles E.S.E. of Granada. From the strength of the port it was deemed by the Moorish kings of Granada one of the most valuable of their fortresses and their best commercial harbour. Sailing hence, their cruisers overawed the Catalans and Italians, and their merchant ships conveyed the produce of the country to Africa, Egypt, and Syria. In the time of the Moors Almeria was the seat of hordes of pirates. The walls of the town, and the Moorish fortress, or Alcazaba, overlooking it, as well as the architecture of many of the houses, still attest its Moorish origin. It is pretty well built, and has several handsome squares, although the streets are generally narrow. Almeria is the seat of a bishop, and has a cathedral and theological seminaries. Off the port there is good anchorage in 12 and 14 fathoms water; and in addition to its landward defences the place is protected towards the sea by the forts of Trinidad and Tiro. In 1866, 46 vessels, of 21,603 tons, with cargoes, entered and cleared the port; and the annual value of the exports is about £50,000. The manufactures are trifling, but there is a good export trade in wine, soda, esparto, silk, and lead; while the imports consist chiefly of coal and manufactured goods. Here there are also some mineral springs. Population (1857), 27,036.

ALMOHADES (*Almoahedun*, Unitarian), a Mahometan dynasty that flourished in Africa and in Spain during the 12th and 13th centuries. Mohammed-Ibn-Abdallah, the founder of the Almoahedun sect, was the son of a lamplighter in the great mosque at Sous-el-Aksa. He studied at Cordova, and afterwards visited Cairo and Baghdad, where he became the disciple of the famous philosopher Algazali. In order to establish his power with his countrymen, he connected himself with Abd-el-Mumen, a young Mussulman of great abilities, whom he sent forth as his apostle to propagate the new doctrine (1116–17); while in his own person he affected an unusual degree of piety and mortification, appearing in tattered garments, and interdicting the use of wine and music and every gratification of the senses. His fame spread rapidly among the mountain tribes of Mahgreb, and the ignorant multitude adopted his opinions with eager zeal. His followers saluted him as the Al-Mehedi on the 28th November 1121. Entering the city of Marocco, this new prophet foretold the downfall of the existing dynasty, and mocked the authority of the reigning prince Ali-Ibn-Yussef. Ali, lulled in security, despised his predictions as the mere ravings of a fanatic; and it was not without some difficulty that he was at length prevailed on to banish him from the city. Mohammed retired to the mountains, and fortified the town of Tinmal, which he defended against every assault of his enemies (1123). His retreat became the rendezvous of a numerous sect, who assumed the title of Almoahedi, or Almohades, and asserted that they alone of all the Mussulmans maintained the religion of Islam in its original purity. Many Arab and Berber tribes acknowledged him as their political chief, and 20,000 soldiers rallied around his standard. Ali only perceived the error he had committed when it was too late: his armies, at each encounter, were panic-struck, and fled. Yet notwithstanding the great success of the Almohades, the vast empire of the Almoravides was not at once subdued: and Mohammed, after an ineffectual attempt to reduce the city of Marocco, died in the year 1130, having failed to accomplish the object of his ambition, the possession of a throne. He was succeeded by Abd-el-Mumen, who assumed the title of *Emir-el-Mumenin*, or Commander of the Faithful. During the thirty years that he reigned, and under his descendants, Yussef and Yakub, called Almanzor-Billah, the dynasty of the Almohades was exceedingly illustrious, and the arts flourished greatly. They rendered themselves masters of

the provinces of Fez, Marocco, Tlemcen, Oran, and Tunis; and passing into Spain, they overran Andalusia, Valencia, and a part of Aragon and Portugal, as far the Ebro on one side and the Tagus on the other. But this vast empire was not of long continuance; for in the year 1212, when the Moslems under Mohammed were defeated by the Christian princes of Spain in the great battle of Las Navas, near Tolosa, the governors of the several provinces took advantage of that disaster to throw off their allegiance, and declared themselves independent—an example that was the signal for a general revolt. The dynasty of the Almohades became extinct in Spain in the year 1257, and in Africa in 1269. The last sovereign of this race, Abu Dabus Edris, who had with difficulty maintained a shadow of power in the city of Marocco, was assassinated by a slave. They were succeeded by the dynasties of the Hafsides, the Mevanides, and the Merinides. See Almoravides.

ALMON, John, a political pamphleteer and publisher of considerable note, was born at Liverpool about 1738. In early life he was apprentice to a printer in his native town, and he subsequently spent two years at sea. He came to London in 1758, and at once commenced a career which, if not important in itself, had a very important influence on the political history of the country. The opposition, hampered and harassed by the government to an extent that threatened the total suppression of independent opinion, were in great need of a channel of communication with the public, and they found what they wanted in Almon. He had become personally known to the leaders through various publications of his own which had a great though transient popularity; the more important of these being *The Conduct of a late Noble Commander* [Lord George Sackville] *Examined* (1759); a *Review of the Reign of George II.*, published on the death of that monarch; a *Review of Mr Pitt's Administration* (1761); and a collection of letters on political subjects. The review of Pitt's administration passed through four editions, and secured for its author the friendship of Lord Temple, to whom it was dedicated. Being thus in the counsels of the party, he was persuaded in 1763 to open a bookseller's shop in Piccadilly, chiefly for the publication and sale of political pamphlets. As he generally received with every pamphlet a sum sufficient to secure him against all contingencies, it cannot be said that he acted entirely from disinterested or patriotic motives. At the same time, he deserves the credit of intrepidity; and it cannot be denied that, whether he knew the full value of the principle for which he was contending or not, he did very much to secure the freedom of the press. The government of course were not unobservant of Almon's proceedings, and, as has often been the case, strengthened his influence by the very measures they took to repress it. In 1765 the Attorney-General moved to have him tried for the publication of the pamphlet entitled *Juries and Libels*, but the prosecution failed; and in 1770, for merely selling a copy of the *London Museum* containing Junius's celebrated "Letter to the King," he was sentenced by Lord Mansfield to pay a fine of ten marks, and give security for his good behaviour. It was this trial that called forth the letter to Lord Mansfield, one of the most bitter of the Junius series. Almon himself published an account of the trial, and of course did not let slip the opportunity of reprinting the matter that had been the ground of indictment, but no further proceedings were taken against him. In 1774 Almon commenced the publication of his *Parliamentary Register*, and he also issued an abstract of the debates from 1742, when Chandler's Reports ceased, to 1774. About the same time, having earned a competency, he retired to Boxmoor in Hertfordshire, though he still continued to write on political subjects. He afterwards became proprietor of the *General Advertiser*, in the management of which he lost his fortune, and was declared insolvent. To these calamities was added an imprisonment for libel and a sentence of outlawry. Being enabled at last to return to Boxmoor, he continued for some years a career of undiminished literary activity. His last work, a Life of Wilkes, in five volumes (1805), was perhaps his worst, being entirely wanting in proportion and arrangement. He died on the 12th December 1805. A complete list of Almon's works, most of which appeared anonymously, is given in Watt's *Bibliotheca Britannica*. Though their literary merit is not great, they are of very considerable value to the student of the political history of the period.

ALMOND. This is the fruit of *Amygdalus communis*, a plant belonging to the natural order Rosaceæ, sub-order Amygdaleæ or Drupiferæ. The tree appears to be a native of Asia, Barbary, and Marocco; but it has been extensively distributed over the warm temperate region of the Old World. It is a tree of moderate size; the leaves are oblong-lanceolate, and serrated at the edges; and the flowers, which appear early in spring, are of a pink colour. The fruit is a drupe, having a downy outer coat, called the epicarp, covering a tough portion called the mesocarp, which encloses the reticulated hard stony shell or endocarp. The seed is the kernel which is contained within these coverings. The shell-almonds of trade consist of the endocarps enclosing the seeds. The tree grows in Syria and

The Almond-tree (*Amygdalus communis*), the fruit of which is a drupe with a tough mesocarp. The Hebrew word *Shaked* is generally translated Almond (Gen. xliii. 11; Exod. xxv. 33, 34; xxxvii. 19; Numb. xvii. 8). The word *Luz*, which occurs in Genesis xxx. 37, and is there translated Hazel, appears to be the name of the Almond-tree, while *Shaked* is the name of the fruit.

Palestine; and is referred to in the Bible under the name of *Shaked*, meaning "hasten." The word Luz, which occurs in Genesis xxx. 37, and which has been translated hazel, is supposed to be another name for the almond. In Palestine the tree flowers in January, and this hastening of the period of flowering seems to be alluded to in Jeremiah i. 11, 12, where the Lord asks the prophet, "What seest thou?" and he replies, "The rod of an almond-tree;" and the Lord says, "Thou hast well seen, for I will hasten my word to perform it." In Ecclesiastes xii. 5 it is said the "almond-tree shall flourish." This has often been supposed to refer to the resemblance of the hoary locks of age to the flowers of the almond; but this exposition is not borne out by the facts of the case, inasmuch as the flowers of the almond are not white but pink. The passage is more probably intended to allude to the hastening or rapid approach of old age. The application of Shaked or *hasten* to the almond is similar to the use of the name "May" for the hawthorn, which usually flowers in that month in Britain. The rod of Aaron, mentioned in Numbers xvii., was taken from an almond-tree; and the Jews still carry rods of almond-blossom to the synagogues on great festival days. The fruit of the almond supplied a model for certain kinds of ornamental carved work (Exodus xxv. 33, 34; xxxvii. 19, 20). Dr Tristram remarks: "The blossom of the almond is a very pale pink, but where, as in the

orchards near Nablous (Shechem), the peach and almond trees are intermingled, the almond looks white by comparison. In early spring it forms a beautiful feature in the landscape there, as the lower slopes of Gerizim, as well as the valley, are studded with almonds and peaches, in lively contrast with the deep green foliage of the orange-trees, and rivalling an apple orchard in splendour of colour. There are also many wild almond-trees on Mount Carmel. The tree seldom exceeds 12 to 16 feet in height." There are two varieties of the plant, the one producing sweet, the other bitter almonds. The kernel of the former contains a fixed oil and emulsin; while that of the latter has in addition a nitrogenous substance called amygdalin, which, by combination with emulsin, produces a volatile oil and prussic acid. The flowers of the bitter almond-tree (*Amygdalus communis*, variety *amara*) are larger and whiter than those of the sweet almond-tree (*Amygdalus communis*, variety *dulcis*). The sweet almond is bland and inodorous. There are numerous commercial varieties, of which the most esteemed is the Jordan almond, imported from Malaga. Valentia almonds are also valued. Fresh sweet almonds are nutritive and demulcent, but as the outer brown skin or episperm sometimes causes irritation of the alimentary canal, they are blanched by removal of this skin when used at dessert. When bitter almonds are pounded in water a ratafia odour is produced, on account of the formation of prussic acid. The essential oil or essence of almonds, so much employed for flavouring dishes, requires to be used with caution, as it possesses marked poisonous qualities. In some cases the oil, even when taken in small quantities, produces nettle-rash. The import of sweet almonds into Britain in 1870 amounted to 36,189 cwt.; of bitter almonds, 7618 cwt.

ALMONDBURY, an extensive parish and township of Yorkshire in England, lying to the S.E. of Huddersfield. As the manufactures of Huddersfield have increased, various outlying districts have been built on, so that the parish of Almondbury now includes a considerable part of that important and flourishing town. The parish contains 28,092 acres. The town lies on the river Calder, 2 miles S.E. of Huddersfield, and had formerly a cathedral and a strong castle. By some writers it is supposed to occupy the site of the Roman *Campodunum* mentioned by Antoninus; but whether or not, the place can boast a Roman origin—it was at least a town of importance in Saxon times, and a seat of the kings of Northumbria. It has a free grammar school founded by James I., a good church, and several other public buildings. The inhabitants of the town and parish are chiefly engaged in the manufacture of fine cloths, and woollen, cotton, and silk goods. In 1871 the population of the parish was 46,299; of the township, 11,669.

ALMONER, in its primitive sense, denotes an officer in religious houses, to whom belonged the management and distribution of the alms of the house. By the ancient canons, all monasteries were to spend at least a tenth part of their income in alms to the poor, and all bishops were required to keep almoners.

LORD ALMONER, or LORD HIGH ALMONER OF ENGLAND, is an ecclesiastical officer, generally a bishop, who has a right to the forfeiture of all deodands and the goods of a *felo de se*, which he is to distribute among the poor. He has also, by virtue of an ancient custom, the power of giving the first dish from the king's table to whatever poor person he pleases, or, instead of it, an alms in money. See MAUNDAY THURSDAY.

ALMORÁ, the principal town in the British district of Kumáon, within the lieutenant-governorship of the North-Western Provinces, is situated in 29° 35′ N. lat., and 79° 42′ E. long. The town is built on the crest of a ridge of the Himálayas, running east and west, and 5337 feet above sea-level. It consists chiefly of a single street, about 50 feet wide and three-quarters of a mile long, closed by a gate at each end. A few detached houses, inhabited by Europeans, are scattered along the face of the mountain below the town. The town was captured by the Gurkhás in 1790, who constructed a fort on the eastern extremity of the ridge. Another citadel, Fort Moira, is situated on the other extremity of the ridge. Almorá is also celebrated as the scene of the British victory which terminated the war with Nepál in April 1815, and which resulted in the evacuation of Kumáon by the Gurkhás, and the annexation of the province by the British. According to the census of 1872, the town contains a population of 5900 souls. It has been constituted a municipality, the revenue and expenditure of which in 1871–72 is returned as follows:—Revenue—Receipts from octroi, £29, 16s.; house-tax, £211, 8s.; other sources of income, £30, 14s.: total, £271, 18s. Expenditure—Establishment, including cost of collection, police, and conservancy, £182; repairs, £90, 16s.; other items, £3, 16s.: total, £276, 12s.

ALMORAVIDES, a family of Mahometan princes who reigned in Africa and in Spain between 1073 and 1147 A.D. This appellation was derived from the sect of *Al-Morabethun* (Dedicated to the service of God), which arose about the middle of the 11th century, among a poor ignorant tribe of Berbers inhabiting the mountains of Atlas, on the shores of the Atlantic Ocean. At the request of a sheik of Lamtouna, who had acquired some taste for learning by travelling in the East, Abdallah-ben-Yazim, an Arabian of extraordinary erudition, consented to instruct the people in the truths of Islam. The enthusiasm of Abdallah created a like zeal in the hearts of his ignorant hearers; and by the energy and novelty of his discourses he so inflamed the minds of his disciples that they compelled those whom persuasion could not move to embrace the new religion. Thus Abdallah found himself at the head of a numerous sect, who soon began to regard him as their leader both in temporal and spiritual matters. Under the name of Almorabethun or Almoravides, they overran the country of Daza, lying between the desert of Sahara and the ancient Getulia, and ultimately extended their conquests from the shores of the Mediterranean to the frontiers of Nigritia. Abdallah died on the field of battle in the year 1058. He was succeeded by Abu-Bekr-Ibn-Omar, a man whose abilities were scarcely equal to the difficulties of the position in which he was placed. In 1072 he was supplanted by Yussef-Ibn-Tashfyn, to whom he had entrusted the government on setting out for Atlas to quell an insurrection of the Berbers. Yussef completely established the Almoravide power in Al-Magreb in 1073. On the invitation of Mohammed of Seville, he crossed to Algeciras in 1086, and at once marched against Alphonso VI., the most powerful prince in Christendom. They met in the plains of Zalaca (23d Oct. 1086), and Alphonso was defeated with terrible slaughter. The news of Yussef's success induced many of the Arabs of Spain to enlist under his victorious banner. In a third expedition to Spain (1091), he attacked Mohammed, and after a protracted siege became master of Seville. This conquest was followed by the subjugation of Almeria, Denia, Xativa, and Valencia. The acquisition of the Balearic Isles was the completion of this vast empire, which extended from the Ebro and the Tagus to the frontiers of Soudan. Although Marocco was his capital, he frequently visited his Spanish dominions; and on the last occasion, having assembled the governors of the province at Cordova, he appointed Ali, the youngest of his sons, as his successor. He then returned to Marocco, where he died at a very advanced age, 1106 A.D. (500 of the Hegira), after a reign of forty years.

Few kings have received so noble a heritage as that to which Ali succeeded. The first years of his reign were prosperous, though disturbed by the Almohades, who were preparing the way for the destruction of the Almoravides. Ali was at last obliged to recall from Spain his son Tashfyn, who was using his utmost endeavours to oppose the victorious career of Alphonso of Aragon, surnamed the Fighter. But the valour of Tashfyn was of little avail against the rising power of the Almohades: disaster followed disaster; and when, in 1143, he succeeded to the throne, but a moiety of the kingdom remained. It was in vain that he received succours from Spain, the troops from that soft climate being little fitted for service in the wild regions of Atlas. Driven from Tlemecen, he sought refuge in Oran; but Abd-el-Mumen appeared before its walls, and by threats so intimidated the inhabitants that Tashfyn was compelled to attempt escape on horseback, with his favourite wife behind him; but being closely pursued, he urged his horse over a precipice, and with his wife was dashed to pieces. With Tashfyn expired the domination of the Almoravides; for although they still remained in possession of the city of Marocco, their power was completely broken. Ishak-Ibrahim, the son of Tashfyn, was taken and put to death at Alcazar in 1147, on the surrender of Marocco by treachery, and with him the dynasty of the Almoravides became extinct. The remnant of the sect, driven from Spain, took refuge in the Balearic Islands, but it was finally suppressed in 1208. (For the history of the Arabians in Spain, see the works of Cardonne, Condé, St Hilaire, D'Herbelot, Al-Makkari, and Dozy.)

ALMQVIST, Karl Jonas Ludwig, one of the most extraordinary figures that the history of literature can produce, was born at Stockholm in 1793. He began life under highly favourable auspices; but becoming tired of a university career, he threw up the position he held in the capital to lead a colony of friends to the wilds of Wermland. This ideal Scandinavian life soon proved a failure; Almqvist found the pen easier to wield than the plough, and in 1829 we find him once more settled in Stockholm. Now began his literary life; and after bringing out several educational works, he made himself suddenly famous by the publication of his great novel, *The Book of the Thorn-Rose*. The career so begun developed with extraordinary rapidity; few writers have equalled Almqvist in productiveness and versatility; lyrical, epic, and dramatic poems; romances; lectures; philosophical, æsthetical, moral, political, and educational treatises; works of religious edification, studies in lexicography and history, in mathematics and philology, form the most prominent of his countless contributions to modern Swedish literature. So excellent was his style, that in this respect he has been considered the first of Swedish writers. His life was as varied as his work. Unsettled, unstable in all his doings, he passed from one lucrative post to another, at last subsisting entirely on the proceeds of literary and journalistic labour. More and more vehemently he espoused the cause of socialism in his brilliant novels and pamphlets; friends were beginning to leave him, foes beginning to triumph, when suddenly all minor criticism was silenced by the astounding news that Almqvist, convicted of forgery and charged with murder, had fled from Sweden. This occurred in 1851. For many years no more was heard of him; but it is now known that he went over to America, and settled in St Louis. During a journey through Texas he was robbed of all his manuscripts, among which are said to have been several unprinted novels. He appealed in person to President Lincoln, but the robbers could not be traced. In 1865 he returned to Europe, and his strange and sinister existence came to a close at Bremen on the 26th of September 1866. It is by his romances, undoubtedly the best in Swedish, that his literary fame will mainly be supported; but his singular history will always point him out as a remarkable figure even when his works are no longer read. He was another Eugene Aram, but of greater genius, and so far more successful that he escaped the judicial penalty of his crimes. (E. W. G.)

ALMUG or ALGUM TREE. The Hebrew words *Almuggim* or *Algummim* are translated Almug or Algum trees in our version of the Bible (see 1 Kings x. 11, 12; 2 Chron. ii. 8, and ix. 10, 11). The wood of the tree was very precious, and was brought from Ophir (probably some part of India), along with gold and precious stones, by Hiram, and was used in the formation of pillars for the temple at Jerusalem, and for the king's house; also for the inlaying of stairs, as well as for harps and psalteries. It is probably the red sandal-wood of India (*Pterocarpus santalinus*). This tree belongs to the natural order Leguminosæ, sub-order Papilionaceæ. The wood is hard, heavy, close-grained, and of a fine red colour. It is different from the white fragrant sandal-wood, which is the produce of *Santalum album*, a tree belonging to a distinct natural order.

ALMUNECAR, a small seaport town of Spain, in the province of Granada, about 33 miles south of the town of that name. It is a place of Moorish origin, and is tolerably well built. The harbour is fit for small vessels only, and is much exposed to gales from the east. Sugar, cotton, and fruits are the chief products of Almunecar and the surrounding country, which is naturally very fertile, but the trade is small compared with that of former times. Population, 5000.

ALNWICK, the county town of Northumberland, is situated on the south bank of the river Alne, 310 miles N. of London, 34 N. of Newcastle, and 29 S. of Berwick. There are remains of the old wall which surrounded the town, and one of the four gates still exists; but most of the houses are comparatively modern, and are laid out in well-paved spacious streets. In the market-place there is a large town-hall, and a handsome building containing an assembly-room and a reading-room. Besides the parish church, Alnwick possesses a beautiful district church, a Roman Catholic chapel, and several Protestant dissenting places of worship. The chief employments are brewing, tanning, and brickmaking, but these manufactures are here of little importance. A small export trade is carried on through Alnmouth in corn, pork, and eggs, and a market is held every Saturday chiefly for these articles. The local government consists of a bailiff, nominated by the Duke of Northumberland, and twenty-four common councilmen, four of whom are elected annually as chamberlains; the councilmen fill up vacancies in their body from the freemen, who usually are about 300 in number. The ceremony of making freemen is of a very peculiar kind. The candidates, mounted on horseback, assemble in the market-place very early in the morning of St Mark's day—the 25th April—clad in white from head to foot, with swords by their sides, and attended by the bailiff and chamberlains, who are mounted and armed in the same manner. From the market-place they proceed, with music playing before them, to a large pool called *Freeman's Well*, where they dismount and draw up in a body at some distance from the water, and, on a given signal from the bailiff, rush into the pool, and scramble through the mud as fast as they can. As the water is generally very foul, they come out in a dirty condition; but they put on dry clothes, remount their horses, and ride at full gallop round the boundaries of the town. According to tradition, the observance of this custom was enjoined by King John to punish the inhabitants for their carelessness, the king having, it is said, lost his way, and been bemired in a bog, from their neglect of the roads near the town. To the

north west of the town is Alnwick Castle, which has belonged to the Northumberland family since 1310. In early times this fortress was an important defence against the Scotch, and was besieged by them on several occasions, most memorably in 1093, when Malcolm Canmore and his son Edward were slain under its walls; and in 1174, when William the Lion was defeated and taken prisoner. For a long time it was permitted to fall into decay, but it has recently been restored, and to some extent remodelled, and is now one of the most magnificent specimens of a baronial residence in England. The grounds are extensive, and contain the remains of two abbeys, Alnwick and Hulme. The population of Alnwick in 1871 was 5822.

ALOE. Aloes is a medicinal substance used as a purgative, and produced from various species of aloe, such as *A. spicata, vulgaris, socotrina, indica*, and *purpurascens*, all belonging to the natural order Liliaceæ. Several kinds of aloes are distinguished in commerce—Barbadoes, socotrine, hepatic, Indian, and Cape aloes. The first two are those commonly used for medicinal purposes. Aloes is the inspissated juice of the leaves of the plant. When the leaves are cut the juice flows out, and is collected and evaporated. After the juice has been obtained, the leaves are sometimes boiled, so as to yield an inferior kind of aloes. The active principle is called aloein. Aloes is used in the form of extract, pill, tincture, and wine. It is irritant, and requires to be used with caution.

The plant called American aloe belongs to a different order, viz., Amaryllidaceæ. The plant is called *Agave Americana.* The juice of the plant, taken immediately before flowering, is used in America for the manufacture of an intoxicating beverage. In Ecuador the spongy substance of the flower stem is used instead of tinder, and in the schools the green leaves serve as paper. A punishment among the Aztecs was introducing the spiny points of the leaves into the skin. The plant often delays flowering for many years, and then pushes up a flowering stalk with great rapidity, sometimes at the rate of 1 foot or even 2 feet in twenty-four hours. The fibrous matter procured from the agave by maceration supplies pita flax.

The aloes or lign aloes of the Bible (Numb. xxiv. 6, and Psalm xlv. 8) is quite different from the medicinal aloes. The Hebrew words *ahalim* and *ahaloth*, and the Greek word *aloe*, are rendered aloes in our version of the Scriptures. The substance is supposed by some to be the fragrant wood of *Aquilaria Agallochum*, a plant belonging to the natural order Aquilariaceæ. There are, however, considerable doubts as to the correctness of this view, more especially as the tree is a native of Cochin China, Silhet, and Northern India, and is not found in Chaldea or Syria. From the allusion made to the trees of lign aloes by Balaam, it seems probable that they were known as growing in Syria. It is quite possible, however, that the precious fragrant substance called aloes, and mentioned in Scripture along with cinnamon, cassia, myrrh, and spices, may have been brought from India. As a perfume it is noted in Psalm xlv. 8; Prov. vii. 17; Song of Sol. iv. 14. The use of aloes in perfuming the coverings of the dead is referred to in John xix. 39, 40.

ALOIDÆ, or ALOIADÆ, the designation of Otus and Ephialtes, sons of Poseidon by Iphimedea, wife of Aloeus. They are celebrated for their extraordinary stature, being 27 cubits in height and 9 in breadth when only nine years old. The story of their piling Pelion upon Ossa in their war with the Olympian gods is one of the best known of the early Greek myths. According to Homer's account, they were destroyed by Apollo ere their beards began to grow. (*Odyssey*, xi. 305; *Iliad*, v. 385.)

ALOMPRA, ALOUNG P'HOURA, founder of the reigning dynasty in Burmah, was born in 1711 at Monchaboo, a small village 50 miles north-west of Ava. Of humble origin, he had risen to be chief of his native village when the invasion of Birmah by the king of Pegu in 1752 gave him the opportunity of attaining to the highest distinction. The whole country had tamely submitted to the invader, and the leading chiefs had taken the oaths of allegiance. Alompra, however, with a more independent spirit, not only contrived to regain possession of his village, but was able to defeat a body of Peguan troops that had been sent to punish him. Upon this the Birmese, to the number of a thousand, rallied to his standard, and marched with him upon Ava, which was recovered from the invaders before the close of 1753. For several years he prosecuted the war with uniform success. In 1754 the Peguans, to avenge themselves for a severe defeat at Keoum-nuoum, slew the king of Birmah, who was their prisoner. The son of the latter claimed the throne, and was supported by the tribe of Quois; but Alompra resisted, being determined to maintain his own supremacy. In 1755 Alompra founded the city of Rangoon. In 1757 he had established his position as one of the most powerful monarchs of the East by the invasion and conquest of Pegu. Ere a year elapsed the Peguans revolted; but Alompra, with his usual promptitude, at once quelled the insurrection. The Europeans were suspected of having instigated the rising, and the massacre of the English at Negrais in October 1759 is supposed to have been approved by Alompra after the event, though there is no evidence that he ordered it. Against the Siamese, who were also suspected of having abetted the Peguan rebels, he proceeded more openly and severely. Entering their territory, he was just about to invest the capital when he was seized with an illness which proved fatal on the 15th May 1760. Alompra is certainly one of the most remarkable figures in modern Oriental history. To undoubted military genius he added considerable political sagacity, and he deserves particular credit for his efforts to improve the administration of justice. His cruelty and deceitfulness are faults common to all Eastern despots.

ALOST, or AALST, a town of Belgium, on the eastern frontier of the province of East Flanders, about midway between Ghent and Brussels. The Dender, a navigable tributary of the Scheldt, passes through the town, which is a clean, well-built place, surrounded by a wall with five gates. The church of St Martin, a fine edifice, although unfinished, contains a celebrated picture by Rubens, "St Roche Praying for the Cessation of the Plague." Among the other public buildings are a town-hall, which was founded about 1200 A.D., a college, and an hospital. The trade is extensive, chiefly in corn, oil, hops, and beer; and there are linen, lace, and cotton manufactories, and iron foundries of considerable importance. Alost was formerly the capital of imperial Flanders. The French under Turenne took it in 1667, but were obliged to abandon it after the battle of Ramillies in 1706. Population, 19,000.

ALPACA is a name applied generally to several allied South American wool-bearing animals, but more properly restricted to one of the species. It is further used to distinguish the wool obtained from these animals, and the woven textures manufactured from the wool are also known as alpacas. The alpacas or llamas are natives of the lofty table-lands and mountain-range of the Andes in Peru and Chili, and in that region of the globe they long occupied the position held in the Old World by their congeners of larger size, the camels. To the ancient Peruvians the llamas were the only available beasts of burden and wool-bearing creatures, just as to the present day the camel is to the tribes of the Asiatic deserts. The camel (*Camelus*) and the llama (*Auchenia*) form the two existing genera of the family Camelidæ; and thus in a zoological sense also the one

represents the other in different regions of the earth. A great deal of doubt and confusion has existed as to the number of species into which the llamas can be divided—a very common occurrence in dealing with domesticated or semi-domesticated creatures. Most authorities now, however, agree in regarding them as separable into four species, following the classification of Von Tschudi, who has given much careful consideration to the subject. The species, according to that naturalist, are the llama (*Auchenia lama*), the huanaco or guanaco (*A. huanaco*), the alpaca or paco (*A. paco*), and the vicugna (*A. vicunna.*) The two first-named species are, or rather were, more valued as beasts of burden, and for their flesh, than as sources of wool, being able to bear from 120 to 150 ℔ burden over long distances daily. The guanaco attains a size not much less than our red deer; and is the largest and most widely spread of all the species, being found from the equator southward to Patagonia. The llama is next in size, but its habitat is limited to the loftier mountains of North Peru. Although both species yield a serviceable quality of wool, which is used by the Peruvians and found in commerce, it is chiefly to the alpaca we owe the supply of wool imported into this country under that name. The alpaca is considerably smaller than either the llama or the guanaco, but in general outline all the species resemble each other. In its native condition the alpaca ranges between 10° and 20° S. lat., from the centre of Peru into Bolivia, not coming lower down in vertical distribution than between 8000 and 9000 feet above the sea-level. At and above these heights it lives in herds in a semi-domesticated condition, being only driven into the villages to be shorn. The wool, which varies in length from 2 to 6 inches, is of a very lustrous and fine quality, and is mostly white, black, or gray, shades of brown or fawn being rarer. The vicugna is a much rarer animal than the alpaca, being found sparsely scattered from Ecuador, throughout Peru, into Bolivia, but seldom descending under 13,000 feet above the sea-level. It is about the same size as the alpaca, and yields an exceedingly delicate wool, varying in colour from a reddish yellow to a dull white. It is usually worth about twice as much as alpaca, and is greatly valued for fine felts.

There is evidence of these animals having been held domesticated and used for their wool in their native regions from remote antiquity. Remains of clothing made from alpaca wools have been found in the graves of the Incas; and when, in the early part of the 16th century, Europeans first visited Peru, these animals formed the chief wealth of the natives, being the carriers of their commerce as well as the main source of their food and clothing. Small quantities of the wool were occasionally met with in English commerce; but it was not till 1836 that it became established as a regular trading commodity with Europe. In that year Mr (now Sir) Titus Salt, a wool-broker and manufacturer in Bradford, purchased a quantity he met with in a Liverpool warehouse at 8d. per ℔, and set himself to discover its capabilities. The amount and manner of his success will be described in the articles WOOL and WORSTED MANUFACTURES; it need only be remarked here that his experiments have resulted in making alpaca a staple second in importance to wool, and so creating an industry of great and rapidly increasing dimensions. The success of his experiments led to the erection of his great manufacturing establishment of Saltaire, in which upwards of 3000 hands are employed in the alpaca manufacture. The quantity of alpaca imported into England from 1836—the year of Sir Titus Salt's first experimental purchase—to 1840, averaged 560,800 ℔ yearly, which sold at about 10d. per ℔. In 1852 the imports had risen to 2,186,480 ℔, and the price advanced to 2s. 6d. per ℔. In 1864 the imports amounted to 2,664,027 ℔, and in 1872 they were 3,878,739 ℔; the value of average qualities being from 2s. 6d. to 2s. 10d. per ℔. The introduction of the various species of llama into Europe has been frequently urged. Geoffrey St Hilaire and other French naturalists having specially pointed out the desirability of their introduction into France, and at one time a herd existed in the Pyrenees; but in Europe the creatures must be still regarded as curiosities of zoological collections. In 1859 systematic and costly attempts were made to acclimatise the alpaca in our Australian colonies by Mr Ledger, a gentleman who had devoted many years to observation of the conditions of life of the animal. At first the experiment presented most encouraging prospects; the herds continued healthy and increased in numbers; but gradually the subtle influences of the loss of their native mountain climate became apparent,—the creatures drooped, their numbers dwindled, and for the present the undertaking must be regarded as a complete failure.

ALP ARSLAN or AXAN, MOHAMMED BEN DAOUD, the second sultan of the dynasty of Seljuk, in Persia, and great-grandson of Seljuk, the founder of the dynasty. He was born in the year 1029 A.D., 421 of the Hegira. He assumed the name of Mohammed when he embraced the Mussulman faith; and on account of his military prowess he obtained the surname *Alp Arslan*, which signifies "a valiant lion." He succeeded his father Daoud as ruler of Khorassan in 1059, and his uncle Togrul Bey as sultan of Oran in 1063, and thus became sole monarch of Persia, from the river Oxus to the Tigris. In consolidating his empire and subduing contending factions he was ably assisted by Nizam-al-Mulk, his vizier, one of the most eminent statesmen in early Mahometan history. Peace and security being established in his dominions, he convoked an assembly of the states, and declared his son Malik Shah his heir and successor. With the hope of acquiring immense booty in the rich temple of St Basil in Cæsarea, the capital of Cappadocia, he placed himself at the head of the Turkish cavalry, crossed the Euphrates, and entered and plundered that city. He then marched into Armenia and Georgia, which, in the year 1064, he finally subdued. To punish the Georgians for the brave defence which they had made, and as a badge of their humiliating condition, the conqueror obliged them to wear at their ears horse-shoes of iron. In the year 1068 Alp Arslan invaded the Roman empire, the seat of which was then at Constantinople. The Emperor Romanus Diogenes, assuming the command in person, met the invaders in Cilicia. In three several campaigns his arms were victorious, and the Turks were forced to retreat beyond the Euphrates. In the fourth he advanced with an army of 100,000 men into the Armenian territory, for the relief of that country. Here he was met by Alp Arslan; and the sultan having proposed terms of peace, which were insultingly rejected by the emperor, a bloody and decisive engagement took place near Malazkurd, in which the Greeks, after a terrible slaughter, were totally routed. Romanus was taken prisoner and conducted into the presence of Alp Arslan, who treated him with a noble generosity. A ransom of a million and an annual tribute of 3000 pieces of gold, an intermarriage between the families, and the deliverance of all the captive Mussulmans in the power of the Greeks, having been agreed to as the terms of peace and the liberty of the emperor, Romanus was dismissed, loaded with presents and respectfully attended by a military guard. He was unable, however, to fulfil the terms of the treaty, and the war was accordingly renewed. At this time the dominion of Alp Arslan extended over the fairest part of Asia: 1200 princes or sons of princes surrounded his throne, and 200,000 soldiers were ready to execute his commands. He now declared

his purpose of attempting the conquest of Turkestan, the original seat of his ancestors. After great preparations for the expedition, he marched with a powerful army, and arrived at the banks of the Oxus. Before he could pass the river with safety, it was necessary to gain possession of some fortresses in its vicinity, one of which was for several days vigorously defended by the governor, Yussuf Kothual, a Kharizmian. He was, however, obliged to surrender, and was carried a prisoner before the sultan. Being condemned to suffer a cruel death, Yussuf became incensed, rushed upon the sultan, and stabbed him in the breast. The wound proved mortal, and Alp Arslan expired a few hours after he received it, on the 15th Dec. 1072.

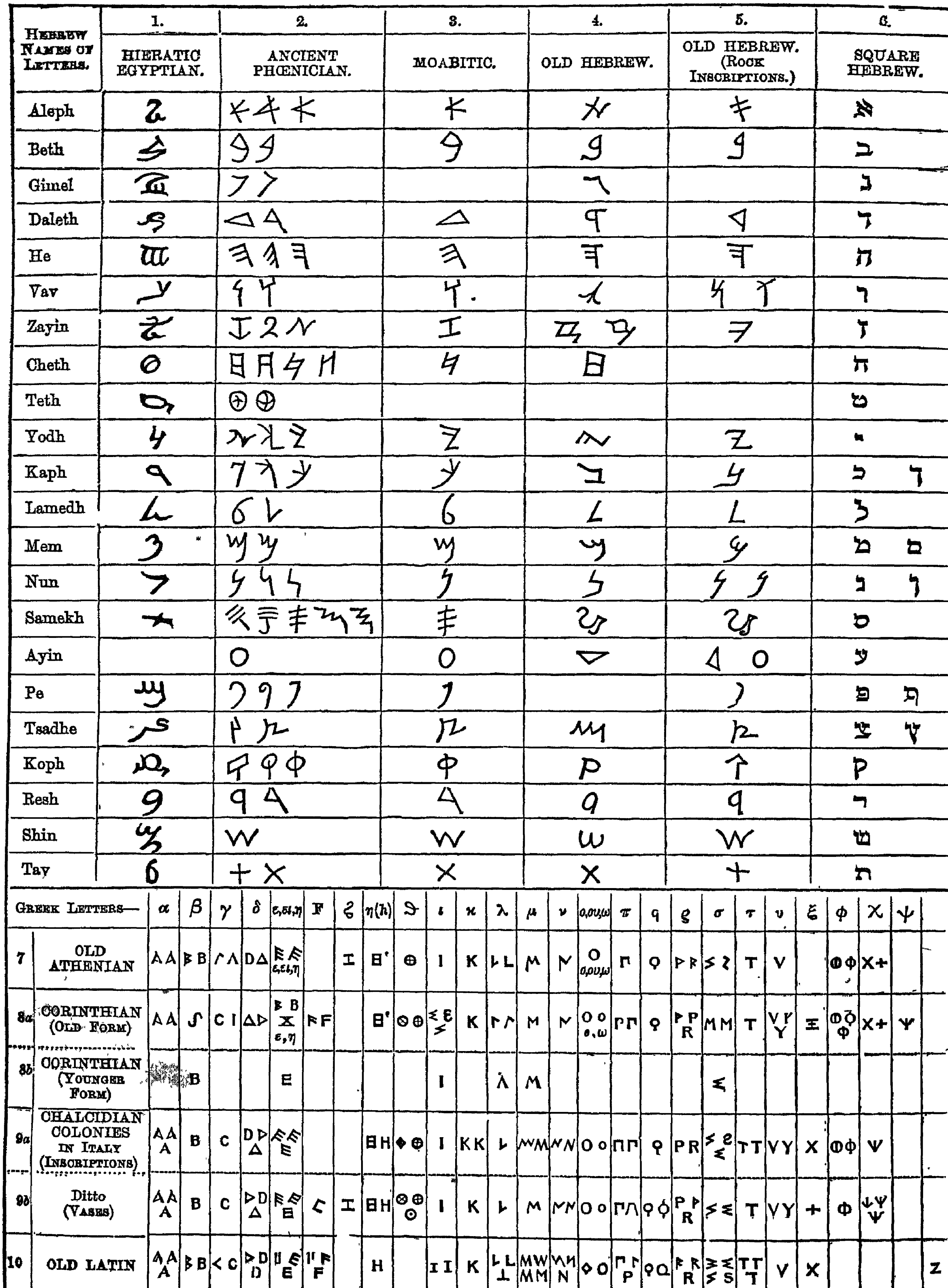
ALPES, the name of three departments in the south-east of France,—*Basses Alpes*, *Hautes Alpes*, and *Alpes Maritimes*.

Basses Alpes is bounded on the N. by the department of Hautes Alpes; on the E. by the kingdom of Italy and the department of Alpes Maritimes; on the S. by the departments of Var and Bouches du Rhône; and on the W. by those of Vaucluse and Drôme. It extends at the widest points 90 miles from N.E. to S.W., and 70 from E. to W., and contains an area of 2680 square miles. Its surface is mountainous, especially on the north-east, where offshoots of the Maritime Alps penetrate into the country, rising near the river Ubaye to an elevation of over 9000 feet above the level of the sea. With the exception of the south-eastern corner, which is drained by the Var, the whole department is in the basin of the Durance, which for a considerable distance separates Basses from Hautes Alpes, but eventually strikes southward through the former. Its chief tributaries are the Buech and the Jabron on the right, and the Ubaye, the Bléone, the Asse, and the Verdon on the left. The climate in the mountainous districts of the north is cold and variable. The soil there is poor, but it is cultivated with great industry—producing rye, oats, barley, potatoes, and timber. In the south and south-west, however, where the country is comparatively flat, the temperature is milder and the soil more fertile; here plums, almonds, apricots, peaches, and other fruits are produced in large quantities, as well as wine of an excellent description, chiefly for home consumption. Considerable numbers of cattle, sheep, goats, and pigs are reared in the Basses Alpes, besides which many flocks of sheep, from Var and Bouches du Rhône, are pastured during summer in the upper valleys of the department. Game is abundant. There are mines of lead and other metals of some value. The manufactures are few and of little importance, the chief being leather, coarse woollen cloths, cutlery, earthenware, and paper. Basses Alpes, one of the departments formed out of ancient Provence, is divided into five arrondissements—Digne, in the centre; Barcelonnette and Castellane, on the east; Sisteron and Forcalquier on the west; which together contain 30 cantons and 251 communes. Digne is the capital and the seat of a bishop, whose diocese is co-extensive with the department; and among the other towns are Barcelonnette, Castellane, Sisteron, Forcalquier, and Manosque. Population (1871), 139,332.

Hautes Alpes is bounded on the N. by the departments of Isère and Savoir; on the E. by the kingdom of Italy; on the S. by the department of Alpes Basses; and on the W. by that of Drôme. It extends nearly 80 miles from N.E. to S.W., and contains an area of 2158 square miles. Its surface is very mountainous, being traversed in all directions by the Cottian and Dauphiné Alps, which, in Mont Pelvoux and other peaks, rise to an elevation of about 13,000 feet above the sea, the highest summits in France. The Drac, flowing northwards into the Isère, and the Durance, with its tributaries the Guil and the Buech, are the chief rivers of Hautes Alpes. The climate is cold in winter, and in summer variable; the soil is barren, yielding only oats, barley, potatoes, rye, and timber, except in a few favoured valleys, where wine of a fair quality and fruits of various kinds are produced. Large numbers of sheep and other domestic animals are reared or pastured in the department. Game, both large and small, is found in great abundance. The mines produce lead, copper, iron, and other metals. There are no manufactures of any commercial importance, although some leather, coarse woollen cloth, hats, woodwork, and iron wares are made. Hautes Alpes, a part of the old province of Dauphiné, is divided into three arrondissements: Gap on the west, Embrun on the south-east, and Briançon on the north-east, with 24 cantons and 89 communes. The capital is Gap, the seat of the bishop; Embrun and Briançon being the only other towns of any size. Population, 118,898.

Alpes Maritimes, bounded on the N. by Basses Alpes and the kingdom of Italy, which also forms its boundary on the E.; on the S. by the Mediterranean Sea; and on the W. by Var and Basses Alpes. It extends at the widest points 55 miles from N. to S., and 50 from E. to W.; and contains an area of 1517 square miles. The surface of this department, like that of the two former, is more or less mountainous, branches of the Maritimes Alpes covering the greater part of the territory. It is watered by the Roya, the Paillon, the Var (with its tributaries the Tinéa and the Esteron), the Loup, and the Siagne. The climate is on the whole warm and gentle, except among the higher mountains; while the mildness of the temperature along the shores of the Mediterranean has made that portion of the department a favourite resort for invalids. The upper valleys and mountain slopes are chiefly devoted to pasture for sheep, being ill-suited for cultivation, although a little barley and maize is grown; the richer districts of the south produce fruits of various kinds, tobacco, honey, and flowers, used in the making of perfumes. The other manufactures are of dried fruits, olive-oil, preserved anchovies and sardines, silk, soap, and paper. Alpes Maritimes is divided into three arrondissements—Grasse and Nice on the south, and Puget Théniers on the north, containing 25 cantons and 146 communes. The arrondissements of Nice and Puget Théniers constitute the bishopric of Nice; Grasse belongs to that of Fréjus. Nice is the capital; and among the other towns are Mentone, Villafranche, Grasse, Antibes, Cannes, and Puget Théniers. The Marseilles, Nice, and Ventimille railway, skirting the coast, connects Cannes, Antibes, Nice, and Mentone, and joins an Italian line which affords direct railway communication with Genoa. The department of Alpes Maritimes was formed in 1860 from the territory of Nice, which had been ceded to France, together with Mentone and Roccabruna, purchased from the Prince of Monaco, and the arrondissement of Grasse, transferred from Var. It had a population of 119,037 in 1871.

ALPHA and OMEGA (A and Ω), the first and last letters of the Greek alphabet, frequently employed to symbolise the idea of completeness or infinity. They are used as a designation of himself by the speaker in Rev. i. 8; xxi. 6; xxii. 13. In the last passage the speaker is undoubtedly Jesus Christ. In the symbolism of the early church A and Ω, combined with a cross or with the monogram of Χριστός, represented Christianity, or, more specifically, faith in the divinity of Christ.


HEBREW NAMES OF LETTERS.
1. HIERATIC EGYPTIAN.
2. ANCIENT PHŒNICIAN.
3. MOABITIC.
4. OLD HEBREW.
5. OLD HEBREW. (ROCK INSCRIPTIONS.)
6. SQUARE HEBREW.
Aleph א
Beth ב
Gimel ג
Daleth ד
He ה
Vav ו
Zayin ז
Cheth ח
Teth ט
Yodh י
Kaph כ ך
Lamedh ל
Mem מ ם
Nun נ ן
Samekh ס
Ayin ע
Pe פ ף
Tsadhe צ ץ
Koph ק
Resh ר
Shin ש
Tav ת
GREEK LETTERS— α β γ δ ε,ει,η Ϝ ζ η(h) ϑ ι κ λ μ ν ο,ου,ω π ϙ ϱ σ τ υ ξ φ χ ψ
7 OLD ATHENIAN
8a CORINTHIAN (OLD FORM)
8b CORINTHIAN (YOUNGER FORM)
9a CHALCIDIAN COLONIES IN ITALY (INSCRIPTIONS)
9b Ditto (VASES)
10 OLD LATIN

ALPHABET

By an alphabet we mean a list of symbols which represent conventionally to the eye the sounds which are heard in the speech of a nation. An alphabet will therefore be perfect if the number of its symbols exactly corresponds to the number of simple sounds which are commonly distinguishable in the spoken language. But this perfection has probably never yet been reached: all known alphabets have failed, either by defect, *i.e.*, from not representing all the simple sounds; or by redundancy, in having more than one symbol for the same sound. They must also necessarily become imperfect by lapse of time. No nation keeps the sound of its language unaltered through many centuries: sounds change as well as grammatical forms, though they may endure longer, so that the symbols no longer retain their proper values; often, too, several different sounds come to be denoted by the same symbol; and in strictness the alphabet should be changed to correspond to all these changes. But little inconvenience is practically caused by the tacit acceptance of the old symbol to express the new sound; indeed the change in language is so gradual that the variation in the values of the symbols is imperceptible. It is only when we attempt to produce the exact sounds of the English language less than three centuries ago that we realise the fact that if Shakespeare could now stand on our stage he would seem to us to speak in an unknown tongue; though one of his plays, when written, is as perfectly intelligible now as then. Such changes of sound are most developed in countries where many different dialects, through conquest, immigration, or otherwise, exist side by side: they are checked by the increase of education and by facility of locomotion—both of which causes tend to assimilate all dialects to that one which by some lucky chance has become the literary speech of the nation.

The term alphabet has come to us from the Latin *alphabetum*, which, however, occurs in no prose writer before Tertullian. It could not have been used, for metrical reasons, by Juvenal, when he wrote, "Hoc discunt omnes ante alpha et beta puellæ"—their A B C. But there is no reason why it should not have existed earlier: the word was borrowed from the Greek, as seems clear from the compound αναλφάβητος, which is as old as the comedian Philyllius (Meineke, *Com. Frag.* ii. 857), and he was alive in 392 B.C. It does not seem likely that this compound adjective would have been coined if the noun itself had not already existed in the same sense which it now bears.

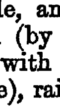
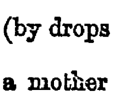
The symbols of our alphabet are nearly those of the Latin; these in their turn were borrowed from a Greek alphabet; and there seems no reasonable ground for doubting the common tradition that the Greeks derived their characters from a Phœnician source. All these borrowings will be fully described hereafter. At this point absolute certainty ends. We cannot prove to demonstration the origin of our alphabet; but positive facts and analogical arguments may be adduced which enable us to attain a very high degree of probability. It is now commonly believed that the characters were originally hieroglyphics, and in that ultimate form were devised in Egypt. There, for convenience of writing, they took a simpler form (called hieratic). In this shape they were borrowed by the Phœnicians; and thus, in their long course down to us, they passed gradually from being the written expression of an idea into the written expression each of a single sound. It is true that the proof is not clear throughout: sometimes the links are feeble, and here we have to employ the analogy of other languages, in which the particular step which we want to prove has undoubtedly been made under similar circumstances. Still, it may with some truth be said that we can only prove the possibility of such a process, while any given alphabet may have had a perfectly independent origin; the Phœnician alphabet *may* have been developed in Phœnicia itself, and never been hieroglyphic at all. But this is very difficult to conceive. The *a priori* argument for the derivation of phonetic from hieroglyphic characters is strong. Hieroglyphics have unquestionably been the first attempt of many nations in a rude state to record their thoughts in a permanent and universally intelligible form. It is also certain that these hieroglyphics have undergone progressive degradation of shape, so that their visible connection with the thing signified was often lost; they became in many cases the expression of those combinations of sounds by which the things were denoted in the spoken language, though they still generally retained their original value as well. Here, at all events, a certain connection between hieroglyphics and sounds establishes itself; and *a priori* it is more probable that all alphabets should have derived the single sounds of which they consist from hieroglyphics, through the medium of their derived phonetic values, than that any alphabet should have been produced independently of hieroglyphics (which are admitted to have existed), by some arbitrary process of formation for which absolutely no testimony can be adduced. As we have said above, such a process is not impossible, and may be true for any particular alphabet; but the opposite theory has the most internal probability and all the evidence of which the case admits. Against this it seems insufficient to urge (as has been done) that there exist upon earth savages who have never developed any alphabetic writing out of their rude attempts—a fact which may be readily granted; or that civilised men often return to the simple methods employed by uncivilised nations, such as cutting notches on sticks or tying knots in strings—such return being apparently adduced to prove that two totally different methods of expression can co-exist without there being any tendency to pass from one to the other; nay, it is added that in Egypt the hieroglyphic and the common (or demotic) character did certainly exist side by side; and if the latter were borrowed from the former, it would have superseded it, which it did not do. Now, in answer to this, reasons will appear shortly why the hieroglyphic characters lingered so persistently, even when the later phonetic character was in common use—nay, in the very same inscription or document with the hieroglyphic. Still, the argument would have some weight if it were not grounded on the false assumption that the demotic alphabet was a *purely* phonetic one, totally unconnected with its more aged rival. But modern research has proved incontestably that the demotic characters can be traced back to their original hieroglyphic shape through the medium of the hieratic; in fact, that the cumbrous hieroglyphics were successively put into more and more abbreviated shapes, for convenience of writing, as its use increased.

Excluding, then, attempts of savages such as have been mentioned above, which were neither durable nor intelligible enough to make them of service, except for the smallest number of men during the most limited time—excluding these as not deserving the name, we derive all real writing from hieroglyphics, such hieroglyphics being either purely pictorial, the expression of visible objects in the external world; or symbolic, when some external object is conventionally chosen to represent some action or

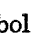
some abstract idea. These two methods were probably nearly contemporaneous in their origin, because the necessity of writing at all supposes a considerable advance in civilisation, and therefore a considerable development of ideas. To this system as a whole the convenient term *ideography* is now generally applied. From this men have passed to phonetic writing, first, apparently, in the form of *syllabism*, in which each syllable of a word is regarded as an independent whole and represented by a single sign; then from this to *alphabetism*, in which the syllable is no longer denoted by an indivisible symbol, but is resolved into vowel and consonant, each with its own accepted sign.

It seems probable that all known alphabets (with one or two possible exceptions) may be traced back to four or five parents. These have differed much in fruitfulness, but all were originally hieroglyphic. These five systems of writing are the Egyptian, the cuneiform, the Chinese, the Mexican or Aztec, and the curiously cumbrous characters of Yucatan and central America: these last may be seen interspersed with figurative paintings in a facsimile given by M. de Rosny at p. 20 of his very useful little summary, *Les Ecritures Figuratives des Differents Peuples Anciens et Modernes.* Of these, the first three alone can be said to have had any great extension; and the first, if the Phœnician, and by consequence the European alphabets, were derived from it, far exceeds in importance all the rest together. These systems were perfectly independent, and developed themselves, each in the same course, but in its own manner, and each in the main to a different degree. At certain points in their history all but one became crystallised, and remained to show us the steps by which the progress to phonetism can be made. We do not propose to describe here fully any of these systems of hieroglyphics. We are only concerned to point out their relative degrees of development, their deficiencies, and the consequent motives which must have impelled men by degrees to the production of a genuine alphabet.[1]

There are obvious deficiencies even in the most highly developed hieroglyphics. In the first place, they must have been excessively burdensome to the memory. They speedily lost their original form, which was in most cases too cumbrous to be retained when writing became frequent; their pictorial value was therefore lost, and the new form could not generally have been intelligible to a learner, who was thus obliged to acquire by memory an enormous number of symbols, compared with which even the Sanskrit alphabet may be regarded as easy. Secondly, it is impossible by hieroglyphics to express grammatical relations: the order, indeed, in which the symbols are placed may denote the distinction between subject and object; plurality may be expressed by the repetition of a symbol; some even of the relations in space, denoted in more advanced languages by cases, may be pictorially rendered; but all these helps do not go far to remedy this obvious want. Experience, however, shows how much inconvenience a nation will undergo rather than make any radical change in its phonetic system. We have only to look at our own alphabet, with its numerous and universally confessed deficiencies and redundancies, and then remember the fruitless attempts which have been made to work a reform in it, to be convinced that no people will of its own accord strike out a thoroughly new system of writing. Such revolutions can only be produced by the meeting of two different civilisations, and the reception by the one of the arts and ideas of the other. But such a meeting may, and more commonly does, only stimulate the inferior race to some partial development. For the new ideas new names are required: these may be metaphorically represented out of the old vocabulary, as when the Romans called the unknown elephant the Lucanian ox, and of course wrote it so. But suppose the inferior people to be one which has not yet advanced beyond hieroglyphic writing; their simplest and most obvious plan will be to take the strange name, and express it by those symbols out of their old stock which denote the nearest sounds to that of the name required. Such symbols then cease to represent ideas only, as they used to do; they are consciously employed to represent mere sounds, and thus arise the first beginnings of phonetism. A good example of this process may be found in the Aztec (Lenormant, i. 29; De Rosny, p. 19, who also gives others). When Christianity was introduced into Mexico, the Lord's Prayer was reduced to writing in the following manner:—The Mexican symbols nearest to the two syllables of *pater* were a flag (sounded as *pantli*), and a rock (*tetl*): *pater* was therefore represented pictorially by a flag and a rock; we cannot tell whether it was sounded as *pan-tetl*, or only as *pa-te*—the nearest possible equivalent in the Mexican language, which has no *r*. Similarly, *noster* was phonetically represented by *noch-tetl*, pictorially by the Indian fig (*nochtli*) and the rock as before. Here, then, we have the application of symbols to denote sound without regard to the original sense; just as we might draw the figures of an eye, a saw, and a horse, and convey by them the idea, "I saw a horse." The Aztec would not long have the ideas of a flag, a rock, and a fig presented to his mind when he read these symbols; and so the first conception of phonetism was gained, the first move from hieroglyphic to alphabetic writing. Yet he had not attained the first real step in the progress—*i.e.*, syllabic writing—because if he had decomposed his new words, *pan* would not have represented to his mind merely so much sound—a syllable by itself meaningless: it would have given him only the idea of a flag. And further than this the Aztec language did not pass: probably it only reached this stage incompletely with a small number of words. The great advance to syllabic writing is to be found elsewhere; first in the Chinese, perhaps through the accident of the monosyllabic nature of the language; but with a clearly-developed purpose in the Aramaic cuneiform inscriptions.

In the Chinese written character we find a considerable number of symbols which were unquestionably at first pictorial. Though but very slight vestiges of their original meaning can now be seen in them, yet they can be traced back to older forms which are unmistakeable; and their origin is further attested by the name "images," which the Chinese give them, as distinguished from others which they call "letters." These symbols were simple, and denoted very ingeniously natural objects—the sun (by a circle with a dot inside), the moon (by a crescent with a line inside), a mountain (by three peaks side by side), rain (by drops under an overarching line), a child (thus ), a mother (, a figure expressing the arms and bosom effectively enough), &c. These symbols could be combined: thus the symbols for water and eye combined denoted tears, an ear and a door expressed hearing and under-

[1] The authorities referred to chiefly are Endlicher (*Chinesische Grammatik*), Oppert (*Expédition Scientifique en Mésopotamie*, tom. 2), and Bunsen (*Egypt's Place in History*, vol. v.) Frequent use has been made of De Rosny's book mentioned above, and still more of the *Essai sur la Propagation de l'Alphabet Phénicien dans l'Ancien Monde*, by M. François Lenormant, of which the first volume only has yet appeared. It contains an introduction to his special subject, in which the labours of Champollion, Young, Lepsius, Bunsen, De Rougé, in Egyptian hieroglyphics, and of Grotefend, Rawlinson, Hincks, and Oppert, among the cuneiform characters, are ably summarised, and set forth with much clearness.

standing; but such combinations of pure hieroglyphics were rare, as they would have been liable to be confused with combinations of the same kind used in a different way, as will be seen immediately. There were also some hieroglyphs used symbolically; *e.g.*, a hand to denote a workman, the two valves of a shell-fish to denote friends. These also are few in number, and not very ingenious. Last in this class come some symbols which are essentially pictorial, though they represent no visible object; *e.g.*, "above" was expressed by a dot above a horizontal line; "below," by a dot below it; the numerals one, two, three, by so many horizontal lines; "right," by the symbol  "left," by , &c. So far, we have simple hieroglyphs, or ideograms (a more convenient term),—pictorial representations, expressing not merely visible objects, but also abstract ideas, and even actions; but each of these could also have the phonetic value of the name of the object which it depicted.

Distinct from these are the "letters"—in use, though not in origin. These have two parts—one, a symbol which was originally an ideogram, and which could still be used as such, but which in this particular combination lost its ideographic value, and retained only the phonetic value of the name of its object; the other, an ideogram, which laid aside its phonetic value, and only restricted to a particular class the phonetic symbol which it accompanied. Thus, for example, the ideogram of a ship had also the phonetic value *tcheu*—*i.e.*, the name denoting ship in the spoken language; the ideogram of fire had the phonetic value *hvó:* these two symbols combined were still pronounced *tcheu*, and meant the flickering of flame. The second symbol dropped its phonetic value altogether, but kept the generic idea of fire: the ship was lost, but the idea of undulating motion modified that of fire, and the complex symbol combined the two ideas, with the one sound *tcheu.* Similarly, the ideogram ship and speech combined expressed loquacity, and this in the spoken language was also *tcheu*, the phonetic value of the symbol for speech being dropped, just like that of the symbol fire above. In this way there are ten different ideas given by Endlicher (p. 10), all called in the spoken language *tcheu*, and all expressed to the eye by different complex symbols formed on this principle. These symbols, he reckons, form at least $\frac{29}{30}$ths of the written language.

This is a very imperfect sketch of the Chinese system of writing, and into the history of the "keys," which indeed belong rather to Chinese lexicography, we do not propose to enter. But it is enough to throw light on some questions connected with our subject. First of all, we see ideography and phonetism existing side by side; and even the same symbol, having in most cases (not in all) either an ideographic or a phonetic value at will. Therefore, in this case the passage from the one system to the other may be considered as certain; but how it was made there is not sufficient evidence to show. It must have been earlier than the combination of pure ideograms mentioned above. It was probably greatly facilitated by the Chinese being a monosyllabic language; each syllable is a complete word in itself, expressing a complete notion: hence the idea of completeness and individuality would attach to such a combination of sound more easily than would be possible in polysyllabic language; and it would seem more natural to give that sound a symbol for itself, quite apart from its ideographic meaning. Further, as the whole number of single syllables of which the language consists is only 450, the effort of remembering the symbols could not be great, and the memory must have been already trained in that direction, because the symbols (even in their ideographic acceptation) had lost their obviously pictorial character, and must have been kept by the memory, not recognised each time by the eye; just as children, in learning to read, commonly remember short and familiar words as a whole, without analysing them into the component letters.

The explanation of the cumbrous "letters" described above is simple; and it will show us, secondly, how so apparently monstrous a system of writing could be maintained, and has been in its essence maintained, down to the present day. With so few radical sounds in the language, it was inevitable that many different objects must have been expressed, as ideas grew and multiplied, by the same sound, as we saw above that there were eleven different ideas (including the ship itself) all called *tcheu.* These could be distinguished in the spoken language by tone or accent, and actually were so distinguished. But how were they to be distinguished in writing? Now, writing is but the visible exponent of language, and therefore is naturally formed under the same conditions—those conditions which, because the effect is obvious while the reason is often difficult to detect, we vaguely call the genius of the language: and it must accommodate itself to the defects as well as the strength of the language. There is an inherent evil in Chinese speech—inevitable in a monosyllabic language with a limited number of radicals—that the same combination of sound should serve to express many different ideas. A combination, therefore, of symbols is absolutely necessary, which shall represent to the mind through the eye the fact that the sound which is heard has changed its meaning to meet that of another sound which is not heard—that *tcheu* no longer means a ship, but means the flickering of flame, or something else quite different. It would have been easy enough to have had different symbols for the different meanings of *tcheu;* but it would not practically have been so convenient, because it would not have represented so well the facts of the language. If the Chinese had chosen in their speech to do universally what they did occasionally, to form compounds like "ear-dooring" for "hearing" a thing, the native genius for pictorial representation would have produced a symbolism which might have supplied all its wants down to the present day. But that was not the bent of the language; and the writing therefore remains to the present day a mixture of ideography and phonetism, and is perhaps better so. Still, a great deal of confusion is possible. In modern writing, according to Endlicher, each syllable has several symbols, partly because of the extraordinary number of meanings belonging, as we have seen, to each combination of sound, partly from considerations of calligraphy, because it is not every symbol which will combine neatly with every other; and therefore for particular combinations a different symbol with the same phonetic value is required, so that the shapes of the mixed symbols increase in number. Also, the pictorial symbols being comparatively few, and many of these being employed phonetically for the same syllable, it is obvious that, with the growth of ideas, many new symbols must have been required. To meet this want, the mixed symbols so often mentioned were employed purely phonetically, each in new combination on the old principle with an ideogram, whose meaning was disregarded. Generally these symbols kept their phonetic worth, but sometimes in combination with particular ideograms they change. Thus we see a double evil arise in the language. Not only have we several symbols for each combination of sound, but also the same symbol can under certain circumstances have different phonetic values. But the difficulties thus caused seem greater to a stranger than to a native; and the Chinese have never been moved thereby to exchange their

picturesque but unwieldy system. The impure syllabism marked out for them by the genius of their language has been their furthest development. It was reserved for the Japanese to borrow the Chinese characters, and, expelling all ideographic associations, to employ them simply as syllables, thus advancing to a pure syllabic writing. This borrowing and extension of a system by a foreign nation will be more fully dwelt upon hereafter. It should perhaps be added that the expression of many different senses by one symbol, which has so largely modified the Chinese writing, is not peculiar to monosyllabic language. It is found in all languages, though not to the same extent: roots of different sense have been worn down by phonetic decay till they reach the same form, and this cause may have operated to some extent in China, though it cannot have been very important.

The cuneiform writing, so called from the wedge-like shape of the characters,  or , which compose it, was employed by different nationalities. It was first deciphered by Grotefend on inscriptions of Persepolis, and was found to be the exponent of the Aryan spoken by the conquering Persians, which belonged, as is well known, to the Indo-European family of languages. But cuneiform inscriptions in three languages were found on a monument at Behistun: the first was the Persian, and much the simplest in form; the second and third were composed of elements of the same shape in much more unwieldy combinations.[1] It was obvious that the three inscriptions were identical in meaning, but in different languages; and principally by the help afforded by recurring proper names, whose value could be compared with the known values in Persian, the characters of the last two inscriptions were deciphered, and found to belong, one to the language of the Assyrian and Babylonian subjects of Darius, the other to the old Scythian population of Media, who used a Turanian speech. Other languages, the old Armenian and that of Susa, were found afterwards to be represented by the same characters; and to these different systems the collective name *Anarien* (*i.e.* non-Aryan) has been given by French writers (Oppert, &c.), to distinguish them from the Aryan-Persian, which is a purely phonetic character.

It seems clear that the origin of this system was Turanian, and that it was borrowed by the Semitic races who used it. It was originally hieroglyphic, though the stiff combinations of wedges give but little indication of such an origin. But both in Assyrian and Babylonian there is an older character and a newer one, and the older forms can again be traced back to a still more archaic shape, which was unquestionably the original of both, and which is not cuneiform, but composed of straight lines only.[2] These show little of the brilliancy of invention of the Chinese; they seem to appeal to the reason rather than to the eye; they are obviously intended to recall the image of the object, but they must have been first explained in order to be intelligible at all, and then they might be remembered. For example, a house was denoted by ; a town by . Neither of these are symbols which will be intelligible as soon as seen by a person who has not been taught them. This is probably due to the fact that they were produced, not by the hair-pencil of the Chinese, but by the chisel; they were intended to be written on rock, and for this straight lines are more convenient; and the wedge shape which they assumed afterwards may be explained by the ease with which it can be made by two strokes of the chisel—perhaps no other figure so clear can be produced with such facility.

This system seems to have reached syllabism before it was adopted by the Aramaic peoples. But the syllabism was still mixed up with ideography, just as we have seen was the case in China—that is, the same symbol denoted ideographically the object, and phonetically the sound, of the name of the object; as though in English we should denote by the symbol B both the insect *bee* and the sound *be*. But there is a difference between this idiom and the Chinese; it was polysyllabic, whereas Chinese was syllabic. When, then, the name of the object contained more than one syllable, the first alone was taken to be denoted phonetically by the symbol. The evidence for this is small in quantity, owing to the scanty remains of the language of that Turanian element of the Chaldee nation from which the cuneiform writing was borrowed. To this language the name Accadian has been given by Dr Hincks, and this name seems to be now generally received. But the Medo-Scythic, mentioned above, which is a closely-connected dialect, supplies us with forms sufficiently close to the old Scythian spoken originally by all the Turanian stock in that part of Asia. Thus one symbol in Assyrian denotes ideographically God and phonetically *an;* now the name for God in Medo-Scythic is *Annap*. Another denotes a city and *but; batin* is a city in Scythian. Another is a father and *at;* in Scythian a father is *atta*. (Oppert, ii. 79; Lenormant, i. 41.) This evidence will doubtless be strengthened with time, but even now it is conclusive; and the principle thus established, the arbitrary selection of the first part of a name to have a particular phonetic value, seems to be exactly the principle which we should *a priori* have expected to find if we had tried to conceive the possible ways in which ideography could pass into phonetism.

The confusion which was occasioned by the imperfection of Assyrian writing was immensely increased by the fact of their characters being borrowed, not indigenous, as in China. There is first of all the obvious difficulty of adapting Turanian symbols to a Semitic language, in which the short vowels were not written, and the meaning of the radical group of consonants in any particular place had to be determined by the context. Instead of being able to retain the same symbol to express a root in its modified forms, *e.g.* in the conjugation of a verb, a new symbol would be necessary for each person-form, which could be expressed by mere vowel change in the root, and these symbols might be totally unconnected, so that all sense of the connection of different parts of a verb would be lost. This is bad enough, but it is an evil inherent in the borrowing of such a system of writing to express a language whose genius was so essentially different. But there was another evil, much greater, which might have been avoided, and was not. This is polyphony—the expression of many different sounds by the same symbol. When the Assyrians took an Accadian symbol, they should have taken only its phonetic value, or one of them, if it had more than one, and in this way they might have acquired a purely syllabic character, as the people of Susa afterwards actually did. But, as was not unnatural at the time, they took it with all its values, ideographic and phonetic, and added more of their own. A striking example given by Oppert (ii. 85) will make this plain. In Accadian this symbol  was the ideogram for an open hand, doubtless originally in a more elaborate form. In the spoken language a hand was called *kurpi*, and therefore, by the principle mentioned above, this symbol had also the phonetic value *kur*. But by a metaphor the hand symbol had the further ideographic

[1] A part of this trilingual inscription is printed in De Rosny's *Écritures Figuratives*, p. 70.

[2] For specimens, see Oppert, vol. ii., p. 63.

values of seizing, possessing, and understanding. To seize in the spoken language must have been *mat*, or something very like it (*imid* occurs in this sense in the Scythian), for this phonetic value also belonged to one symbol. But further, in Accadian a mountain was called *kur;* sunrise, *kurra;* earth was *mat;* to go was *mit;* and these sounds, identical or nearly identical, were every one expressed by the same symbol, which thus had eight ideographic and two phonetic values, *kur* and *mat;* and in this wretched condition it was taken by the Assyrians, and employed by them in all these different senses. But this was not all. In the Assyrian language *kur* was the name of a furnace, and *mat* meant to die; and as it must have been to obtain a visible exponent for these sounds that the foreign symbol was adopted, both of these ideas were necessarily denoted by it. Again, in Assyrian, "to understand" was pronounced as *nat*, and to "possess" was *nal;* and so were added two more phonetic values by reason of the metaphoric value of *mat* in Accadian. Lastly was added the phonetic value *shat*, because that was the Assyrian name for a mountain, which we saw was denoted in Accadian by *kur*. Thus, when an Assyrian came upon this little plain-looking symbol he had to determine whether it meant the earth, a mountain, sunrise, a furnace, or seizing, possessing, understanding, going, or dying; or whether it had only one of the phonetic values, *kur*, *mat*, *shat*, *nal*, or *nat*. And a large list of other symbols is given by M. Oppert, which, in a similar way, have two, three, four, and even six different phonetic values. It may seem incredible that a people under such difficulties should ever have been able to express what they wished to say, much less to understand what was written. It is a great witness to the strength of the feeling which must have existed in these old people that ideography was the natural and proper method of writing, and phonetics were only a supplement to eke out its deficiencies. To us such a feeling is at first incomprehensible, but after such an example we cannot doubt its existence. With respect, indeed, to the difficulty caused by one symbol having many ideographic values, we have only to think of the many different significations expressed in our own language by the same combination of sound, without any confusion arising, because the particular meaning is marked out by the context; for instance, when the one sound *but* denotes a conjunction, a verb, and a noun with two senses—one original and one derived, but now quite different,—we should therefore only see in the Assyrian an aggravated case of this want of clearness. But the difficulty is much more serious when the same symbol has different phonetic values; and much help cannot have been obtained from the grammatical lists which have actually been dug out under the superintendence of Mr Layard, in which the Assyrian kings state, avowedly for the instruction of their subjects, the different values which each symbol could possess. (See Oppert, ii. 53.) By these lists some limit might undoubtedly be put to the further multiplication of values for the same sign, but it could not help a reader to trace which of all the authorised values he was to give to a symbol at any particular time. It would appear that in the cuneiform, as unquestionably in the Egyptian, conventional phonetic symbols could be used as complements to other symbols, which might represent an idea or a mere syllable, and by these phonetic complements the special sense could be defined with some approach to exactness. But into these remedies of the ills of polyphony we need not further enter.

It is far beyond the scope of the present article to describe fully the development of hieroglyphism in Egypt, the country in which the last step to alphabetism—the separation of the vowel-symbols from those which mark the consonants—was undoubtedly taken, though with much faltering, and even turning back. According to M. Lenormant, the Egyptians passed through every stage which we have already seen successively reached by different peoples; and at one of which every one of these peoples halted, without ever achieving for themselves the triumph of alphabetic writing. And evidence of each stage, more or less distinct, certainly lingers in the Egyptian, producing an extraordinary medley, little suited for popular or even literary use, but well adapted for the transmission of occult records and rituals, the purpose for which the Greeks not unnaturally supposed the whole hieroglyphic system to have been invented by the priests. As we have already described the phenomena of each stage with some fulness, it is not necessary to do more here than to indicate their occurrence in Egyptian. The hieroglyphs themselves are certainly the finest of their kind. Whether they represent the full contour of the object with all the assistance of vivid colouring, or whether they are simply formed by lines which convey its essential character—a practice which doubtless owed its origin to the increased use of writing—it is impossible not to admire the extraordinary completeness of the representation. Nothing can be more perfectly pictorial than the portraiture of the different emotions, each by the figure of a man affected by it: the position of the body and the gestures of the arms are simply perfect. These belong in the main to the *symbolic* use of the hieroglyphs: this use we saw in Chinese was but slight, but in Egypt it was immense. Thus, the sun, with rays streaming from it, denoted to the Egyptian light and clearness; the moon, with its horns turned downward, denoted the month,—in these cases the cause is put for the effect. Sometimes the part is put for the whole: two arms, one holding a shield and one an offensive weapon, express battle; two legs with the feet denote movement, forward or backward according to the direction of the feet,  or ; an arm holding a stick denotes force. Sometimes the symbol is purely metaphorical: as when a king is expressed by a bee; knowledge by a roll of papyrus; or justice by the feather of an ostrich, because all feathers of that bird were supposed to be of equal length. Such symbols are clearly of later origin than the other; they imply the existence of conventional rules, which could acquire currency for meanings quite unintelligible in themselves. These symbolic ideograms were not very often used alone; most commonly they accompanied other symbols used phonetically, merely to determine their special meaning in each place: as such they are commonly called *determinatives;* this practice we also saw in China, less skilfully employed. Thus, for example, on the Rosetta stone—whose trilingual inscription, hieroglyphic, demotic, and Greek, is the basis of all our knowledge of Egyptian writing—the word for a decree is expressed by characters, consonant and vowel, which denote the sounds of which it is composed, just as in any modern writing; but at the end of these, forming part of the word, though adding nothing to its pronunciation, is the figure of a man with his hand raised to his mouth, which adds the idea of passive obedience to the phonetic combination, and limits it to the idea of a decree. In like manner, the arm with the stick, which as we said denotes force, is added as a determinative to express actions which require force; and the ideogram of motion is also very frequent. This seems to us unnecessary and cumbrous; but when a phonetic combination might have two different meanings, they could hardly have been differentiated in a more intelligible manner. A good list of these symbols may be seen in De Rosny, p. 46.

The traces of the *rebus* stage which we saw in the Aztec

in which a symbol could be transferred from one object to another, because the names of the two had the same sound in the spoken language, are not very distinct, and have not been fully examined; on this point we may hope for more light from M. Lenormant. He points out that the same symbol denotes "holiness" and a "slave." No metaphorical explanation seems possible here; but both are sounded *hen* in the spoken language, and the community of symbol becomes at once intelligible. In such a practice as this we see at once a cause of great confusion, especially when the same symbol was employed to denote two things the names of which were not exact homophones, and yet sufficiently near in sound to allow themselves to be expressed by the same symbol; *e.g.*, when the circle which denoted the sun was also taken to denote the idea of day, the sun was called *ra*, the day *hru*, and so the symbol became a polyphone; it had two not very different sounds. It is true that here the application of the symbol for the sun to denote the day was not caused only by the similarity of sound in the two words—it was probably employed at first metaphorically; but there can be little doubt that it was helped to its double use by the indistinctness of the Egyptian vowel-sounds, which caused the two words to be sounded nearly alike. From this and similar causes arose that polyphony which necessitated the use of the determinatives described above. Vestiges of the syllabic stage in Egyptian exist beyond a doubt, and they point to a slowly-effected transition from the older to the newer form of writing. Thus the symbol of a fish represented at the syllabic stage the syllable *an*; later on, the letter *a* alone came to be denoted by a reed, and *n* by a waving line. Now we find the syllable *an* represented not merely by its own simple exponent, the fish, but also by the reed and fish together, that is, in phonetic value, by $A\,.\,an$; by the reed above the waving line $\left(\frac{an}{n}\right)$; and even by all three $\left(A.\,\frac{an}{n}\right)$ (Lenormant, ii. 44). This surely points to a stage at which the alphabetic values of the reed and line were not yet so firmly fixed that the writer could dispense with the older and more familiar sign of the fish to specialise the other two. Of Egyptian alphabetism proper it is not necessary to give examples; we are sufficiently acquainted with the use of letters pure and simple, and their use in Egypt is not denied.

To what cause are we to assign the progress of the Egyptian beyond the Assyrian method of writing? What circumstances enabled the one nation to develop at least an imperfect alphabetism, while the other never advanced beyond syllabism? No certain answer can be given; but at least a probable suggestion is made by M. Lenormant. The Egyptian vowel-sounds were indistinct: the consonants were clear and definite. Therefore it was natural (as Lepsius pointed out) that in each syllable the consonant should come to be regarded as the important element, and should finally extrude the following vowel altogether. Thus a large number of symbols, which originally represented syllables beginning with the same consonant but followed by different vowels, would become in time absolutely identical in value, the different representatives of the same consonant. And a great abundance of such homophones is actually found in Egyptian. The method, therefore, which was followed in passing from the syllable to the mere alphabetic sign, was identical with that which we have already pointed out in Assyrian, by which the symbol of a polysyllabic word was taken to have the phonetic value of the first syllable of that word; in each case it denoted the first element of the name—the syllable in Assyrian, the single sound in Egyptian. And in each language the symbol thus applied to a new use still retained for a long time its old value as the hieroglyphic or at least conventional exponent of a material object or of an idea. Thus in Egypt *nefer* meant good. This word in writing is expressed in two ways: first, by a single symbol—which had originally been the pictorial representation of some material object, but was afterwards the conventional symbol of the idea of goodness; secondly, by this same symbol followed by two others, which had also, from being originally hieroglyphs, acquired the phonetic values of *f* and *r*; that is to say, one symbol could at will express the whole word *nefer* and its initial letter *n*. This is the natural, perhaps the only possible way of eliminating the single sound; but it is obvious that great difficulties would attend it at the outset. There could be at first no convention to restrict the symbol for *n* to that of the particular word *nefer*; any other beginning with *n* would have served. There was no law to prevent a writer taking as many symbols for *n* as took his fancy; and in fact each letter in this way did have several different symbols.

It follows that while Egypt must be credited with having first invented an alphabetic system, and must for ever claim for this the gratitude of the world, yet that system was far too imperfect to become the instrument of a popular literature. It suffered equally from the opposite diseases of homophony and polyphony, from the expression of the same sound by many different symbols, and from the use of one symbol to denote many different syllables. And each of these evils was only aggravated by time. The earlier Egyptian writing is much more simple than the later, wherein homophones increased to a degree to which there was practically no limit except the strength of the memory; and the numerous phonetic devices to unravel the confusions of polyphony must have been equally burdensome. It might have been expected that polyphony at least would have become extinct with time; that the different symbols for the same syllable would all have been worn down into single letters, and thus, though homophony might have multiplied, polyphony would have perished. This might have been the case if these symbols had ever become perfectly clear of their originally pictorial or conventional origin. But this was never the case. To the last, the employment of a symbol to express an object or idea continued side by side with its employment as a single letter. The spirit of hieroglyphism, real if not apparent, could not be vanquished by alphabetism; and in order that ideography may be finally expelled, it would seem that circumstances are needed more favourable than can be often found combined at any period of any nation's history. In fact, a purely phonetic alphabet is most likely to be produced when one nation borrows from another such portion of that nation's symbols as it requires for its own needs, and rejects that superfluity which only leads to confusion. We have already seen indications of this fact.

Many circumstances combine to render it difficult for a nation to reach of itself pure phonetism in writing. There is the strong disinclination to change, of which we have before spoken. It is always easier to put up with difficulties to which we have been accustomed all our life than to make any radical change, especially when that change causes at once serious difficulties at every moment. It was easier for the Egyptians to retain the odd mixture of ideographic, syllabic, and alphabetic writing, and occasionally to add some new key for unlocking the difficulties to the formidable list which was already in use. The ingenuity of these grammatical devices almost surpasses belief. We can only refer the curious to the hieroglyphic grammar in the fifth volume of Bunsen's *Egypt's Place in Universal History*. In the second place, a good deal must be allowed to the restraining influence of religion. It is well known that most of the ancient nations ascribed a divine origin to their systems of writing. It might well

seem to them to be too wonderful a thing for the result of human ingenuity. Thus in one of the Assyrian lists of the different values of syllables, published, as has been already mentioned, by royal authority, Sardanapalus V. states that the god Nebo has revealed to the kings, his ancestors, the cuneiform writing, which he thus endeavours to simplify for the better understanding of his people (Oppert, ii. 53). The Sanskrit character, which is now known to be due to a Phœnician source, was called *Devanâgarî*, "belonging to the city of the gods," unless, as Prof. M. Müller suggests (*Sanskrit Grammar*, p. 1), we are to understand by the gods here only the Brahmans; but whatever the name may mean, their belief in its divine origin is certain enough. And M. Lenormant points out (i. 80) that the native Egyptian term for writing meant "writing heavenly words." Now it is clear that no nation among which this belief lingered in any degree would be likely to alter fundamentally the spirit of their system of writing. Lastly, it is possible, though, as we have suggested above, not very probable, that the obscurities of the existing system may have recommended it to the priests. These reasons may suffice to show that it was not in Egypt that we should expect to find the development of a purely phonetic system. But just as the Japanese took the Chinese characters, and gave them a development which they have never had in the land of their creation—just as the people of Susiana took the cuneiform writing and made it purely phonetic, without any remnant of ideography,—so the work of extracting order out of the chaos of Egyptian writing was reserved for the Phœnicians.

The Phœnicians were peculiarly fitted to perform this inestimable part in the history of human development. An active and enterprising nation, they were early brought into commercial relations with Egypt, and must of necessity have learnt something of their system of writing; they could see its advantages and its perfectly remediable faults; the advantage of one definite symbol for one sound, and the disadvantage of a dozen; the desirability that this symbol should signify that sound only, and the undesirability of its denoting a horse or a man as well. And the religious scruples which may have affected the Egyptians need have no weight for strangers. If the characters were divine for the priests of Isis, they were a convenient instrument to supply every-day wants for the sailors of Tyre.[1]

These considerations do not, of course, amount to a proof that the Phœnician alphabet was derived from Egypt. It is of course possible that it disengaged itself by degrees out of an earlier hieroglyphic system at home. But of such a system no vestiges remain; and the correspondence between the Phœnician characters and those of the earlier Egyptian hieratic is sufficiently striking to warrant us in regarding it as at least provisionally true that what was natural and perfectly possible did actually take place.[2] The general testimony of the early Greek and Roman writers, that the alphabet was invented in Phœnicia, must then be limited to the sense in which Tacitus says that the Phœnicians had this credit—*tanquam repererint, quæ acceperant.*

It cannot be known with certainty whether the Phœnicians took, together with the Egyptian symbols, the phonetic values which they had in Egypt, or whether they totally disregarded those values, and simply assigned to the symbols the value of their own sounds at will. The first view, however, seems clearly the more probable. The Phœnicians could only become acquainted with the Egyptian symbol and sound together; the one would naturally suggest the other; and we should expect that they would first take the symbols belonging to those sounds which exactly corresponded in Egyptian and Phœnician, then the symbols of other Egyptian sounds which did not exactly correspond to their own, but which seemed in each case the most analogous to them; but that there would never be any violent rupture between the symbol and its old sound. Yet it seems quite certain that there is no connection between the names which the letters bore in Phœnicia and the original object of which the Egyptian character is the debased representation. Thus the first letter of the Phœnician alphabet (corresponding to the Hebrew *aleph*) was named from its fancied resemblance to an ox's head, the second (Hebrew *beth*) to a house, and so on. But the symbol which strangely seemed to the Phœnicians like an ox is only the form, rapidly drawn, of an eagle; *beth*, in like manner, is the quickly-drawn figure of a crane. It would seem, then, that the Phœnicians borrowed sound and symbol, but no name. They cared nothing for the history of the symbols; and when they found it convenient to have a name for each symbol they chose some object whose name began with the letter in question; and we should have said that it was totally impossible that any similarity in form between the letter and the object whose name it borrowed could have helped to give currency to the nomenclature, did we not see evidence of similar and apparently equally impossible fancies in the names of the constellations, let the origin of those names be what it may.

Such, very briefly traced, seems to have been the origin of the Phœnician alphabet, the parent of almost every alphabet, properly so called, existing on the earth. For the main ramifications of this alphabet in subsequent times we cannot do better than translate the summary of an author already often referred to, M. François Lenormant. He distinguishes (p. 110) five main stems. These are—

1. The *Semitic* stem, wherein the values of the letters have remained exactly the same as those of the Phœnicians, except in a few derived alphabets framed in Persia and the countries immediately adjacent, which being employed to write Indo-European languages, turn the soft breathings of the Phœnician into genuine vowels. This stem subdivides itself into two main branches—the Hebræo-Samaritan and the Aramaic.

2. The *Central* stem, whose province includes Greece, Asia Minor, and Italy. The transformation of the symbols of the smooth, and even of the rough, breathings into symbols of vowels is here the invariable rule. This stem contains first the different varieties of the Hellenic alphabet, then the alphabets derived from the Greek, including three families—the Albanian, Asiatic (taking Asia in the same sense as the old Greeks did), and the Italian. In the Asiatic family we distinguish two groups—one for the Phrygian alphabet only, which is made up of elements whose origin is exclusively Greek, the other containing the Lycian and Carian, where these elements are mixed up with Cypriote[3] characters. The Italian family must also be subdivided into an Etruscan group and a Latin group, between which stands the Faliscan alphabet, of a mixed character.

3. The *Western* stem, containing the systems of writing which resulted from the spread of the alphabet by the colonists of Tyre among the indigenous inhabitants of ancient Spain. This stem reckons but one single family. It has, as that which precedes it, for its fundamental character the change of the value of the Phœnician breathings. But the direction in which the forms of the letters vary is signally different. . . .

4. The *Northern* stem, containing only one branch, the runes of the Teutonic and Scandinavian peoples, who were settled at a particular epoch in the north of Europe, but had arrived from Asia, where they still lived during a part of historic time, and where they must have had imparted to them the alphabet produced by the Phœnicians. Some elements in the runic writing seem to point to a direct reception of the writing from the seamen of Canaan; others, on the contrary, bear a certain stamp of Greek influence. . . .

[1] M. Lenormant (p. 83) will have it that the Phœnicians must have been "très peu religieux, et au fond presque athée." They may have been so, but surely not merely in order to borrow an alphabet from Egypt. It is enough that that alphabet could have had no sanctity for them.

[2] For evidence of this, see plate, p. 600.

[3] The only two alphabets, in the strict sense of the term, which M. Lenormant cannot classify as of Phœnician origin are the Cypriote and the Persian cuneiform—the former still imperfectly deciphered, but seemingly to some extent syllabic; the latter perhaps not pure alphabetic, but retaining certain ideograms.

5. The *Indo-Homerite* stem, distinguished by the appearance of a new principle, the expression of vowel sounds by means of conventional adjuncts attached to the symbol of the consonant, and thus sometimes considerably modifying its shape. The place of its origin seems to have been southern Arabia. From thence it has radiated on the one side to Africa, where the Abyssinian and the African systems form a separate family with the Himyaritic, or alphabet of the old inhabitants of Yemen; on the other side to Ariana, where a special form of writing established itself; and to India, whose most ancient alphabet, Mâgadhî, now referred by A. Weber to a Phœnician origin, has given birth to an enormous list of derivatives, which can be classified among six families—Devanâgarî, Pâlî, Dravidian, Transgangetic, Oceanic, and Thibetan—which we here enumerate in their chronological order of descent.

It will of course be observed that this classification of alphabets runs entirely counter to the universally-accepted classification of languages into certain well-recognised groups under three main heads—Indo-European, Semitic, and that family which, rather because its members differ from the two first-named than from any especial bond of union among themselves, is called Turanian. This is in nowise surprising. There is no necessary connection whatever between the sound and the symbol which signifies it —between the language and the alphabet. The languages of nearly all Europe are Indo-European (or Aryan, as they are sometimes called); the alphabets are universally Semitic —that is the fact, explain it as we may. In fact, if we wish to maintain that sound and symbol correspond, so that the second is the only natural exponent of the first, we must form two hypotheses which refute themselves—first, that it was possible that any race of men, when they first felt the need of an alphabet, deliberately set themselves to form their letters so as to represent the different positions of the organs of speech as each sound was produced; secondly, that such forms could have been exactly preserved through long lapse of time, so as to convey to subsequent generations exactly the same idea as they gave to their inventors. But each supposition is clearly impossible. An alphabet so formed would also be an artificial alphabet, such as could never have entered the minds of men who needed to supply just their actual wants as they arose, not to construct a scientific table of signs to denote all possible sounds. But the construction of such a pictorial alphabet as we have supposed is quite possible, and it has actually been formed most ingeniously by Mr Melville Bell. In his system, which he calls "Visible Speech," consonants are denoted by curved lines, which represent the position of the tongue or lips in their formation. For example, in forming the gutturals *k*, *g*, *ng*, the back of the tongue is raised, and this is expressed by the curve ; in pronouncing *y*, the front of the tongue is arched, and this is denoted by ; in pronouncing dentals, the point of the tongue is raised, and this is expressed by ; in sounding labials, the lips are closed, and this is denoted by ; where the passage of the mouth is completely closed by the symbolised organ (as in *k*, *g*, *t*, *d*, *p*, *b*), the ends of the curve are shut by a connecting line—thus denotes *k*; the consonants which are voice articulations (*i.e.*, in producing which the *chordæ vocales* vibrate, and so produce voice), as *g*, *d*, *b*, &c., are further distinguished by a short straight line within the curve, the physiological sign which is chosen (conventionally, it must be allowed) to represent voice being (I) a straight line; and the other distinguishing marks of the consonants are similarly expressed either by added marks or by slight modifications of the primary curve. Equally ingeniously, the vowels are expressed by the straight line which is the sign of voice, a subordinate symbol, or "definer," being added to denote the part of the mouth which modifies the vowel—*e.g.*, a hook or a solid point at the top or bottom of the vowel-line, a bar across the line to express that the lips are contracted or drawn across the aperture of the mouth, &c., &c. We need not enter further into the minutiæ of the system; enough has been said to show the principle on which it is formed. It is obvious that there would be no greater difficulty in teaching this alphabet to a child than in teaching it *a*, *b*, *c*, except that the number of symbols is greater, because one is provided for every sound in the language, which our alphabet certainly fails to do; still, to learn either our alphabet or "visible speech" must for a child be simply an effort of memory. And one great practical gain which would be derived from the general adoption of such a system is the ease with which foreign languages could be mastered. The great difficulty in learning to speak a foreign language does not consist in the mere mastering so many declensions; it lies in the fact that two alphabets may be composed of exactly the same symbols, and yet many of these symbols may express to the two nations quite different sounds. This is a preliminary difficulty which must be mastered at once; and it would be immensely lessened if such dissimilar sounds—as, *e.g.*, the German, French, and English *u*—were not all presented to the learner under the same symbol. It seems certain that, with the lapse of time and the progress of invention, the intercourse between nations must be largely increased; and the need of some more perfect instrument of speech between them must increase proportionately. But in spite of the obvious gains, it is utopian to suppose that the world will ever be converted to a system of universal writing; and the real and immense gain of such a method is the power which it gives to a linguistic inquirer to denote accurately on paper the exact sounds heard in any dialect spoken in any part of the world, civilised or uncivilised; for it is as competent to register the click of the Hottentot as the most subtle vowel sound of Europe. With our present alphabet it is utterly impossible to represent adequately the strange sounds of some out-of-the-way dialect (which for students of language may be as important as the literary speech) in such a way as to be generally intelligible, because there often is no symbol to correspond exactly, and naturally no two inquirers agree upon the nearest out of the existing symbols. The science of language is therefore greatly indebted to Mr Bell for providing so effective a method for preserving for ever those dialectic peculiarities which are vanishing with startling rapidity in these days of constant communication between different parts of a country. Another system, equally valuable scientifically, has been invented by the eminent philologer, Mr Alexander J. Ellis. In his "Palæotype" only the ordinary symbols are employed, but they are printed in different ways to denote different sounds—sometimes as capitals, sometimes in italics, sometimes turned upside down; so that, despite the familiarity of the letters, a page of palæotype is at least as appalling to the uninitiated as the curves and lines of "visible speech."

We may proceed to trace the variations from the Phœnician alphabet to our own, down the central stem of Greece and Italy. The Phœnician alphabet consisted of twenty-eight letters, which for convenience we may call by the names of their Hebrew equivalents. These were (1) Aleph, (2) Beth, (3) Gimel, (4) Daleth, (5) He, (6) Vav, (7) Zayin, (8) Cheth, (9) Teth, (10) Yodh, (11) Kaph, (12) Lamedh, (13) Mem, (14) Nun, (15) Samekh, (16) Ayin, (17) Pe, (18) Tsadhe, (19) Koph, (20) Resh, (21) Shin, (22) Tav. None of these were vowel sounds. Aleph was the lightest guttural or rather faucal sound, being pronounced below the guttural point at the very top of the larynx: it can have been barely audible even before a vowel. He corresponded nearly

to our *h*. Cheth was a strongly-marked *ch*, a continuous guttural sound produced at the back of the palate. Ayin represents a faucal sound peculiar to the Semitic race, varying between an evanescent breathing and a *g* rolled in the throat.

The Phœnicians employed hardly any vowel signs: in Hebrew the three principal sounds *a*, *i*, *u* (see article A) were sometimes expressed in writing, and long *i* and *u* were denoted, not by special signs, but by consonants akin to them, *yodh* and *vav*: *a* was regularly omitted except at the end of a word, where it was denoted by He and sometimes by Aleph. In fact, in all Semitic languages the practice was to ignore vowels in writing, leaving it to the reader to fill in, according to the context, the unvarying framework of consonantal sounds: the Hebrew vowel-points were a later invention, rendered necessary when the language had ceased to be spoken.

When the Greeks received the Phœnician alphabet it is obvious that they must have made considerable changes in the values of the symbols. Several of them would be unnecessary, for they had no sounds in their language to correspond to them: while for other most important sounds, *e.g.*, the vowels, no symbol was provided. It is clear how imperfect any previous alphabet of the Greeks must have been when they adopted in its stead another so foreign to the genius of their language, which developed the vowels and marked strongly the momentary consonants and nasals, but rejected as far as possible the continuous consonants, both palatal and labial, and even under many circumstances the dental *s*, the one sibilant they employed. But they ingeniously adopted the strange signs to new ends. Aleph, He, and Ayin were turned without difficulty into α, ε, and ο: Yodh became ι, as it seems that the semi-vowel *y* had totally disappeared from Greece even at that early period: on the same principle Vav might have served to express υ, although apparently the *w*-sound was still sufficiently common to require the retention of Vav with its consonantal value. But from what source they took their *upsilon* cannot be known with certainty. Professor Key thinks that it is the Hebrew form of Ayin, which differs much in shape from the nearly perfect circle of the old Phœnician. This is possible enough, for the sound of Ayin was not more like *o* than *u*; and if the Greeks knew the two forms, it is not likely that they may have taken both. On the other hand, it is equally possible that υ may be a remnant of an earlier native alphabet. Among the consonants β, γ, δ, κ, λ, μ, ν, π, ρ, τ were borrowed with little change of form, and probably of value. And these letters (with σ and the vowels already mentioned) are stated by tradition to have been the only ones brought to Greece from Phœnicia by Cadmus, others having been added by Palamedes, Simonides, or Epicharmus; but which were the letters added by each of these is a question on which the different authorities do not agree; and the incorrectness of most of them is proved by the letters being found in Greek inscriptions before the time of their supposed inventor. In fact, all tradition on this point is worthless, unless it is borne out by inscriptions. It is at least probable that the whole alphabet was borrowed at one time, for all, or nearly all, the characters occur on the oldest inscriptions we possess. Thus on inscriptions of Thera dating from Olympiad 40 (see Franz, *Epigraphice Græca*, pp. 51–59; Kirchhoff, *Studien zur Geschichte des Griechischen Alphabets*, p. 41), we find Cheth in the form B, denoting mainly the rough breathing *h*, but also applied to denote *e*, as it afterwards did regularly by the name *Eta*: Teth occurs as ⊕, nearly the later *Theta*; and Koph as Ϙ, *Koppa*, a symbol which was once current throughout Greece, and remained universally as the numeral 90, though as a letter it was retained only by the Dorians, and passed with the Doric alphabet into Italy as Q. It may be observed that in this alphabet, and in some later ones of Crete, Corinth, and Corcyra, Iota appears not as a straight line, but in many curved shapes, approximating much nearer to the old Phœnician; and the same is true of Pi, which has the top rounded like a crook. We have then left only the four sibilants, Zayin, Samekh, Tsadhe, and Shin. These are believed to have had the values *dz*, *s*, *ts*, *sh* respectively. We have already said that the Greeks had no great affection for sibilants; witness the manner in which σ was constantly dropped, *e.g.*, in γένεος for γένεσ-ος. It was therefore not to be expected that they could employ all the wealth of the Phœnicians; and one symbol (Tsadhe) appears in no Greek alphabet. The name, however, recalls the name *Zeta*; but the shape of Zeta (always I) is unquestionably that of Zayin; and its place in the alphabet agrees to this. It seems, therefore, most probable that the Greeks confounded together the two compound sounds *dz* and *ts*, and kept but one symbol, perhaps with the name of the other (Tsadhe), because it was most like that of the neighbouring letters Eta and Theta. This confusion of the two sounds seems the more probable when we remember that no symbol was required for the compound *ts* at the time when a special symbol for *ps* was added, and that for *ks* (another analogous compound) perhaps revived. There is also much uncertainty with regard to the relations of Samekh and Shin in their Greek dress. *Xi* (=*ks*) occupies the place of Samekh, *sigma* of Shin. One form of Samekh seems unquestionably to have furnished that of the Greek Σ (see the forms, p. 600); another Ξ is exactly the Greek ξ of all the inscriptions. Sigma had the sound (*s*) of Samekh, and cannot be shown ever to have had the sound (*sh*) of Shin. Two names were preserved among the Greeks, *sigma* and *san*. Herodotus (i. 139) speaks of the "same letter which the Dorians call σάν, the Ionians σίγμα;" and though *san* was no letter of the Ionic alphabet, the compound *sampi* (=σαν+πι) denoted 900. The name *san* is obviously the Semitic *shin* or *sin*: it is just possible that σίγμα may be an attempt to turn *samekh* into a form which should explain its meaning to Greek ears. The oldest Greek alphabets known to us—those of Thera, Melos, Crete, and the earlier forms of those of Argos, Corinth, and Corcyra—have the form M to denote *s*,—that is, the equivalent of *Shin*. It seems fair to infer that this was originally the case in the other alphabets also. Then this symbol was dropped by degrees to avoid confusion with *m*, while one form of *samekh*, with the name *sigma*, was introduced into its place: another form was kept in its old place to denote the compound *ks* (*xi*).

We now come to the apparently non-Phœnician letters of the Greek alphabet, φ, χ, ψ, ω. Of υ we have already spoken: we may add that its sound was not a pure *u*, but modified, perhaps as is the German *u*. This appears from the fact that, when the Romans borrowed Greek words in the later times of the republic (when Roman taste had grown more scrupulous), they did not use their own symbol *u* to denote the Greek *upsilon* (as their forefathers had done), but together with the sound borrowed the symbol also: which clearly shows that the sound of *upsilon* was different from the ordinary *u*. We now take the aspirates φ and χ. It is most probable that the sounds of the Greek aspirates χ, θ, φ, were not those of the German *ch*, and the English *th* and *f*: that is, they were probably not continuous consonants, but momentary

sounds, followed in each case by a slight but distinctly audible breath; so that χ might be represented in English characters by *k'h*, though the following breath is not so distinct as an English *h*,—if it were, we should have a compound, not a simple sound. Now two of these aspirates were actually written in the oldest alphabets KH and ΓH (*pi* having the right down-stroke much shorter than the left): for the dental the single symbol θ, borrowed from the Phœnician, sufficed. Afterwards the symbols φ and χ (variants Φ and +) were taken to supply the place of these compounds, from what source cannot be certainly known; but it is not impossible that they may have been characters of an older Greek alphabet which originally had the values *p* and *k*. This draws some probability from the history of ψ. That letter was originally written ΓΣ; and ξ, of which we have already spoken, written as KΣ (or KM). But each of these also appears as ΦΣ and XΣ; so that here at least φ and χ appear as no more than *p* and *k*: the compound ΦΣ remained permanently in the Western alphabets. It is to Epicharmus that tradition (here with some probability) ascribes the establishment of ψ in the alphabet. The history of ω is closely connected with that of η. At an early period, certainly before the 40th Olympiad, in the eastern part of Hellas an attempt was made to distinguish the different kinds of *e*. The symbol ε had hitherto denoted both ε and the diphthong ει, where the ι was probably not a much more important sound than the *y*—*e.g.*, in our *day*. The habit of writing the two symbols came in late in the Ionic alphabet, and so spread through Greece. But at the earlier time of which we speak the symbol H began to denote some *e*. It is commonly supposed that this was long *e* as distinguished from epsilon, which, by the way, does not mean *short e*, but "*e* unaccompanied," perhaps by that after sound of ι mentioned above, though a different reason is commonly given for the name. It seems very strange that the Greeks should have introduced symbols to express long *e* and *o*, and none to mark the length of the other vowels, which must have been just as urgently needed: surely this would have been done at Athens at the time of the formal introduction of the Ionian alphabet. Again, there are a great many recognisable varieties of sound which border closely on pure *e* and *o* (but none of importance near *i* and *u*), and such varieties are clearly marked in the south of Europe now. For these two separate reasons, it seems at least more probable that η was adopted to express a sound the same, or nearly the same, as the open *e* of the Italians. For the same reasons, it seems probable that ω was taken not to denote long *o*, but a more open sound; perhaps something between open *o* and the English *au*. The form Ω is of doubtful origin. It is found in an alphabet of Miletus of about Olympiad 60; not earlier. It looks like a conscious modification of O.

Greek writing in the earliest times was from right to left, following the example of Phœnicia: several specimens of this still exist. The more convenient practice of writing from left to right soon became universal. It was preceded, however, by an intermediate method, in which the direction of the lines was alternately right to left and left to right, so that it was not necessary to carry the eye back, as with us, from the end of one line to the beginning of the next. This was called βουστροφηδόν, because the lines were made in the same way as the furrows by oxen in ploughing.

Kirchhoff distinguishes two main divisions of Greek alphabets—the East and the West; not that this geographical distribution is exact, but it is the most convenient. The eastern includes first the alphabets of the towns of Asia Minor—Halicarnassus, Ephesus, Teos, Miletus, Colophon, and Rhodes, which, agreeing essentially, became that Ionic alphabet that was adopted at Athens 463 B.C., and is the Greek alphabet with which we are familiar; secondly, those of the Ægean islands—Thera, Melos, Crete, Paros, Siphnos, Thasos, Naxos,—in which Ω does not stand for Omega, but occasionally appears as well as *o* for Omicron, and there are other minute differences in the shape of the letters; thirdly, some of the alphabets of the mainland of Greece, which have a closer affinity to the Ionic than to their neighbours, viz., the old one of Attica, down to Ol. 94—Argos, Corinth and its colonies, Corcyra, and even Syracuse. The western division includes the remainder of the towns of Greece proper and their Sicilian and Italian colonies; these are marked by peculiar variations of certain characters, especially *g*, *e*, *h*, *th*, *l*, *r*, and *s*, by the use of *h* as the aspirate only, by the absence of *omega*, and by the universal application of the symbol Ψ or Ψ to denote, not *ps*, but *ch*, whilst X or +, the symbol of *ch* in the eastern alphabets, here denotes *x*. Compare with this last variation what we have said above of the use of XΣ to express X: there can be little doubt that it was from the occurrence of X in this collocation, and no other, that this new value for it arose, and Σ was dropped. It is significant that in the old Latin alphabet XS appear instead of X. The difference in value of Ψ in the eastern and western alphabets is perplexing: it seems that in one or the other the original value must have been consciously changed, but it is not easy to say in which. The most important alphabet of this group for our purpose is that of the Chalcidian colonies of Sicily and the west coast of Italy—Cumæ, Neapolis, &c.—because from this was derived the Latin alphabet, the direct progenitor of our own. It is distinguished from others of the same class by the rounded form of the Gamma C, by the peculiar form of the Lambda L, by the very old Mu (/W), and by a rounded Sigma S, though it has also the two other ordinary forms ≶ and Σ: in common with some other western alphabets, it has a double *rho* (P and R). (See p. 600.)

From this Chalcidian alphabet it seems clear that all the Italian alphabets were derived. They fall into two families, which differ from each other considerably, but principally in the loss of old letters and the insertion of new—differences which do not militate against their common origin, but show the cause of their separate development. The first family contains the Etruscan, Umbrian, and Oscan alphabets; the second the Latin and Faliscan. Into the peculiarities of the members of the first group we do not propose to enter at length: they agree in the total rejection of O and X, and the addition of a strange symbol 8 to denote the *f* sound, *vau* being retained with a slightly modified form for *v*: the Etruscan retains the symbols Φ and V which the other two dropped, and the Etruscan and Umbrian agree in rejecting the soft mutes. The Umbrian, however, has a new symbol for a modified *d*, peculiar to itself, and also for a modified *k*; the Oscan has new symbols for a modified *i* and *a*, and in general shows a difference in the shape of its characters from all the other Italian dialects, which does not seem due to any other foreign influence so much as to its own individuality. These three languages are all written from right to left, in which the Faliscan agrees with them: the Latin alone, from the earliest time of which we have any records, was written from left to right; but there can be little doubt that it did not originally differ from its fellows, but changed at a later time, just as the Greek alphabet itself

had done. The fact that X, found in the Latin and Faliscan alphabets, has the value of *x*, and not of *ch*, and that Ѵ, as already mentioned, is found with the value of *ch* in Etruscan, shows that the common source of these five alphabets was a western, not an eastern Greek alphabet; and the rounded form of C, and the peculiar L (V, not Λ) limit the choice to the Chalcidian family. The points in which the Latin differs from the Chalcidian alphabet of Cumæ, from which it was probably derived through commercial intercourse, lie—

(1.) In the application of the symbol *vau* (F), to denote not the *v* but the *f* sound, which was probably strange to the Greeks.

(2.) In allowing K to fall almost out of use—it was employed only in abbreviations, such as the first letter of a prænomen, as Kæso, or for Kalendæ, &c.—and employing C instead, which had of course in the present Greek alphabet the power of *g*. This change may point to a time when the distinction of the sounds *k* and *g* was obliterated, to be afterwards restored.

(3.) In the formation of the new symbol G—*i. e.*, C with a distinguishing line—to mark the soft gutturals, when the want of a distinctive symbol was again felt. This was some time in the 3d century B.C.; but instead of replacing K for the hard guttural sound, they preferred to leave C in its old place, but with a new value, *k* instead of *g*; while the modified form G was inserted into the place of I (Z), which may have been taken by the Romans (as it certainly was found in the other Italian alphabets), but which fell out of use absolutely without any record.

(4.) In absence of the aspirates Ѵ, ⊕, and Φ: these sounds were not natural to the Roman tongue, and therefore the symbols were never regularly received into their alphabet, though they were taken to represent numerals. Their forms, however, were much altered, and so in process of time they became confused with other letters: thus Ѵ denoted 50; but it came to be written ⊥, and so naturally passed into the quite meaningless L: ⊕ denoted 10, but being too cumbrous to write, the circle was dropped, and the cross (X) alone remained. A variant form of the same letter (⊙) seems to have originally represented 100, and either to have been shortened into the common form C, or C superseded it as being the first letter of *centum*. Φ was taken for 1000, but for convenience of writing it was broken up into CIↃ, and this was the more easily done because the parts were characters in use; but this symbol also was replaced by M, the first letter of *mille*. It is probable that Φ was simply divided, and the half of it (D) then stood for half of 1000, or 500; and half of X, ten, became V, five. Neither D nor V have any other propriety as symbols.

(5.) In the addition, in the 1st century B.C., of the two symbols Y and Z after X (which had long been the last letter of the alphabet), to express the Greek sounds *v* and Z. In borrowed words these in earlier times had been roughly denoted by *u* and *ss*; but in Cicero's day greater precision was desired; and not being able to compound two characters of their own to denote the strange sound (as they did for the aspirates *kh*, *th*, *ph*, formerly denoted only by *k*, *t*, and *p* or *b*), they took sound and symbol together, so that Φρύγες appeared, not as *Bruges*, but as *Phryges*: τραπεζίτης ceased to be *tarpessita*, and *sona* became *zona*, &c.

The Latin alphabet agrees with the Chalcidian in the retention of koppa (Ϙ); the downward stroke became by degrees more oblique. This symbol had a much wider use in Latin than it had in any Greek language: it was needed to express a modified *k*-sound which the Latins liked, wherein a slight *w* sound was heard after the *k*. This sound was distasteful to the Greeks, and consequently they changed this *kw* (or *qu*) into *p*; so also did the other Italians (compare *equos*, ἵππος, *Epona*, &c.); but the Romans liked it, and therefore, alone in Italy, kept the Ϙ to denote it. It is true that the Q was generally followed by a written *u*, though not always in the older inscriptions; but it was fully recognised that this *u* was not a real letter. It was only a symbol expressing further, and somewhat unnecessarily, the indistinct after-sound which made Q different from K; it would have been more logical to have written Q alone, as was actually attempted under the empire, where we find on inscriptions forms such as *qis*, *qidem*, *qaerella*; but this never became general. The Latin and Chalcidian alphabets are again at one in not having the symbol M for *s*, differing in this respect from the alphabets of South Italy, and also from the Etruscan and Umbrian, which had both forms. Lastly, the Chalcidian (as we saw) had two forms for *r*, P and R; of these the Latin chose the last, and generally employed the first for *p*; though for that letter the genuine Greek form Γ also appears rarely.

The Romans did not retain the Greek names for the characters of the alphabet. The vowels were known by their sounds only. The momentary sounds and *h* were denoted by their own sound followed by a vowel, as *be*, *ce*, *de*, *ge*, *pe*, and *te*, but *ka*, *ha*; *q*, as we saw, had sufficient vowel sound to float it; on the other hand, the continuous consonants were preceded by the vowel, as *ef*, *el*, *em*, *en*, *er*, *es*; *x* was called *ix*. The difference in the names of the consonants obviously was caused by their nature: momentary sounds are produced by a complete closure and opening of the organs required in each case; when this opening is made, the organs are so placed as to form a vowel, which naturally is produced by the remnant of sound required for the consonant; whereas a vowel cannot be produced before any one of these sounds without conscious effort: hence it was simpler to call *k*, *ka*, than to call it *ak*. But the continuous sounds are pronounced when the necessary organs only approximate more or less closely to each other; the channel through which the sound passes from the larynx to the lips is never closed altogether, and by reason of this slightly open position a certain amount of vowel sound tends to escape just as the organs are drawing together to produce the consonant, and thus is heard before it; but to sound a vowel after one of these consonants the organs must be intentionally put into the proper position. Thus, then, exactly the same principle —the conscious or unconscious striving for ease of articulation—produces exactly opposite results in the case of the momentary and the continuous consonants. The same reason caused a different vowel to be employed for *h* and *k* from that which is used for the other letters. In sounding *a* the organs are in nearly the same position as in sounding these two gutturals, only a little more open; whereas the position of *e* is more nearly that of all the other consonants. It must of course be remembered that a Roman, if he had wished to speak of his A B C, would not have said, as we do, *a-bee-see*, but *ah-bay-kay*.

The arrangement of the letters of the alphabet has caused much ingenious speculation. It has been more than once pointed out (as by Prof. Key, *The Alphabet*, p. 28) that there are certainly traces of regularity of arrangement. The three soft momentary sounds *b*, *g*, *d*, were placed together; and it is possible that *p*, *k*, *t* (if denoted by Pe, Koph, Tau), may have once been together, and separated by later intrusions; *l*, *m*, *n* have an affinity more apparent than real, which was perpetuated by their meaningless designation as "liquids;" still, the appearance is sufficient to justify the idea that they may have been

purposely put together. It has been suggested that the alphabet was at first composed of "four quaternions" of letters, each headed by a vowel, and the scattered position of the vowels lends itself to this arrangement; but it must be remembered that the arrangement of the European alphabets is certainly the same as that of Phœnicia, and in the Phœnician there were breathings but no vowel symbols. Besides, the remaining letters are just as necessary as any sixteen which we might so arrange, and to all appearance just as ancient. The author of the *New Cratylus*, indeed (p. 170, ed. 3), actually drew up his list of fours: the three soft momentaries headed by *aleph;* then came *h*, followed by *vau*, *cheth*, and *teth*, oddly grouped as aspirates; then the three "liquids," with *samekh* behind them; and lastly, *pe*, *koph*, and *tau*, under the care of *ayin*. This, of course, renders it necessary to "omit *caph*, which is only a softened form of *coph*, the liquid *resh*, and the semi-vowel *yodh*, which are of more recent introduction." Also it is "quite certain that at the first there was only one sibilant, *samekh*." In this way Dr Donaldson satisfies himself that the "original Semitic alphabet contained only sixteen letters." We give this futile attempt at arrangement with no wish to sneer at a philologer who did good work in his day, but simply to show the arbitrary nature of all such attempts, resting as they must do simply on internal evidence. If we bear in mind the history of the derivation of the Phœnician alphabet, as we have attempted to give it, from the Egyptian hieratic, we shall conclude that it is hardly probable that symbols borrowed for practical uses should have been arranged upon any scientific method; that chance guided the general arrangement, though a few sounds obviously similar may have been put intentionally together. No argument can be drawn (as by Rödiger in his Hebrew Grammar) from the juxtaposition of two letters meaning a hand (*yodh* and *kaph*), two meaning a head (*koph* and *resh*), &c.; reasons have been given above for believing that these names have no relation to the original import of the signs, but were merely fanciful analogies drawn by the Phœnicians themselves; and it seems as possible that the juxtaposition may have suggested the idea of the names as that the names caused the arrangement. But if the argument be sound, it is valid against the supposition that the order was fixed throughout on scientific grounds.

It is quite certain that the Teutonic tribes of north-western Europe possessed characters of some sort before they received the Greek or Latin alphabets. These characters are generally called *runes*, and have been the subject of some sound scholarship and much baseless speculation. They may be divided into three main classes—the Anglo-Saxon, the German, and the Scandinavian; each of these contain a number of lists of characters, which, however, do not differ from each other more than the Greek alphabets; and there is so much likeness in the whole family that we may infer a common origin for all. The term *rune* is recognised as the name of a German letter by Venantius Fortunatus at the beginning of the seventh century, in the lines—

> Barbara fraxineis pingatur rhuna tabellis;
> Quodque papyrus agit, virgula plana valet.

i.e., these characters were cut on smoothed ash-boughs. The meaning of the word *rûn* in Anglo-Saxon is a "secret;" and the verb *rŷnan*, which is derived from the same, means "to whisper"—the same verb which appears in the now disused phrase, to "round in the ear." *Rûna* denoted a magician; the word is contained in the German *alruna*, the well-known designation of those prophetesses whom the German tribes venerated, which appears corrupted by Tacitus (*Germ.* c. viii.) into *aurinia*. There is sufficient evidence to show that the knowledge of these runes was confined to a small class; that they were used as magical characters, and also as means of augury. It was for this reason undoubtedly that they were generally proscribed on the introduction of Christianity; and the reception of the Latin characters by the Anglo-Saxons was regarded as important as their reception of the Christian doctrines.

It is impossible to believe that the barbarous inhabitants of the German forests should have worked out for themselves a genuine alphabet before they came into intercourse with the civilised nations of the south. When we remember the long process through which a pure alphabet was reached by the highly-developed nations which dwelt on the eastern shores of the Mediterranean, it is utterly incredible that such success should have been achieved, as it were, *per saltum*, under so much more unfavourable circumstances in the West. It may be asserted with some confidence that if the runes were genuine alphabets (which there seems no reason to deny), they must have been derived from the Phœnicians in process of commerce. There is quite sufficient similarity in several of the characters to make this view antecedently probable, but any historical proof would be extremely difficult, if not impossible. It is true that even where the characters resemble the Phœnician the names of the letters differ altogether; but this, as we have before seen in the case of the Phœnicians themselves, is nowise unnatural when an alphabet is borrowed; the form is important, the name signifies little, and new names are attached according to the fancy of the borrowers. It is highly probable, both from the meaning of the word rune itself and from the evidence of foreign writers, that these symbols were not used by their owners for any of the ordinary ends of an alphabet (except, perhaps, for inscriptions) until the Teutonic nations came into contact with Greek and Roman civilisation; by the mass of the people they were probably looked on simply as charms, the unknown symbols of an occult science. Nay, it might be held that even to the initiated they had merely a sort of hieroglyphic value, and were developed into phonetic significance only by the contact of the Greek and Roman alphabets. For this view, indeed, there is no evidence, and it is not in itself probable. But we should be driven to it if we were to suppose that the runes were the creation of the Teutonic intellect.

These ancient characters occur plentifully on memorial stones, rings, coins, &c., in Scandinavia. In England they have been found principally in Northumbria, Mercia, and East Anglia. It has been suggested (by Mr Haigh) that this may be due to the milder principles of the Irish monks, who restored Christianity to the north of England after its fall with Edwin in 633, and did not pursue that system of eradicating every trace of paganism which had been originally commanded by Gregory. Runic writing was even employed in the service of Christianity. Mr Kemble (*Archæologia*, vol. xxviii. p. 349) interpreted with great ingenuity the mutilated inscription on the famous cross discovered at Ruthwell, and showed that it refers to the Crucifixion. But the Anglo-Saxon alphabet was soon—early in the 7th century—conformed to the Latin type, those letters of the older form alone being retained which were required to denote sounds that had no counterparts in Latin; these were ƿ (wên), and ꝥ (thorn), the latter of which expresses the surd breathing heard in "*th*in:" in order to express the corresponding sonant (heard in "*th*at," and confusedly denoted by the same compound *th*) a stroke was drawn across the simple *d* (ð), and the new letter was called *edh*. The symbol ȝ is sometimes found instead of *y*. Curious admixtures of runes with Latin characters occasionally occur even to late times. Thus, in the *Codex Exoniensis* (p. 400, ed. Thorpe), an enigma occurs in verse, and the parts apparently of the subject to be guessed are

written in runes; the odd effect is increased by these runes being written in the regular way—(sometimes they were written βουστροφηδόν)—from right to left, contrary to the general run of the words. Kemble, in the *Archæologia*, has given an interesting translation of an Anglo-Saxon poem, each stanza of which begins with the name of a runic letter; thus the first stanza begins with Fesh, "money," the name of *f*, the first runic letter, and goes on to say—

> "Money is a consolation
> To every man:
> Yet shall every man
> Liberally distribute it;
> If he will that, before God,
> Honour shall fall to his lot."

The second stanza is dedicated to the bull, Ur (*u*), the third to thorn (*th*), &c. This poem accordingly gives the order of the alphabet, which agrees in the main with that of all other runic alphabets. Yet the poem is not old, for the name of *s* (Sigel, "the sun") is treated by the writer as though it had been Segel "a sail"—clearly a mistake of a later time, when the true name had passed out of use. It may be added that the names of this alphabet are sometimes strangely abstract; thus we find "gift," "hope," "need," "war," which differ much from the very concrete objects which the Phœnicians chose to denote their letters. In consequence of all these old alphabets beginning with the letters *f, u, th, o, r, c*, in the same order, the alphabets are called by some antiquarians "futhorcs," just as we commonly speak of the ordinary alphabet as the A B C.

The doctrines of Christianity were first presented to a Teutonic people in a written form by Ulfilas, who, though not the first successful missionary to the Goths, has thereby established his claim to be regarded as the apostle of his race; and while the main body of the Goths, spurning the weak control of Rome, poured westward in their fierce career of victory towards Italy and Spain, a remnant was left in Mæsia, to whom Ulfilas gave the gospel in their own tongue. This was at the end of the 4th century of our era. He employed an alphabet of twenty-four or twenty-five letters, some of which are unmistakably Greek in form; others are common (or nearly so) to the Greek and the runic alphabets, and may therefore have been derived from either; but if they were runic, they at least received a more rounded form, it being no longer necessary to retain those angles which (as we saw above in describing the cuneiform characters) were most convenient in days when writing meant cutting on stone or wood. But some of the letters seem to be beyond doubt runic: most clearly so are *f, r, u, y*, and the symbol for the compound sound *kw*; and the reason for all these (except *r*) appears to be the lack of a proper equivalent in Greek. The letter which Ulfilas adopted to denote the surd breath *th* is not runic, so that the Gothic and Anglo-Saxon alphabets here differ: it is apparently the Greek φ. It would seem, therefore, that this letter still denoted an aspirate (*p'h*) in Greek, and not a breath, otherwise it would surely have been taken for *f*; here, on the contrary, it seems to have been selected at random from a list of symbols which denoted no corresponding sounds in Gothic. On the same lack of principle ⊙ was taken to denote *hw*. X was the exponent of the breath *ch*, as heard in German words: here the difference between the true aspirate and the breath is not great. Long *o* formed a symbol which is very like *omega*.

Another alphabet which has had an important influence on Europe, and which may be destined to a yet wider extension as the alphabet (in a modified form) of the great and progressive Russian empire, is the Cyrillic. This was the work of Cyril, a monk of Constantinople, who, together with Methodius preached the gospel among the Sclavonic tribes of Bulgaria and Moravia, in the 9th century, long after the Teutons had come under the influence of Christianity. Cyril held the services of the church among his new converts in the vulgar tongue, into which he also translated certain books of the Scriptures. The alphabet which he employed for this purpose is more thoroughly Greek than that of Ulfilas; but since the Greek alphabet was not nearly sufficient to express all the Sclavonic sounds—especially the numerous sibilants—he added further signs, the history of which is not clear. This alphabet has been largely adopted by the eastern branches of the Sclavonic race, including the Russians, Bulgarians, and the Illyrian division of the Sclaves. The old Bulgarian (commonly called the Ecclesiastical Sclavonic) is the language into which Cyril translated the Scriptures; in philology it holds the same rank as the Gothic has among the Teutonic languages: it is the parent, however, only of one of the least important dialects, the modern Bulgarian. The Illyrian family is divided into the Servians on the one hand, and the Croats and Slovenian peoples on the other. These parties are separated by difference of religion: the Servians belong mainly to the Greek Church, while the others are exclusively Roman Catholic; and the members of the Greek Church naturally cling to the Cyrillic characters, while the Catholics have adopted the Latin alphabet. It is not easy to predict which characters will ultimately predominate. The Latin letters are insufficient to express the Sclavonic sounds; but this deficiency can be eked out by diacritical signs, and the greatest literary activity is shown by the Latinising party. Lastly, the Cyrillic alphabet has been adopted by the Wallachians, through the influence of their Sclavonic neighbours, though it is little adapted to express their essentially Latin speech, derived from the colonists whom Trajan settled in the new Roman province of Dacia. Most of the needless symbols have been dropped in the newest form of the Wallachian alphabet. (See Max Müller, *Survey of Languages*, pp. 39–84.)

Cyril's original alphabet consisted of forty-eight symbols, but some of these are slightly different representations of the same sound; others are tachygraphies for combinations of sound, as *sht, ts*, &c. The names were not Greek, with the exception of three—*ksi, psi*, and *thita*—which were relegated to the end as unnecessary, but they retained their original Greek place as numerical signs. The alphabet is printed at the end of this article. It will be seen that B occupies the third place, while a modified B stands second: the reason is, that B had come to denote the *v* sound in Greek, and therefore carried this value into the Sclavonic. The modified letter denotes the old *b* sound. The 7th letter, which is not Greek, had the sound of English soft *j*, a little softer than the French *j* in *jamais*. The 8th and 9th symbols are the Greek *s* and *z*: they are supposed to have had the same sound, that of the soft English *z* (not *dz*)—perhaps one of them may have originally denoted *dz*, a sound which easily passes into *dj*; *dj* had a special symbol both in the Servian and Wallachian, though it had none in the Cyrillic, probably because the sound had not then been produced; if it had, we may conclude, from the exactness which the Cyrillic alphabet everywhere shows, that it would not have been left without a mark. The 8th letter has been expelled from the Russian alphabet as superfluous: the Russians have no *dj* sound. The 10th and 11th letters were sounded alike as *i*; the 10th is the Greek *Eta*, which had therefore become undistinguishable from Iota in Cyril's day, as it is in modern Greek. The 12th letter, *I* pure and simple, denoted the semi-vowel *y*. The 22d was *t*, followed by a parasitic *y*. The 23d and 24th are only different ways of writing the same combination *ou*; the Greeks having changed the *u* sound into *ü*, Cyril was obliged to write *ou* for *u*, as the Greeks themselves did. The Russian has one symbol (У) to denote this sound: it is

probably a tachygraphy of the 24th. The 25th and 26th denoted respectively the breathings *f* and German *ch*. We may recall here the different treatment of ϕ by Ulfilas; it seems a fair inference that the sound of ϕ had changed from an aspirate to a breathing between the times of Ulfilas and Cyril. The 27th and 28th are the Greek Omega in the simple and in a modified form: they denoted the sounds heard in *note* and *not* respectively; these have been dropped in all the derived alphabets, in which the 17th letter does work for both. We now come to a series of letters (29–44) which are not Greek, and denote sounds which were probably unknown, or at least had no separate exponents, in the Greek system. The first four are sibilants, simple or compound. It will be remembered how the Greek dropped the large Phœnician stock of sibilants, through their own disinclination to such sounds. Cyril, however, did not go back to the original types, but had recourse to the inartistic expedient of using two or three upright strokes, with small modifiers below. Letter 29 is the compound *ts*, 30 denotes the fuller compound *tsch* (English *ch* in "church"), 31 is the simple *sh*, 32 is *sht*, which in Russian is said to be expressible only by *schtsch*, unquestionably a very strong sibilant; the newer form of Wallachian used 29 to express *dj*. The letters 33–36 were attempts to express the neutral vowel (heard in English in *fir*, *sun*, &c.), the first two in its aspect nearest to *u*, the last two nearer to *i*. The first and last are important in Russian: they are written, but not pronounced; but the first hardens a preceding letter, or, if it be a continuous consonant, makes it be sounded as though it were double. The 36th, on the contrary, softens a preceding letter, giving it the *mouillé* sound. The 34th letter has been dropped in Russian; the 35th has a peculiar kind of *i* sound. The 37th letter has an *e* sound; it was apparently introduced into the alphabet in consequence of the polyphony of the original *e*, which in Russian does the work of *e*, *o*, and *œ*, and also of each of these preceded by the semi-vowel *y*; but as the new letter has three of these sounds, there is not much gain of clearness. A third symbol, however, has been introduced—an inverted *e*, Э, which did not belong to the Cyrillic alphabet: it is used at the beginning of words where the pure *e* sound is heard—not *ye*, and also in foreign words beginning with *œ*. Letters 38–40 are compounds expressing the *u*, *a*, and *e* sounds, preceded by *y*. The combinations seem to us needless, but the Greek had no symbol for *y*; therefore Cyril probably thought it necessary to connect the I-symbol with the following vowel, in order to show that it was only the semi-vowel, not a full vowel, which would have caused another syllable. The first of these symbols has been retained in Russian unchanged; the second is now written rather like an inverted *r* Я; the third was suffered to drop—whence arose the confusion respecting *e* which we have just mentioned. Nos. 41 and 42 denote nasalised vowels, *e* and *o*, as heard in the French *en* and *on*: these sounds seem to have fallen out of all Sclavonic languages, except the Polish. 43 and 44 denote the same vowels "pre-iotised," like the three 38–40: these also are now unknown. Then came the Greek Ksi and Psi, the characters being very slightly altered: they have fallen out of use altogether. No. 47, Thita, is retained in Russian, but sounded as an *f*, which has thus two exponents, θ and ϕ. Lastly came the equivalent of the Greek Upsilon called *ijica*: this is employed in Russian in words borrowed from the Greek.

Fourteen of these letters have been expelled from the Russian alphabet, namely 8, 11, 22, 23, 27, 28, 34, 40–46; their list of 35 letters is made up by the addition of the inverted *e*, which stands in the 31st place of the alphabet. The forms of the letters are more rounded than those of Cyril, as will be seen by a comparison of the two. This reform, among others, was due to Peter the Great, who printed the first Russian periodical at Moscow in 1704. (Max Müller, *Survey*, p. 49.)

The Servian alphabet differs from the Russian chiefly by the insertion of symbols to denote modification of sound caused by a following *y*. Thus we find a character to express *dy* (equivalent to the Hungarian *gy* heard in "Magyar"); another for *ly*, denoting the sound of the Italian *gli*; another for *ny*, the Italian and French *gn*; and one for *ty*, a softer sound than the *tsch*, the symbol for which is common to Russian and Servian.

The Wallachian adopted nearly all the Cyrillic characters, except the superfluous vowel-symbols and the nasalised vowels. The list was soon considerably shortened, as was natural in a language originally non-Sclavonic, though in the course of time it has naturally borrowed many words from its neighbours. Since it has been used for literary purposes, it has been further diminished to 27 symbols by the loss of the short sibilant (32), the second *e*, and the iotised *a*; the other iotised vowels had gone before. The forms of the characters have also been much assimilated to the Latin types: instead of the peculiar symbol for *sch*, which the Russian retains, the new Wallachian has a J with a wavy stroke through the middle; *n* is written as N, not as H; and Cyril's combinations of perpendicular lines are more rounded than the Russian. The Wallachian has one special symbol Ꙟ to denote the sound *ün*.

We have thus described the alphabets used in modern Europe. The only others which have any special interest for Englishmen are the different Indian alphabets; but these are too numerous and complicated to be fully described here. (J. P.)

CYRILLIC AND RUSSIAN ALPHABETS.

CYR.	RUSS.	CYR.	RUSS.	CYR.	RUSS.	CYR.	RUSS.	CYR.	RUSS.	CYR.	RUSS.
А а	А а	Н н	И Й и й	Р р	Р р	Ѿ ѿ		Ѣ ѣ	Ѣ ѣ	Ѯ ѯ	
Б б	Б б	Ї ї		С с	С с	Ц ц	Ц ц		Э э	Ѱ ѱ	
В в	В в	І і	І і ї	Т т	Т т ш	Ч ч	Ч ч	Ю ю	Ю ю	Ѳ ѳ	Ѳ ѳ
Г г	Г г	К к	К к	Ћ ћ		Ш ш	Ш ш	Ꙗ ꙗ	Я я	Ѵ ѵ	Ѵ ѵ
Д д	Д д	Л л	Л л	Оу оу		Щ щ	Щ щ	Ѥ ѥ			
Є є	Е е	М м	М м	Ȣ ȣ	У у	Ъ ъ	Ъ ъ	Ѧ ѧ			
Ж ж	Ж ж	N н	Н н	Ф ф	Ф ф	Ꙑ ꙑ		Ѫ ѫ			
Ѕ ѕ		О о	О о	Х х	Х х	Ы ы	Ы ы	Ѩ ѩ			
Ꙁ ꙁ	З з	П п	П п	Ѡ ѡ		Ь ь	Ь ь	Ѭ ѭ			

ALPHEUS, (Ἀλφειός), the chief river of Peloponnesus, now called *Rufia* or *Rouphi*. Its sources are in the mountains of Arcadia, to the east of Megalopolis. Being fed by a great number of small streams, it becomes navigable, and traversing Elis, empties itself into the Ionian sea. At several points in its course it runs in a subterranean channel. This fact probably gave rise to the well-known myth which represents Alpheus, the river-god, as passing under the sea to the nymph Arethusa, who had been changed into a fountain in the island of Ortygia. Milton in his *Arcades* thus alludes to the story—

> "That renowned flood, so often sung,
> Divine Alphéus, who by secret sluice
> Stole under seas to meet his Arethuse."

ALPHONSO, Alfonso, Alonzo, Affonso, or Ildefonso. This name, so famous in the annals of the Spanish peninsula, has been borne by no fewer than twenty-two of its sovereigns —viz., by ten of the Asturias and Leon, one of Castile when separate from Leon, five of Aragon, and six of Portugal.

1*st, Asturias and Leon.*—Alphonso I., surnamed "The Catholic," King of the Asturias, the son of Pedro, duke of Biscay, was born in the year 693. On the death of Favila, the son of Pelayo, Alphonso, who had married Ormisinda, the daughter of the latter, was proclaimed king of Asturias. During his whole reign he was engaged in almost perpetual conflicts with the Moors, and is said to have wrested Leon, Galicia, and Castile from their hands. His zeal for the church, displayed in endowing and repairing monasteries and churches, gained for him his surname of "The Catholic." Alphonso died at Cangas in 757, and was succeeded by his son Fruela I.

Alphonso II., surnamed "The Chaste," King of the Asturias, the son of Fruela I., was but a child when his father was assassinated in 768, and consequently his claims to the throne were passed over in favour of Aurelio, who was probably a cousin of Fruela. Alphonso was invested with regal authority by Silo, the successor of Aurelio; on whose death, in 783, he became sole ruler. He was afterwards dethroned by his uncle Mauregato, and was compelled to retire into Biscay. Mauregato, after a reign of about five years, was succeeded by Bermudo, who, in 791, took Alphonso as his partner on the throne. Bermudo reigned for only about four years longer. A rebellion of many of the chief nobles in 802 compelled Alphonso to surrender his throne for the third time; but he was soon afterwards restored, mainly through the assistance of Theudius, one of his most faithful followers. In addition to having to defend himself against these internal dissensions, Alphonso was during the greater part of his reign at war with the Moors, obtaining, among other successes, a signal victory over Mohammed, governor of Merida, in 830. Alphonso died in 843, in the city of Oviedo, which he had greatly adorned and made the capital of his kingdom. He had some years previously abdicated in favour of Ramiro, son of Bermudo. His surname of "The Chaste" has been connected by some with the legend that he refused to pay the Moors their tribute of a hundred Spanish virgins, but is rather to be ascribed to his vow to preserve an absolute continence.

Alphonso III., surnamed "The Great," King of the Asturias, was born in the year 848, and succeeded his father Ordoño I. in 866. In the following year, Fruela, count of Galicia, disputed Alphonso's right of succession, and forced him to retire to Alava; but Fruela's tyranny so exasperated the people that he was assassinated before he had been a year in power, and they gladly recalled Alphonso to the throne. Other conspiracies marked the beginning of Alphonso's reign, but he soon felt himself tolerably secure at home, and turned his arms against the Moors. By 901, the year in which he gained a splendid victory at Zamora, he had, it is said, extended his empire to the banks of the Guadiana, and had, by founding and fortifying cities, made good his hold over a large part of the conquered territory. But Alphonso's victories abroad were greatly neutralised by discontent among his own subjects, who found it difficult to bear the heavy war taxes that had been imposed upon them. There was a rising under Ano in 885, and another under Witiza in 894; and in 907 a more formidable insurrection broke out, headed by Garcia, the king's eldest son. Garcia was defeated and taken prisoner; but as the greater part of the nation sided with the queen in demanding that he should be released, Alphonso, either wishing to prevent a civil war, or thinking that his cause was hopeless, resigned his crown to his son in 901. After his abdication, Alphonso, offering his services to his son in the true spirit of the age, led an expedition against the Moors, in which he gained fresh victories. He died towards the end of the same year (901). He was the last monarch who bore the title King of Asturias, his successors being called kings of Leon, from the new capital of the kingdom. It was in his reign that the counts of Navarre became independent. There is still extant a Latin chronicle, treating of the history of Spain from the Moorish invasion down to the death of Ordoño, which is usually attributed to Alphonso.

Alphonso IV., "The Monk," King of Leon, succeeded Fruela II., his uncle in 924. On the death of his wife, about six years afterwards, he resigned his crown to his brother Ramiro, and retired into a cloister; but soon growing weary of monastic life, he made an attempt to resume the sceptre. He was, however, taken prisoner at Leon, and confined in the monastery of St Julien, where he died, probably about two and a half years after.

Alphonso V. succeeded his father Bermudo II. in 999, being then about five years of age. Gonsalez, count of Galicia, and his wife, were, by appointment of Bermudo II., guardians of the young king; and on arriving at manhood he married their daughter Elvira. The regency is remarkable for the defeat and death of the famous Moor Almansur in 1002—a success that led ultimately to the conquest of Cordova by the Christians. Alphonso himself made war upon the Moors, recapturing Leon and other places that had been lost during his minority. Alphonso died at the siege of Viseo in 1028. He was succeeded in the kingdom of Leon by his son Bermudo III., while the hitherto dependent countship of Castile became a separate kingdom under the sovereignty of Sancho el Mayor, king of Navarre, and husband of the eldest daughter of the late count.

Alphonso VI. of Leon, and eventually I. of Castile, surnamed "The Valiant," was born in the year 1030. His father, Fernando the Great, who in his own right was king of Castile only, but succeeded to the throne of Leon in right of his wife, died in 1065, leaving his kingdom divided among his children. Sancho, the eldest son, received as his portion Castile; to Alphonso was given the kingdom of Leon, the territory of Campos, part of Asturias, and some towns in Galicia; and Garcia the youngest brother, received a part of Galicia and of Portugal; while the towns of Toro and Zamora were left to Urraca and Elvira, Fernando's two daughters. Peace was not long maintained between the three brothers. In 1068 Sancho made war upon Alphonso, and defeated him in a bloody battle at Piantica, on the Pisuerga. In 1071, hostilities, which seem to have been suspended, again commenced, and Alphonso having recruited his army, defeated Sancho at a place called Valpellage, on the banks of the Carrion; but the latter, being reinforced, it is said by the famous Roderigo Diaz de Bivar, commonly called "The Cid," made an attack during the night, and almost exterminated the Leonnese army, Alphonso himself being taken prisoner. He

was compelled to abdicate his throne, and was imprisoned in the monastery of Sahagun, probably with the intention of making him become a monk; but escaping from this place of confinement, he sought refuge with Almamun, the Moorish king of Toledo, who received him with great hospitality. Sancho having taken possession of Leon, advanced into Galicia against Garcia. The two brothers met at Santarem, when the Galicians were defeated with great slaughter, and Garcia himself captured and thrown into prison. Sancho was assassinated in 1073, and Alphonso, after making a solemn declaration that he was guiltless of his brother's death, was reinstated in his own dominion, besides receiving his brother's kingdom of Castile. Garcia, who had been liberated on the death of his brother, was preparing to recover his throne, when Alphonso, having treacherously invited him to his court, shut him up in the castle of Luna, where he died ten years afterwards. Being now the undisputed master of nearly all his father's kingdom, Alphonso was at liberty to turn his arms against the Moors. His first expedition, in 1074, was in defence of Almamun of Toledo, who had befriended him in his adversity, and whose kingdom was now invaded by the Cordovans. Some years later, however, disregarding the ties of gratitude, he himself laid waste the territories of Yahia ben Ismail, the son and successor of Almamun, and ended by taking the city of Toledo itself in 1085. Many parts of Spain, hitherto subject to the Moors, were now added to the empire of Alphonso; and it is not improbable that he would have reduced the entire peninsula to his sway, had not a new and formidable power arisen, which threatened to undo all he and his predecessors had accomplished. A large army of Moors from Africa, under Yussef ben Tashfyn, one of the Almoravides, entered Spain, and, with the assistance of Ben Abad, king of Seville, inflicted a terrible defeat upon Alphonso near Zalaca, in the year 1086. Fortunately for the Christian cause, the Moorish chiefs began to quarrel among themselves, and Alphonso was enabled not only to recover his position, but even to extend his conquests in some directions. In 1108, however, the Almoravides made another serious attempt to destroy the power of Alphonso. A bloody battle was fought at Uclès, in which the Leonnese army was completely defeated, and Sancho, Alphonso's only son, who commanded in place of his father, slain. Alphonso died at Toledo in 1109, and was succeeded by his daughter Urraca, whose husband, Alphonso I. of Aragon, is by some historians enumerated among the kings of Leon as Alphonso VII. Through his illegitimate daughter Teresa, whom he gave in marriage to Henry of Burgundy, Alphonso became an ancestor of the kings of Portugal.

Alphonso VII., the same as Alphonso I. of Aragon (*q.v.*)

Alphonso VIII. of Leon (or VII., according to those who do not consider Alphonso of Aragon as properly a king of Leon) and II. (or III.) of Castile, often called Alphonso Raymond and "The Emperor," was born in the year 1106. He was the son of Urraca, daughter of Alphonso VI., and Raymond of Burgundy, her first husband. In 1112 he was proclaimed king of Galicia, by whom it does not clearly appear; in 1122 he was associated with his mother in the government of Leon and Castile; and on her death in 1126 he became sole monarch. Soon after this event he made war upon his stepfather, Alphonso of Aragon, in order to recover the territories, properly belonging to Leon and Castile, which had been lost owing to his mother's misgovernment. The two kings came to an agreement about the year 1129, Alphonso of Leon having regained most of his possessions. In 1135, Alphonso, elated by the homage of the king of Navarre and the counts of Barcelona and Toulouse, caused himself to be solemnly crowned emperor of Spain. This dignity was, however, little more than a name, for Alphonso Henriquez of Portugal and Garcia Ramiro of Navarre declared war upon the new emperor almost immediately after his elevation. Intestine feuds between the various Christian princes of Spain, which resulted in no very definite gain to any of them, lasted until the advance of large Moorish armies under the Almohades compelled the Christians to turn against their common foe. Alphonso invaded Andalusia in 1150, and gained several victories, which contributed greatly to the extension of Christian territory in Spain. He died in 1157 at Tremada, on his return from an indecisive battle with Cid Yussef at Jaen; and was succeeded by his elder son, Sancho, in the throne of Castile, and by his younger, Fernando, in that of Leon. In 1156 he instituted the order of St Julien, afterwards so celebrated under the name Alcantara (*q.v.*)

Alphonso IX. (VIII.), King of Leon only, succeeded his father Fernando in 1188. In 1190 he sought to strengthen his position by marrying his cousin Teresa of Portugal. This marriage, being within the forbidden degrees, was pronounced null by the pope (Celestine III.), who excommunicated Alphonso and his queen until 1195, when they agreed to separate. In 1197 Alphonso a second time defied the papal authority by marrying his cousin Berengaria, daughter of Alphonso III. of Castile, with a view of putting a stop to the frequent quarrels between the two kingdoms. As before, the pope (Innocent III.) prevailed, and in 1204 the separation took place, Innocent, however, granting that the children already born should be recognised as legitimate. After the dissolution of the marriage the old chronic state of feud between the two kings returned, and was kept up, although with little actual warfare, until the death of Alphonso of Castile in 1214. In 1217, Fernando, the eldest son of Alphonso and Berengaria, became king of Castile. Alphonso, thinking that his own claims had been unjustly passed over, declared war upon his son; but finding that the people preferred Fernando, he relinquished his claims. The remainder of Alphonso's reign was chiefly spent in campaigns against the Moors. Along with his son, he captured Merida, Badajoz, and other cities; and in 1230 gained a brilliant victory over Mohammed Ibn Hud at Merida. He died in the same year, and was succeeded by his son Fernando, who thus finally united the kingdoms of Leon and Castile.

Alphonso X., surnamed *El Sabio*, or "The Wise," King of Leon and Castile, was born in 1221, and succeeded his father Fernando III. in 1252. He ascended the throne with the entire approbation of his subjects, and with every prospect of a happy reign; but, through the ill-directed aims of his ambition, few sovereigns have been more unfortunate. He first attempted to gain possession of Gascony, contending that he had a better right to that province than Henry III. of England. The arms of England, however, proved too formidable; and he agreed to renounce his claim on condition that Henry's son, afterwards Edward I., should marry his sister Eleonora. The marriage was solemnised with great pomp and magnificence towards the end of October 1254. Alphonso's next act was to lay claim to the duchy of Swabia, which he believed to be his in right of his mother Beatrix, daughter of the late duke. This claim was passed over, but when advancing it Alphonso formed a connection with the German princes, and in 1256 became a competitor, against Richard, Earl of Cornwall, for the imperial crown. He was again unsuccessful, the Earl of Cornwall being elected by a small majority. In 1271, on the death of Richard, he a second time attempted to make himself emperor of Germany, and even after Rodolph of Hapsburg had actually been elected, he undertook a fruitless journey to Beaucaire

in order to prevent the pope (Gregory X.) from confirming the election. These repeated attempts to increase his dignity weakened rather than strengthened the power of Alphonso, and forced him to impose heavy taxes upon his subjects, and even to debase the coinage, thus producing much discontent and disturbance, while the Moors were ever ready to take advantage of any misfortunes that might happen to him. From 1261 to 1266 he was engaged in a war with Mohammed of Granada, during which his army suffered several defeats. In 1270 an insurrection broke out, headed by Felipe, brother of the king, who was assisted by Mohammed of Granada; it was only quelled after nearly all their demands had been conceded to the rebels. In 1275, when Alphonso was absent on his fruitless journey to Beaucaire, his eldest son, Fernando de la Cerda, died, an event which, raising as it did the question of the succession to the crown, threatened anew to involve the kingdom in war. Sancho, Alphonso's second son, was, according to the law of the Visigoths, proclaimed heir by the Cortes at Segovia; but Philip of France, uncle of the two young sons of Fernando, declared war with Alphonso on their behalf; actual hostilities were, however, prevented by the intercession of Pope Nicolas III. In 1281, Sancho, irritated probably by some attempt that Alphonso had made to favour the sons of Fernando, raised the standard of revolt against his father. Sancho, who was a favourite with the people, having secured the assistance of Mohammed of Granada, reduced his father to such extremities that the latter solemnly cursed and disinherited his son, an act which he confirmed by his will in 1283, and at the same time solicited aid from the king of Marocco. At the commencement of the following year, however, Alphonso, on receiving intelligence from Salamanca that Sancho was dangerously ill, pardoned him. Alphonso died a few days afterwards, on 4th April 1284. He was a learned prince, and a great encourager of learning, brave and energetic, but at the same time restless and ambitious. He has been charged with impiety, chiefly on account of a well-known saying of his, that "had he been present at the creation, he could have given some useful hints for the better ordering of the universe." To him science is indebted for a set of astronomical observations known as the *Alphonsine Tables,* which were drawn up under his auspices by the best astronomers of the age; and in the palace of Segovia a room is still shown as the observatory of Alphonso. He was also distinguished as a poet and as a legislator. In the Escurial is preserved a curious manuscript containing some hymns of his composition; and he was the principal compiler of a code of laws which is still extant under the name of *Las Siete Partidas.*

Alphonso XI., "The Avenger," was an infant when he succeeded his father, Ferdinand IV., in 1312. During his long minority the kingdom was cruelly distracted by intestine warfare. Assuming the reins of government in 1324, he strove to repress the turbulent spirit of the nobility, and to put down that system of brigandage to which it had given rise, acquiring by his inflexible severity the title of "The Avenger." He lost Gibraltar in 1329, but as commander of the allied armies of Catholic Spain, on the 29th Oct. 1340 he gained a complete victory over the kings of Morocco and Granada at the Salado. The slaughter was immense, and the booty so rich that the value of gold is said to have fallen one-sixteenth. In 1342 Alphonso laid siege to Algeciras, where cannon were employed for the first time in Europe by the Moors in defence of their walls. This siege had lasted two years, when the Moors capitulated on condition of a truce between the two nations for ten years; but the king of Castile broke his word a few years after by besieging Gibraltar, where he died of the plague on the 26th March 1350, aged 40. He was succeeded by his son, Pedro the Cruel. From this reign dates the institution of *regidors* or jurats, to whom was committed the administration of the communes; and these regidors became the exclusive electors of the Cortes, in which the people ceased to have a voice.

2*d, Castile.*—Alphonso III. (according to other enumerations, VIII. or IX.), surnamed "The Noble," is the only king of Castile of the name who was not also king of Leon. He was born in 1155, and succeeded his father, Sancho III., in 1158. His minority was disturbed by the contention of the two powerful houses of Lara and Castro for the regency; but after his marriage with Eleanor, daughter of Henry II. of England, he was proclaimed sole ruler. After compelling the kings of Aragon, Navarre, and Leon to surrender the territories they had taken possession of during his minority, he turned his arms against the Moors, and at Alarcos, in 1195, sustained one of the most terrible defeats recorded in the annals of Spain. This disaster encouraged the kings of Leon and Navarre to renew their hostilities, which were carried on for several years with varying success. In 1211 the Moors again threatened Castile; but in the following year, Alphonso, along with Pedro II. of Aragon and Sancho VII. of Navarre, gained a most complete and splendid victory over them at Las Navas de Tolosa. Alphonso died at Garci Muños in 1214, and was succeeded by his son, Enrique I. Alphonso was a patron of literature, and in 1208 founded a university at Palencia, the first in Christian Spain. This university was afterwards transferred to Salamanca.

3*d, Aragon.*—Alphonso I., surnamed *El Batallador,* "The Fighter," King of Navarre and Aragon, was the second son of Don Sancho Ramirez, and succeeded his brother Pedro I. in 1104. By his marriage in 1109 with Urraca, daughter and heiress of Alphonso VI. of Leon and Castile, he became her associate in the government of these kingdoms, and in the same year assumed the title of "Emperor of all Spain." Misunderstandings soon arose between Alphonso and his wife, and he separated from her shortly after their marriage, an act which was confirmed by the council of Palencia in 1114. Alphonso, however, refused to give up his claims to the kingdoms of Leon and Castile, and maintained a constant struggle with Urraca till her death in 1126. Alphonso's chief victories were gained over the Moors. He laid siege to Saragossa for the first time in 1114, but the city was not captured until 1118, after several bloody battles had been fought in its neighbourhood. In 1120 his territories were menaced by a large force sent against him by Ali; but engaging the enemy near Daroca, he left 20,000 Almoravides dead on the field. Three years afterwards, while the king of Marocco was fully occupied at home by the rise of a dangerous sect of Almohades, Alphonso seized the opportunity to invade Valencia. In 1125 he undertook a new expedition against Granada in aid of the Mozarabes or Christian Moors. The Moors in their reprisals invaded Estremadura, and defeated the Castilians near Badajoz. The king of Aragon, so far from rendering his neighbour any assistance, determined to take advantage of the critical position of Alphonso Raymond, as well as of the troubles which the death of Urraca had occasioned in several parts of his dominions, but when on the point of battle the two kings came to an agreement. Alphonso next crossed the Pyrenees, and captured the cities of Bordeaux in 1130, and Bayonne in 1131. On his return to Spain he took Mequinenza from the Moors in 1133, and invested Fraga in 1134, where, during a sally from the town, he received a wound from which he died a few days after.

Alphonso II. was born in 1152, and in 1163 succeeded his father, Raymondo V., as count of Barcelona, his mother, Petronilla, daughter of Ramiro II., king of Aragon, at the same time resigning that kingdom to him. He was frequently at war with Raymondo of Toulouse, and also directed an expedition against the Almohades, from which the invasion of Aragon by Sancho of Navarre recalled him. He assisted Alphonso of Castile against Cuença, for which service he was relieved from doing homage to Castile. He died in 1196. He was a patron of the troubadours, and wrote some poems in the Provençal language.

Alphonso III., the son of Pedro III., was born in 1265, and in 1285, on the death of his father, being absent in Majorca on an expedition against his uncle Jayme, assumed the title of king without taking the oaths of adherence to the articles to which his predecessors had subscribed. When he returned in 1286, however, he was compelled to go through the usual coronation ceremony. In 1287 he signed the Privilege of Union, which permitted his subjects to have recourse to arms to defend their liberties, and invested the *justizero* with the power of citing the king himself to appear before the Cortes. Alphonso's chief wars were with Jayme of Majorca, Sancho of Castile, and the pope. He died in 1291.

Alphonso IV., son of Jayme II., was born in 1299, and ascended the throne in 1327. During almost the whole of his reign he was occupied in war with the Genoese about the possession of Corsica and Sardinia. He died in 1336.

Alphonso V. of Aragon, I. of Sicily and Sardinia, and latterly I. of Naples, was born in 1385, and succeeded his father, Fernando the Just, as king of Aragon and of Sicily and Sardinia, in 1416. In 1420 Joanna I. of Naples offered to make Alphonso her successor if he would assist her against Louis of Anjou. This he did; but, owing to misunderstandings, the queen revoked her adoption of Alphonso in 1423, making Louis of Anjou her heir. Recalled to Spain immediately after by an attack made by the Castilians upon his hereditary kingdom, he left his brother Pedro as his lieutenant at Naples, which he had taken by storm the year before. On his way to Spain he captured, but generously refrained from pillaging, Marseilles, a city belonging to his rival the duke of Anjou. After restoring peace at home, Alphonso again turned his attention to Naples, where his cause now appeared to be hopeless. Louis of Anjou died in 1434, and Queen Joanna the following year, leaving Naples to Louis's brother René, who had in his possession the whole kingdom except a few fortresses which still held out for Alphonso. In the same year (1435) Alphonso laid siege to Gaëta, but the siege was raised, and Alphonso himself taken prisoner by Philippo Maria Visconti, duke of Milan. Visconti, however, being greatly pleased with the high character and noble appearance of Alphonso, soon released him, and even made him his ally. Immediately on recovering his liberty, Alphonso made a third attempt upon the kingdom of Naples. The issue of the war at first was doubtful, but latterly the arms of Alphonso were nearly everywhere victorious. He laid siege to Naples, and after an obstinate resistance captured it in 1442. The States-General were then convoked, and solemnly proclaimed Alphonso king; his election being sanctioned by Pope Eugenius IV., who had previously promised that honour to René. Alphonso now fixed his residence at Naples, and devoted himself chiefly to the improvement of his kingdom; although he was also frequently involved in the wars and disputes of the Italian princes. He died at Naples on the 27th June 1458; and was succeeded in his kingdoms of Aragon and of Sicily and Sardinia by his brother John, and in that of Naples by his natural son Ferdinand. Alphonso was undoubtedly one of the best monarchs of his name. His bravery and generalship fitted him for the warlike enterprises he had to undertake; and it is evident that, from his generous and humane disposition, as well as from his love of literature and encouragement of law and justice, his rule would have been equally successful had it been his lot to live in more peaceful times.

4th, Portugal.—Alphonso I., *Enriquez*, son of Henry of Burgundy, count of Portugal, and Teresa of Castile, was born at Guimaraens in 1094. He succeeded his father in 1112, and was placed under the tutelage of his mother. When he came of age he was obliged to wrest from her by force that power which her vices and incapacity had rendered disastrous to the state. Being proclaimed sole ruler of Portugal in 1128, he defeated his mother's troops near Guimaraens, making her at the same time his prisoner. He also vanquished Alphonso Raymond of Castile, his mother's ally, and thus freed Portugal from dependence on the crown of Leon. Next turning his arms against the Moors, he obtained, on the 26th July 1139, the famous victory of Ourique, and immediately after was proclaimed king by his soldiers. Not satisfied with this, however, he assembled the Cortes of the kingdom at Lamego, where he received the crown from the archbishop of Braganza; the assembly also declaring that Portugal was no longer a dependency of Leon. Alphonso continued to distinguish himself by his exploits against the Moors, from whom he wrested Santarem in 1146, and Lisbon in 1147. Some years later he became involved in a war that had broken out among the kings of Spain; and in 1167, being disabled during an engagement near Badajoz by a fall from his horse, he was made prisoner by the soldiers of the king of Leon, and was obliged to surrender as his ransom almost all the conquests he had made in Galicia. In 1184, in spite of his great age, he had still sufficient energy to relieve his son Sancho, who was besieged in Santarem by the Moors. He died shortly after, in 1185. Alphonso was a man of gigantic stature, being 7 feet high according to some authors. He has long been regarded as a saint by the Portuguese, who reverence him both on account of his personal character and as the founder of their kingdom.

Alphonso II., "The Fat," was born in 1185, and succeeded his father, Sancho I., in 1211. He was engaged in war with the Moors, and gained a victory over them at Alcazar do Sal in 1217. He also endeavoured to weaken the power of the clergy, and to apply a portion of their enormous revenues to purposes of national utility. Having been excommunicated for this by the pope (Honorius III.), he promised to make amends to the church; but he died in 1223 before doing anything to fulfil his engagement. Alphonso framed a code which introduced several beneficial changes into the laws of his kingdom.

Alphonso III., son of Alphonso II., was born in 1210, and succeeded his brother, Sancho II., in 1248. Besides making war upon the Moors, he was, like his father, frequently embroiled with the church. In his reign Algarve became part of Portugal. Alphonso died in 1279.

Alphonso IV. was born in 1290, and in 1325 succeeded his father, Dionis, whose death he had hastened by his intrigues and rebellions. Hostilities with the Castilians and with the Moors occupied many years of his reign, during which he gained some successes; but by consenting to the barbarous murder of Iñez de Castro, who was secretly espoused to his son Pedro, he has fixed an indelible stain on his character. Enraged at this barbarous act, Pedro put himself at the head of an army, and devastated the whole of the country between the Douro and the Minho before he was reconciled to his father. Alphonso died almost immediately after, on the 12th May 1357.

Alphonso V., *Africano*, was born in 1432, and succeeded

his father Edward in 1438. During his minority he was placed under the regency, first of his mother, and latterly of his uncle, Don Pedro. In 1448 he assumed the reins of government, and at the same time married his cousin Isabella, daughter of Don Pedro. In the following year, being led by what he afterwards discovered to be false representations, he declared Don Pedro a rebel, and defeated his army in a battle at Alfarrobeira, in which his uncle was slain. In 1458, and with more numerous forces in 1471, he invaded the territories of the Moors in Africa, and by his successes there acquired his surname of "The African." On his return to Portugal in 1475 his ambition led him into Castile, where two princesses were disputing the succession to the throne. Having been affianced to the Princess Juana, Alphonso caused himself to be proclaimed king of Castile and Leon; but in the following year he was defeated at Toro by Ferdinand, the husband of Isabella of Castile. Alphonso went to France to obtain the assistance of Louis XI., but finding himself deceived by the French monarch, he abdicated in favour of his son Juan. When he returned to Portugal, however, he was compelled by his son to resume the sceptre, which he continued to wield for two years longer. After that he fell into a deep melancholy, and retired into a monastery at Cintra, where he died in 1481.

Alphonso VI., the second king of the house of Braganza, was born in 1643, and succeeded his father in 1656. In 1667 he was compelled by his wife and brother to abdicate the throne, and was banished to the island of Terceira. These acts, which the vices of Alphonso had rendered necessary, were sanctioned by the Cortes in 1668. Alphonso died at Cintra in 1675.

ALPHONSUS a Sancta Maria, or Alphonso de Cartagena, a celebrated Spanish historian, was born at Carthagena in 1396, and died on the 12th July 1456. He succeeded his father, Paulus, as bishop of Burgos. In 1431 he was deputed by Juan II. of Castile to attend the council of Basle, in which he made himself conspicuous by his learning. He was the author of several works, the principal of which is a History of Spain from the earliest times down to the year 1496, printed at Granada in 1545, fol.

ALPINI, Prospero (in Latin *Prosper Alpinus*), a celebrated physician and botanist, was born at Marostica, in the republic of Venice, on the 23d November 1553. In his youth he served for a time in the Milanese army, but in 1574 he quitted it, and went to Padua to study medicine. He was admitted to the degree of doctor of physic in 1578, soon after which he left the university, and settled as a physician in Campo San Pietro, a small town in the Paduan territory, at the invitation of its citizens. In the course of his studies he had paid particular attention to botanical science; but the sphere of his present practice was too limited to afford him much opportunity of prosecuting his favourite study. He wished particularly to extend his knowledge of exotic plants, by observing their economy and habits in their native soil. To gratify this laudable curiosity an opportunity presented itself when George Emo or Hemi, the consul for the Venetian republic in Egypt, appointed Alpini his physician. They sailed from Venice in September 1580, and arrived at Grand Cairo in the following year. Alpini spent three years in Egypt, and by his industry and assiduity greatly improved his botanical knowledge, having travelled along the banks of the Nile, visited every place, and consulted every person from whom he expected any new information. From a practice in the management of date-trees which he observed in this country, Alpini seems to have deduced the doctrine of the sexual difference of plants, which was adopted as the foundation of the celebrated system of Linnæus. He says that "the female date-trees or palms do not bear fruit unless the branches of the male and female plants are mixed together; or, as is generally done, unless the dust found in the male sheath or male flowers is sprinkled over the female flowers." His treatise *De Medicina Ægyptiorum* contains the first account of the coffee-plant that was published in Europe. When Alpini returned to Venice in 1586 he was appointed physician to Andre Doria, prince of Melfi; and during his residence at Genoa he was esteemed the first physician of his age. The Venetians were unwilling that the Genoese state should number among its citizens a person of such distinguished merit and reputation; and in the year 1593 he was recalled to fill the botanical chair in the university of Padua, with a salary of 200 florins, afterwards increased to 750. He discharged the duties of his professorship for many years with great reputation, till his declining health interrupted his labours. He died of slow fever on the 6th February 1617, in the sixty-fourth year of his age, and was succeeded as botanical professor by one of his sons. The genus Alpinia, belonging to the order Zingiberaceæ, is named after him. Alpini wrote the following works in Latin:—1. *De Medicina Ægyptiorum Libri iv.*, Venice, 1591, 4to; 2. *De Plantis Ægypti Liber*, Venice, 1592, 4to; 3. *De Balsamo Dialogus*, Venice, 1592, 4to; 4. *De Præsagienda Vita et Morte Ægrotantium Libri vii.*, Venice, 1601, 4to; 5. *De Medicina Methodica Libri xiii.*, Padua, 1611, folio; 6. *De Rhapontico Disputatio*, Padua, 1612, 4to. Of all these works various editions have appeared; and besides these, two posthumous treatises were published by his son—1. *De Plantis Exoticis Libri ii.*, Venice, 1627, 4to; 2. *Historiæ Naturalis Egypti Libri iv.*, Lugd. Bat. 1635, 4to. Several other works of Alpini remain in manuscript.

ALPS

Taking a general view of the earth's surface, the continent of Europe appears to be no more than a great peninsula extending westward from the much vaster continent of Asia. Its shores are deeply indented by two inland seas connected by narrow straits with the Atlantic Ocean, and these in their turn are divided into gulfs that penetrate still more deeply into the land, and form a number of secondary peninsulas. The Mediterranean Sea, by its branches—the Gulf of Genoa, the Adriatic, and the Ægean Sea—forms the Iberian, the Italian, and the Greek peninsulas; and the Baltic Sea, extending northward into the Gulf of Bothnia, forms on one side the great Scandinavian peninsula, and on the other that of Denmark. Save the last, all these peninsulas of Europe are essentially mountain regions, traversed by lofty chains that occupy a large portion of their surface. But in height and importance these are much surpassed by a great mountain zone stretching from the south-east of France to the frontiers of Hungary, and between Italy and the plains of southern Germany, which is collectively known as the Alps, and which must be considered as the most important feature in the physical geography of our continent. Of the influence of this mountain system on the climate of the surrounding regions, on the distribution of animal and vegetable life, and, indirectly, on the political condition of Europe, some brief notice will here be given; but it may be well to remark that owing to the peculiar disposition of the greater masses which form this system, the Alps do not present so continuous a barrier as might be expected from a comparison with other great mountain ranges.

Thus if we take the great masses of the Himalaya in Asia, the Andes in South America, or even such lesser ranges as the Pyrenees or the Great Atlas, we find that they interpose a far more absolute limit between the regions lying on their opposite flanks than occurs in respect to the Alps. These are formed of numerous ranges divided by comparatively deep valleys, which, with many local exceptions, tend towards parallelism with the general direction of the entire mass. This, between Dauphiné and the borders of Hungary, forms a broad band convex towards the north, and most of the main valleys lie between the directions west to east and south-west to north-east. But in many parts deep transverse valleys intersect the prevailing direction of the ridges, and facilitate the passage not only for purposes of human intercourse, but also for the migration of animals and plants, and for currents of air which mitigate the contrast that would otherwise be found between the climates of the opposite slopes.

Origin of the name Alps.

The received opinion is, that the name Alps is derived from a Celtic root—*alp* or *alb*—signifying height. This has been connected by some writers with the Latin *alb*, *albus*, white, referring to the colour of the peaks. Strabo says that the name Ἄλπια was formerly Ἄλβια. *Alp* in south Germany—*alpa* in old High German—is exclusively applied to mountain pastures. For the present the derivation must remain somewhat uncertain.

Limits of the Alps.

To define the precise limits of the Alps, as will be seen fully in describing the several groups, is a somewhat arbitrary operation. To the W. they extend through a large portion of the French departments of Savoie, Haute-Savoie, Hautes Alpes, and Basses Alpes, being divided from the mountain district of the Cevennes by the broad and deep valley through which the Rhone flows from Lyons to the Mediterranean. The Jura range, usually regarded as distinct from the Alps, is nevertheless closely connected on one side with the outer ranges of the Alps of western Savoy, and on the other with those of northern Switzerland. On the N. side the Alps are definitely bounded by the lake of Constance, the plain of Bavaria, and the low country extending from Salzburg to the neighbourhood of Vienna. By these they are completely separated from the mountainous districts of central Germany, which extend through western Bohemia and Saxony in one direction to the Hartz mountains, and in the other to the Sudeten, or Riesengebirge, of Silesia. Hence it happens that the drainage of the northern slopes of the Alps flows either to the North Sea through the Rhine, or is diverted through the Danube to the Black Sea, and no portion of it reaches the Baltic. The eastern limit of the Alps is not easily defined with accuracy. The region of high hills, chiefly formed of tertiary strata, that extends from the left bank of the Mur into Hungary is continued by the north side of Lake Balaton to the Danube near Buda; and some geographers see in the hilly district that stretches thence to the northern Carpathians a connection between that range and the Alps. For practical purposes it seems that the line of depression, partly formed by the valley of the Mur, through which the railway is carried from Vienna to Laybach, may be considered as the eastern boundary of the Alpine chain. On the southern side the difficulty of fixing the precise limits of the Alpine chain is still more apparent. For a distance of some 350 miles, from the neighbourhood of Turin to that of Gorizia, the boundary is sufficiently obvious. The mountains subside into the continuous plain which includes the greater part of Piedmont, Lombardy, and Venetia; and their drainage is all borne eastward to the Adriatic. But on the west side of Piedmont the Alpine chain dividing Italy from France extends nearly due southward till it approaches to the Mediterranean in the neighbourhood of Nice. About 40 miles north of this city, that which, from its superior height and its geological structure, we call the main chain, is bent round from west to east in a curve, slightly convex towards the south, till it becomes parallel to the Mediterranean shore, and is merged in the chain of the Apennines. For reasons hereafter mentioned it would appear that the limits of the Alps in this direction may best be fixed at the Col d'Altare, west of Savona, though the boundary commonly adopted is that of the Col di Tenda, lying considerably farther to the west. At the south-eastern extremity of the Alpine chain the difficulty of fixing its limits arises rather from the vague use of geographical terms by ancient and modern writers than from the physical structure of the region. Taking no account of the arbitrary proceedings of geographers who have included in the Alps the mountains dividing Bosnia from Croatia and Dalmatia, and regarding only the natural features of the country, it seems clear that the south-eastern extremity of the Alps must be looked for in the group of lofty peaks between the head waters of the Isonzo and those of the Save, whose highest summit is the Terglou; and if we are not to include all the mountain ranges of European Turkey and Greece within the same designation, the plateau of the Karst must be held to form the boundary between these and the Alps. Within these limits the Alps extend from about the 44th to the 48th parallel of N. lat., and from about 5° 10′ to 18° 10′ E. long.

Main chain of the Alps.

In every mountain system geographers are disposed to regard the watershed, or boundary dividing the waters flowing towards opposite sides of the range, as marking the main chain; and this usage is often justified by the fact that the highest peaks lie on, or very near, the boundary so defined. In applying this term in the case of the Alps, there are, however, difficulties arising from their great extent and the number of their branches and ramifications. Many of the loftiest groups lie altogether on one side of that which we call the main chain, and at the eastern extremity, where all the drainage is ultimately borne to the Black Sea, we must be partly guided by geological considerations in deciding which of several ranges deserves to be considered pre-eminent.

Starting from the pass of Altare or Cadibona, west of Savona, the main chain extends first south-west, then nearly due west, to the Col di Tenda, but nowhere rising beyond the zone of coniferous trees. Beyond that limit the range is more lofty, and includes four peaks exceeding 10,000 feet in height, till the line dividing the waters flowing to the Adriatic, through the Po, from the short streams that flow into the Gulf of Genoa, reaches the Mont Enchastraye. Beyond that point, although the line of watershed is very sinuous, its general direction for a distance of about 75 miles is nearly due north. On the east side the waters run to the Po; on the west they flow through the Durance to join the Rhone near Avignon. The most considerable peaks in the range immediately north of the Mont Enchastraye are the Grand Rioburent and the Aiguille de Chambeyron; but these are much surpassed by the Monte Viso, which is the highest peak in the range dividing Piedmont from Dauphiné. On the north side of Monte Viso the main chain diminishes much in average height, and presents no prominent peaks until we reach the Mont Tabor. That summit forms the apex of a salient angle which the main chain here presents on the side of France. For a distance of about 28 miles this extends eastward to the prominent peak of the Roche Melon, which may be considered as a re-entering angle in the great rampart by which Italy is guarded from her northern neighbours. Here the main chain resumes its northerly direction, and attains a greater average height than it had previously exhibited. Several of the prominent peaks in the range connecting the Roche Melon with Mont

Blanc exceed 11,000 English feet in height, though they are much surpassed by the highest group of the Graian Alps, lying on the side of Piedmont, and that of the Tarentaise Alps in Savoy; while there is in this part of the main range but one considerable depression, which is that crossed by the road of the Little St Bernard. In the range crowned by the summit of Mont Blanc the Alpine chain attains its highest elevation. From thence to the Pass of St Gotthard its general direction varies between east and north-east. To the east of Mont Blanc a comparatively low tract allows of several comparatively easy passes between Switzerland and Piedmont, one of which has long been famous as the Pass of the Great St Bernard; but from that to the Simplon Pass, a distance of about 52 miles in a straight line, or about 75 miles if measured along the watershed, the main chain preserves a greater average height than in any other part. Several peaks lying in the dividing ridge, such as the Grand Combin, Matterhorn, Lyskamm, and Monte Rosa, exceed 14,000 feet in height; and these are rivalled by at least six summits on the north side of the same ridge, which at two points only sinks below the level of 10,000 feet. The Simplon Pass corresponds to what may be called a dislocation of the main chain. From thence to the St Gotthard the dividing ridge runs nearly due north-east, and does not present any dominant summit excepting the Monte Leone. On the east and south-east side of the St Gotthard Pass, as far as that of the Maloya, the line of watershed between the affluents of the Rhine and that of the Po is determined by what may be called accidental conditions. The chief mountain ridges, which culminate in the Cima Camadra, Piz Valrhein, and Tambohorn, instead of being arranged along the parting of the waters, lie in a transverse direction, and hence the natural frontier of Italy is here more broken and irregular than elsewhere; and it is only on the south side of the Maloya Pass that the main chain assumes a tolerably continuous direction from west-south-west to east-north-east, as between Piz Güz and the Bernina Pass it rises into the lofty group whose dominant peaks are Piz Tremoggia, Piz Bernina, and Piz Cambrena. Eastward of the Bernina Pass the same direction is preserved, and in the range including the Corno di Campo, Monte Zembrasca, and Monte Foscagno the level scarcely sinks below 9000 feet; but beyond the last-named summit, in the space lying between the Lower Engadine, the head waters of the Adige, and those of the Adda, the semblance of a continuous ridge forming the watershed between the Inn and the Adriatic altogether disappears. If we adhere to the usage of designating as the main chain the ridges which part the waters flowing in different directions, it must be owned that the disposition of the chief mountain masses has no connection with the direction of that chain. Lying between the great mass of the Orteles Alps to the south and the considerable group of the Silvretta Alps on the north side of the Inn, the greater part of the mass in question is drained by streams that flow into the latter river; but the arrangement of the valleys seems to be largely due to erosive action. Few summits in this part of the main chain exceed 10,000 feet, the highest being Piz Scesvenna, on the east side of Val Scarla.

The break in the continuity of the Alpine chain marked by the deep valley through which the main branch of the Adige descends, first southward and then eastward from its source to Meran and Botzen, is one of the most remarkable features in the orography of the Alps. The little lake which is regarded as the chief source of the river lies within less than five miles of the Inn, where that river enters the Tyrol, and no apparent barrier divides the lake from the Inn valley. Eastward of this limit the Alpine chain exhibits a degree of order in its general arrangement which it is impossible to trace in its western and central portions. For a distance of some 250 miles a broad zone of crystalline rocks extends from west to east, flanked on the north and south sides by parallel zones of sedimentary rocks, chiefly belonging to the older secondary formations. Two great valley systems on the opposite sides of the central zone closely coincide with those geological boundaries, and mark out in the physical aspect of this region the limits between the central and the secondary zones. In the former are situated all the highest peaks of the eastern Alps. For a distance of about 140 miles, from the Schafkogel, south-east of Nauders, to the Markkahrspitz, the average level of the main chain is nearly as high as in any equally long section of the central or western Alps. There is one very considerable depression which is marked by the Brenner Pass, but elsewhere in that long barrier there are but three points where the range is passable by beasts of burden. Between the two main sources of the Adige, at the Reschen Scheideck and the Brenner Pass, the considerable groups of the Oetzthal and Stubay Alps attain a great average elevation, though two points only—the Wildspitz and the Weisskugel—surpass the level of 12,000 feet. The drainage of these groups is mostly carried to the Inn, and the line of watershed, about 53 miles in length, is much less direct than in the more easterly portion of the chain. This extends nearly due east for about 90 miles from the Brenner Pass, nowhere falling below the level of 8000 feet, and in two prominent peaks—the Gross Venediger and the Gross Glockner—rising considerably above the limit of 12,000 feet. At a point somewhat north of the Markkahrspitz the central chain divides into two parallel ranges, between which lies the upper valley of the Mur. This river flows for a distance of fully 80 miles nearly due east, till at Bruck-an-der-Mur it turns southward to approach the Drave, and ultimately joins that stream. Various reasons combine to induce geographers to regard the more northern of the two ranges above mentioned, which divides the Enns and other minor tributaries of the Danube from those of the Drave, as constituting the eastern extremity of the main chain of the Alps. This extends a little north of due east for more than 110 miles, with a comparatively low mean elevation, from the Arlscharte to the Semmering Pass, which we regard as the eastern limit of the main chain of the Alps.

Measured along the watershed, as above defined, but without taking into account the minor sinuosities, which would considerably increase the total, the length of the main chain is about 790 English miles.

Passes of the Alps.

For ages before there existed any correct knowledge of the configuration of the Alpine chain, the needs of war and commerce had urged the people dwelling on the opposite sides of the great barrier to seek out the easiest and most direct routes for traversing it. Hence the chief passes of the Alps have been known and frequented from a period antecedent to authentic history, while until a quite modern period little attention was given to the parts of the chain which did not lie in or near the lines of traffic. It is highly probable that many other passes, affording the easiest means of communication between adjacent valleys, have been known and used by the native population from a very remote period, but only those which served for international purposes of war or peace became known at a distance, and are alluded to by ancient writers. A pass is a depression between two adjacent mountains, and the track is usually carried over the lowest part of that depression; but nevertheless nearly all the passes of the Alps involve a long ascent to reach the summit, and a long descent upon the opposite slopes. Hence the Romans, who were the first semi-civilised people to make extensive

use of the Alpine passes, applied to each of them the term *Mons*. The same names, more or less modified in the middle ages, have been preserved in the dialects of Latin origin that prevail throughout the western half of the Alpine chain, and the modern name for the chief passes are still Mont Genévre, Mont Cenis, Mont Iséran, Petit Mont St Bernard, Grand Mont St Bernard, Monte Moro, and Monte San Gottardo. In more recent times, since geographers have attempted to fix the names and positions of the chief summits of the Alps, they have been continually misled by the supposition that a name of high antiquity designating a mountain must belong to some prominent peak. The errors arising from that source have not yet disappeared from geographical works of high repute, but in point of fact each of the names above enumerated belongs solely to the pass, and there is no neighbouring peak entitled to the same designation. The more important passes of the Alps are enumerated in the following description of the chief groups of the Alps; but it may be here remarked that the direction of the main routes for traffic is not exclusively determined by the position of the lowest and easiest passes over the main chain. The configuration of the mountains is such that a traveller proceeding from Italy to France, Switzerland, or Germany, after crossing a comparatively easy pass over the main chain, may find it necessary to traverse a second and loftier pass over a lateral chain, or else follow a circuitous route that may double the length of his journey. Thus a traveller going from Turin to Lyons, who should take what appears to be the direct course over the pass of Mont Genévre, the easiest in the whole range of the western Alps, will find on descending to Briançon that he must cross the much higher and more difficult pass of the Col de Lautaret, or else descend along the Durance till it emerges into the lower country near Gap, and thus more than double the length of his journey. Including the Semmering Pass, there are now not less than 60 Alpine passes that are traversed by carriage roads; and besides three lines of railway now open for traffic, several others are in course of construction.

Ancient divisions of the Alps.

From the time of Julius Cæsar downwards, the Romans, in the prosecution of their policy of universal dominion, or for the purpose of maintaining communication with their military colonies, had become acquainted with all the easiest and most serviceable passes of the Alps, and were thus naturally led to attach names to the chief groups. As their acquaintance with the entire region was very incomplete, the exact boundaries of these groups were imperfectly understood, and the denominations adopted by them were never accurately defined. As might have been expected, the divisions thus roughly established had reference rather to the aspect of the mountains as presented to one travelling from Italy towards the north or west, than to a general view of the physical conformation of the entire region. Hence the ancient divisions are essentially defective, as taking no note of some important groups, or including under a single designation groups entirely distinct. Notwithstanding these defects, the ancient divisions have been adhered to by all but a few modern geographers, and it is therefore desirable to record them separately.

1. *Maritime Alps* (Alpes Maritimæ).—These included the portion of the main chain dividing south-western Piedmont from the coast of the Mediterranean, and extending northward to the neighbourhood of the conspicuous peak of Monte Viso.

2. *Cottian Alps* (Alpes Cottiæ or Cottianæ) included the portion of the main chain dividing Piedmont from Dauphiné and Savoy, and extending from Monte Viso to the neighbourhood of the Mont Cenis. The name appears to be derived from Cottius, the king or chief of a powerful tribe who ruled the greater part of this region when the paramount authority of Augustus was established in Cisalpine Gaul.

3. *Graian Alps* (Alpes Graiæ).—Under this designation was known the great group of mountains between Turin and the upper Val d'Aosta, and the portion of the main chain lying between the Mont Cenis and the Little St Bernard. Pliny and other Latin writers derive the name from the legendary passage of a body of Greeks led by Hercules through this region; but the true derivation is probably from some lost Celtic appellation.

4. *Pennine Alps* (Alpes Penninæ) was the name applied to the great range including Mont Blanc and Monte Rosa, which, from the time of Julius Cæsar, if not earlier, was recognised as the highest portion of the entire chain. The word Pen or Ben is still in use in the living dialects of the Celtic stock as a common designation for a conspicuous mountain, and was certainly in use in the speech of this part of Cisalpine Gaul, where many other Celtic terms are preserved in the local names. The Roman designation *Jupiter Penninus* was undoubtedly taken from the Celtic root, but the asserted use of the name Pen for a divinity by the native tribes is not established by valid evidence.

5. *Lepontine Alps* (Alpes Lepontinæ).—It would appear that this denomination was originally restricted to the parts of the main chain lying on either side of the pass of St Gotthard, including the sources of the river Ticino, with those of its tributaries, of which the most important is the Tosa or Toccia, draining the range between the neighbourhood of the Simplon Pass and that of the Gries. The name is derived from the Lepontii, a tribe of doubtful extraction (Rhætian, according to Strabo) who inhabited the main valley of the Tessin or Ticino, the upper part of which is still called Val Leventina. The eastern limit of this group was usually fixed at the pass of San Bernardino.

6. *Rhætian Alps* (Alpes Rhæticæ) derived their name from the Rhæti, a powerful tribe or nation holding a large tract of territory which appears to have extended from the sources of the Rhine and the Ticino on the west, to those of the Adige and the Salza on the east. The area included under this vague heading is at least equal in area to that of the five divisions hitherto enumerated.

7. *Noric Alps* (Alpes Noricæ).—Under this name the entire region lying north of the Drave, and extending thence to the valley of the Danube on the north and the plains of Hungary on the east, was included.

8. *Carnic Alps* (Alpes Carnicæ).—This name was given to the mountain tract lying between the upper Drave and the low country of Friuli. By some writers it has been limited to the ranges that feed the Tagliamento (*Tilaventus*) and its tributaries; by others the range seems to have been held to extend from the sources of the Piave to those of the Save. The name Carnia is still in use in Friuli, but is strictly limited to the basin of the Tagliamento.

7. *Julian Alps* (Alpes Juliæ).—This designation has been still more vaguely used by ancient and modern geographers than any of the preceding. The lofty group of peaks crowned by the Terglou, and lying between the head waters of the Isonzo and those of the Save, undoubtedly forms the chief nucleus of the group distinguished by this name; but it also appears to have included the ranges of eastern Friuli, which province, as well as the Alps in question, took its name from the Roman Forum Julii, now known as Cividale. By others, and even by contemporary Italian writers, the term Julian Alps is made to extend southward through the district of Karst between Carniola and the shores of the Adriatic, and thence through Croatia to the frontiers of Bosnia. A great part of this district is an undulating plateau, in part not attaining to 2000 feet above the sea-level, to which by no stretch of language can the term Alps be properly applied.

In addition to the groups above mentioned some writers have enumerated the *Dinaric Alps* (Alpes Dinaricæ), and include under that term the mountain range extending along the western frontier of Bosnia. This is a portion of the extensive mountain system of European Turkey, which in one direction includes the Balkan, and in another is continued through Albania into Greece. The Romans probably applied to these the designation Alps as some of their later writers did to the Pyrenees and the mountains of southern Spain; but it can merely cause confusion to speak of them as a portion of the great system to which the name Alps specially applies. For the reasons already mentioned it is impossible to regard the ancient groups above enumerated as affording a satisfactory division of the region under consideration; but so far as they can be made to correspond with the divisions suggested by a more exact knowledge of its physical configuration, it seems desirable to retain the established nomenclature.

Modern division of the Alps into groups.

Actual observation of the Alpine region through the greater part of its extent, or even the careful study of accurate models, must convince any one who seeks to divide it into groups that it is not possible to do this by adhering rigidly to any single test or rule. In a general way, it is natural and desirable to include under the same name mountain masses that are not divided by a broad and deep opening; but it is sometimes more convenient to include in one group disjoined masses that have some natural connexion with each other, rather than multiply groups to an inconvenient extent. In some cases the geological structure may supply a rational ground for preferring one arrangement to another, when the choice would otherwise be arbitrary; and in a few cases it may be well to yield something to ancient usage, based upon political

or ethnological grounds. Accurate knowledge of the Alps is so recent that few attempts have been made to establish a general division of the entire region, and it cannot be said that any one arrangement has obtained such general recognition as not to be open to future modification; but there is a pretty general agreement as to the main features of that here proposed, to which a few general remarks must be premised.

Whatever may have been the original cause of those disturbances of the earth's crust to which great mountain chains owe their existence, it is generally, though not universally, true that the higher masses (formed of rocks geologically more ancient) are found towards the central part, and that these are flanked by lower ranges, composed of more recent rocks, which surround the central groups very much as an outer line of entrenchment may be seen to surround a fort. In most cases it is not possible to descend continuously in a nearly direct line from the crest of a great mountain chain to the plains on either side, for there are usually intermediate valleys, running more or less parallel to the central range, which separate this from outer secondary ranges. These, in their turn, are often accompanied by external ranges, intermediate between them and the plains, and related to them as they are to the central ranges. The type of arrangement here described is more or less traceable throughout the greater part of the Alps, but is most distinctly exhibited in the eastern portion lying between the Adige and the frontier of Hungary. We have a central range, composed mainly of crystalline rock; a northern range, formed of secondary rocks, separated from the first by the great valleys of the Inn, the Salza, and the Enns; a southern range, somewhat similar to the last in geological structure, divided from the central one by the Rienz, or east branch of the Adige, and the Drave. Flanking the whole, as an external entrenchment on the north side, are the outer ranges of the Bavarian Alps, of the Salzkammergut, and of Upper Austria, to which correspond on the south side the Monti Lessini, near Verona, the mountains of Recoaro, those of the Sette Comuni, and the considerable masses crowned by the summits of the Grappa, the Col Vicentino, the Monte Cavallo, the Monte Matajur, and Monte Nanos. Where, as in the cases above mentioned, the secondary ranges of the Alps rise to a greater altitude, and are completely separated from the neighbouring portions of the central chain, it is impossible not to distinguish them as distinct groups; but the outermost ranges, which rarely rise above the forest zone, are in all cases regarded as appendages of the adjoining groups. These outer ranges are called in German *Voralpen*, and in Italian *Prealpi*, and it is to be desired that equivalents should be introduced in other European languages. A complete catalogue of the peaks and passes of the Alps would exceed the limits of this article, but it seems desirable to append to each of the main groups in the following arrangement the names of the more conspicuous summits, with the height of each above the sea-level in English feet. No limit of absolute height has been fixed in selecting the peaks here enumerated, as the highest summits of the less lofty groups would appear insignificant in those whose average elevation is much greater. The more important passes are also enumerated, distinguishing those traversed — (1) by carriage road, (2) by bridle-path, practicable for beasts of burden, and (3) by footpath; and (4) snow passes, involving the necessity of crossing snow-fields or glacier

Main Divisions of the Alps.

1. *Maritime Alps.*—On examining a map of the region where the chain of the Alps approaches the shores of the Mediterranean, it will be seen that, about 50 miles N.N.W. of Nice, and about 20 S.S.W. of the Monte Viso, several valleys diverge in various directions, disposed, roughly speaking, like the rays of a fan. These are formed by a number of ridges which converge towards, although they do not actually meet at, the *Mont Enchastraye* or *Cima dei Quattro Vescovadi.* On the west side one of these ridges divides the upper valley of the Ubaye from that of the Verdon, and sends out a branch which separates the latter from the Bléone. A third ridge divides the Verdon from the Var, and a fourth separates this from its main affluent, the Tinéa. As already mentioned, the range extending S.E. from Mont Enchastraye is regarded as the main chain of the Maritime Alps, and extends, with numerous diverging secondary ridges, in a curved line, gradually approaching nearer to the coast till it is merged in the chain of the Apennines. To fix the limit between the Alps and the Apennines in this direction is necessarily a somewhat arbitrary process, and different criteria may be applied with different results; but it seems most natural to fix on the depression west of Savona known as the Col d'Altare or Col di Cadibona, over which the road is carried which leads in one direction to Alessandria, and in the other to Mondovi. This is by far the lowest depression in the barrier dividing the Adriatic from the Mediterranean, the summit being only 1608 feet above the sea-level; and during the Miocene epoch it formed a strait connecting those seas. In modern times the project of utilising the same pass for the construction of a canal to connect the Po with the Gulf of Genoa is an illustration of its geographical significance. On the north side of the Mont Enchastraye, a comparatively low pass, *Col de l'Argentière*, divides that mountain from the adjoining portion of the main chain. This might properly be regarded as the northern limit of the Maritime Alps, but ancient usage has included in that group the ranges that enclose the Val Maira, and separate it on one side from the Stura di Demonte, and on the other from the Vraita. Conforming to that practice, we fix the northern limit of the Maritime Alps at the Col de Longet, S.E. of the peak of Monte Viso, connecting the head of Val Vraita in Piedmont with the sources of the Ubaye in France.

Chief Peaks of the Maritime Alps.
(The heights are given in English feet.)

Monte Galè	5,649	Monte Matto	10,230
Monte Frontè	7,198	Mont Tinibras	10,223
Monte Bertrand	8,209	Mont Enchastraye	9,747
Rocca dell' Abisso	9,193	Grand Rioburent	11,142
Cima dei Gelas	10,433	Aiguille de Chambeyron	11,155
Rocca dell' Argentera	10,617	Pointe Haute de Mary	10,537

Chief Passes of the Maritime Alps.

Col di San Bernardo (Albenga to Garessio), carriage road	3301
Col di Nava (Oneglia to Ormea), carriage road	3150
Col di Tenda (Tenda to Cuneo), carriage road	6158
Col delle Finestre (S. Martino to Entracque), footpath	8189
Col delle Cerese (S. Martino to Valdieri), footpath	8412
Col di Frema Morta (Val Tinea to Valdieri), bridle-path	8839
Col della Lombarda (Val Tinea to Vinadio), footpath	7858
Col di Sta. Anna (same), footpath	8009
Col de Pouriac (San Stefano to Bersesio), footpath	8360
Col de l'Argentière (Val. of the Stura to Barcelonnette), bridle-path	6545
Col de Sautron (Val Maira to Barcelonnette), footpath	about 8000
Col de Lauzanier (Val Tinea to the Ubaye), footpath	about 8300

2. *Cottian Alps.*—In the well-known panorama presented to an observer who takes his stand on the Superga, or some other eminence near Turin, the most distant objects are the peaks of the Maritime Alps south of Cuneo and, exactly in the opposite direction, the great mass of Monte Rosa. In the western horizon, subtended by this chord, about 120 miles in length, the eye follows the irregular curve traced out by the main peaks of the western Alps, that separate upper Italy from France. More than any other part of the Alpine chain, this is characterised by extreme irregularity in the disposition of the mountain masses and the chief valleys. On the west side the pre-

vailing direction seems to be from south-west to north-east, while on the east side it is more nearly from west to east; but the valleys and the ridges that enclose them are often curved or irregularly sinuous. Convenience seems to confirm immemorial usage in subdividing this region into two or more groups; but it is not easy to decide how this is to be effected. The great valley of the Dora Riparia, and the low passes connecting it with the valley of the Durance, seem to afford the most natural division. Ancient and modern usage being alike opposed to this, it appears that the valley of the Orco in Piedmont and that of the Arc in Savoy, with the connecting pass of the Col del Carro, may best be taken as the boundary between the northern and southern portions. The latter is distinguished as the group of the Cottian Alps. This includes a number of secondary ridges that extend from the main chain on the side of Piedmont, with a general direction from west to east; and on the French side one considerable range, stretching south-west from the neighbourhood of Monte Viso, that divides the Ubaye from the Guil, besides a lesser parallel ridge lying between the Guil and the head waters of the Durance.

Chief Peaks of the Cottian Alps.

Monte Viso	12,605	Mont Albaron	12,014
Monte Meidassa	10,991	Mont Chardonnet	12,373
Mont Albergian	9,990	La Levanna	11,516
Roche du Grand Galibier	10,637	Pointe de Sainte Anne, or Pte. des Orches	about 11,000
Mont Tabor	10,436	Roche Brune	10,906
Roche d'Ambin	11,096	Mont Chaberton	10,258
Roche Melon	11,621		
Ciamarella	12,081		

Chief Passes of the Cottian Alps.

Col de Longet (Val Vraita to the Ubaye), footpath	8,727
Col de St Veran (Val Vraita to Queyras), footpath	9,564
Col de la Traversette (Crissolo to Abriès), footpath	9,827
Col de la Croix (La Tour de Luserne to Abriès), bridle-path	7,611
Col de Sestrières (Pignerol to Cesanne), carriage road	6,335
Mont Genèvre (Cesanne to Briançon), carriage road	6,102
Col d'Izouard (Queyras to Briançon), bridle-path ......about	6,500
Col des Echelles de Planpinet (Bardonnèche to Briançon), footpath	5,873
Col de la Roue (Bardonnèche to Modane), bridle-path	8,334
Col d'Etiaches (Bardonnèche to Bramans), footpath	9,301
Col du Clapier (Bramans to Susa), footpath	8,107
Mont Cenis (Susa to Lanslebourg), carriage road	6,772
Col de l'Autaret (Viù to Lanslebourg), snow	10,170
Col de Colorin (Ala to Lanslebourg), glacier	10,662
Col de Séa (Groscavallo to Lanslebourg), glacier	10,154
Col della Crocetta (Groscavallo to Ceresole), footpath	9,179

3. *Dauphiné Alps.*—On the west side of the Cottian Alps, and separated from these by the broad valley of the Durance, rises a group of lofty peaks, surpassing them considerably in height, and almost completely isolated from their neighbours. This group has not usually been included amongst the Cottian Alps by geographers, and it is more natural to regard it as the nucleus of a distinct division constituting the Dauphiné Alps. On the north side of this central mass, and separated by the valley of the Romanche and the Col de Lautaret, is a considerable group, including three principal ridges, whose direction is nearly due north and south, separated from the neighbouring mountains of Savoy by the deep valleys of the Arc and the Isère, which may best be regarded as an outlying portion of this division. On the south side of the main group another outlying mass, which on one side feeds the chief sources of the Drac, and on the other several short tributaries to the Durance, must also be included in this division. The ranges of secondary rocks lying west of the broad valley between Grenoble and Chambéry, which are geologically and orographically a southern extension of the chain of the Jura, are at the same time exactly parallel to the northern ranges of the Dauphiné Alps, and must be regarded as the outer range or "Border Alps" (*Voralpen*) of the group. The only doubt in fixing the limits of the Dauphiné Alps is as to the boundary between their northern group and the adjoining mass of the Cottian Alps. It seems that this may best be fixed at the *Col de Galibier*, connecting the chief source of the Durance with the valley of Valloires in Savoy.

Chief Peaks of the Dauphiné Alps.

Pic des Ecrins, or Pointe des Arcines	13,462	Grandes Rousses	11,395
La Meije, or Aiguille du Midi de la Grave	13,081	Taillefer	9,387
Pic d'Ailefroide	about 13,000	Pic de Belledonne	9,780
Mont Pelvoux (highest peak)	12,973	Pic du Frêne	9,203
Pic d'Olan	11,739	Pic Bonvoisin	11,503
Aiguille d'Arve (highest)	11,529	Dormillouse	10,571
Aiguille de la Sausse (high'st)	10,896	Chamechaude	6,847
		Mont Granier	6,348
		Dent du Chat	5,302

Chief Passes of the Dauphiné Alps.

Col de Galibier (Briançon to St Michel), footpath	9,154
Col de Lautaret (Monestier to Bourg d'Oisans), carriage road	6,791
Col des Ecrins (Vallouise to La Bérarde), glacier	11,071
Col du Glacier Blanc (Vallouise to La Grave en Oisans), glacier	10,811
Col de l'Echauda (Vallouise to Monestier), bridle-path	7,936
Col de la Lauze (St Christophe to La Grave en Oisans), glacier	10,509
Col de Venosc (Venosc to Freney), bridle-path	5,292
Col de Saïs (La Bérarde to Val Godemar), glacier	10,289
Col de Célar (Vallouise to Val Godemar), glacier	10,092
Col des Tourettes (Orcières to Châteauroux), footpath	8,465
Col de l'Infernet (La Grave en Oisans to St Jean de Maurienne), footpath	8,826
Col de la Croix de Fer (Bourg d'Oisans to St Jean de Maurienne), bridle-path	6,500

4. *Graian Alps.*—The lofty group of snowy mountains lying between the plain of Piedmont and Mont Blanc has from a remote period borne the designation Graian Alps. To the north they are bounded by the Val d'Aosta, and to the south by the valley of the Orco; but on the west side the boundary is not so easily determined. The portion of the main chain dividing Savoy from Piedmont, between the Levana and Mont Blanc, must undoubtedly be included in this division; but it is not so easy to determine the relations of a group of lofty summits that are divided from the rest of the Graian Alps by the upper valley of the Isère, filling the space between the upper course of that river and that of the Arc. This is further geologically distinguished by the fact that the higher summits are chiefly composed of nearly unaltered sedimentary rocks. This group has by some writers been associated with the mountains of Beaufort, lying between the Isère and the Arly, to form, with some subordinate branches, a group of south Savoy Alps; but we prefer to adhere to the older usage of those who have united them with the Graian Alps. The exact boundary between these and the Mont Blanc group may best be fixed at the pass of the Little St Bernard, the lowest in the main chain between the Mont Cenis and the Simplon.

Chief Peaks of the Graian Alps.

Main Chain.		La Grivola	13,028
Grand Apparei	11,494	Becca di Nona	10,384
Aiguille de la Sassière	12,326	Mont Emilius	11,677
Mont Bassac	11,200	Punta di Tersiva	11,503
Ormelune	10,833	*Savoy Group.*	
Ruitor	11,480	Grande Motte	about 11,800
Piedmontese Group.		Grande Casse	12,780
Grand Paradis	13,300	Dent Parassée	12,137
Tour du Grand St Pierre	12,069	Roche Chevrière	10,765
Punta di Lavina	10,824	Mont Pourri	12,491
Bec d'Invergnuon	about 12,100		

Chief Passes in the Graian Alps.

Col del Carro (Locana to Lanslebourg), glacier	10,292
Col de Galese (Locana to Tignes), snow	9,836
Col de Gailletta (Tignes to Val de Rhêmes), glacier	10,049
Col Vaudet (Tignes to Val Grisanche), snow	9,305
Col du Mont (Sainte Foi to Val Grisanche), footpath	8,635
Pass of Little St Bernard (Bourg St Maurice to Aosta), car. road	7,192
Col de la Croix de Nivòlet (Cerosole to Val Savaranche), bridle-path	8,624
Col de Grancrou (Cogne to Noasca), glacier	11,034
Col de Telleccio (Cogne to Locana), glacier	10,925
Col della Nouva (Ponte to Cogne), glacier	9,664
Col de Lauzon (Cogne to Val Savaranche), bridle-path ......about	9,500
Fenêtre de Cogne (Cogne to Bard), bridle-path	8,860
Col de Lore (Cogne to Brissogne), glacier	10,049
Col d'Iséran (Bourg St Maurice to Lanslebourg), bridle-path	9,085
Col de la Leisse (Tignes to Entre-deux-Eaux), snow	9,127
Col de la Vanoise (Moutiers Tarentaise to Lanslebourg), footpath	8,271
Col de Chavière (Pralognan to Modane), snow	9,144
Col de la Platière (Moutiers Tarentaise to St Jean de Maurienne), footpath	6,800
Col de la Madeleine (Albertville to La Chambre), bridle-path	6,637

5. *Pennine Alps.*—The portion of the great chain that includes the peaks of Mont Blanc and Monte Rosa has always been recognised as the most important among the divisions of the Alps. This pre-eminence is due not only to its surpassing height, but to the fact that its peaks are so conspicuous. Throughout the plain of Upper Italy, from Turin to Milan, and even as far as the slopes of the Apennines, Monte Rosa, with its attendant peaks, is commonly the most remarkable object in the northern horizon; while in western Switzerland, and as far westward as the heights above Lyons, the dome of Mont Blanc, rising in the distant eastern horizon, attracts the frequent attention alike of natives and strangers. Some doubts may arise as to the precise limits that should be assigned to this group. Towards the north-east it is generally agreed that the Simplon Pass is the most natural limit. In the opposite direction most writers have fixed on the Col de Bonhomme, south-west of Mont Blanc, as the proper boundary; but it seems reasonable in a general arrangement to regard the range extending from the last-named pass to Grand Cœur, in the valley of the Isère, as a south-western prolongation of the range of Mont Blanc. From the portion of the main chain connecting the Mont Combin with Monte Rosa, numerous branches, with peaks that rival these in height, diverge northward. The secondary ranges that extend on the side of Italy, southward and eastward from Monte Rosa, are much inferior in altitude. On the north and west sides of Mont Blanc an extensive mountain district, including the French department of Haute Savoie, must be considered as an appendage to the group of the Pennine Alps. On the south side, the short range extending parallel to that of Mont Blanc, from Courmayeur to the Val de Bellaval, corresponding to the range of the Aiguilles Rouges and the Brévent, on the opposite side, mav best be included within the group of the Pennine Alps.

Chief Peaks of the Pennine Alps.

Cima des Fours	12,615	Fletschhorn (Laquinhorn)	13,176
Aiguille de Trélatête	12,907	Grauhaupt	10,702
Aiguille de Bionnassay	13,324	Corno Bianco	11,014
Mont Blanc (Calotte)	15,781	Pointe de Salles ......about	10,200
Aiguille Verte	13,527	Buet	10,207
Grandes Jorasses	13,799	Tour Sallière	10,587
Aiguille d'Argentière	12,796	Dent du Midi	10,450
Grande Rossère	10,904	Pigne d'Arolla	12,471
Mont Vélan	12,353	Rouinette	12,727
Grand Combin	14,164	Mont Blanc de Cheillon	12,700
Mont Gelé	11,539	Dent Blanche	14,318
Mont Colon	12,264	Grand Cornier	13,022
Dent d'Hérens	13,714	Sasseneire	10,692
Bec de Luseney	12,350	Gabelhorn	13,363
Matterhorn, or Mont Cervin	14,780	Rothhorn, or Moming	13,855
Breithorn	13,685	Weisshorn	14,804
Lyskamm	14,889	Strahlhorn	13,750
Mte. Rosa (highest peak)	15,217	Mischabelhörner (Dom)	14,935
Weissmies	13,225		

Chief Passes of the Pennine Alps.

Col de Bonhomme (Contamines to Chapiu), bridle-path	8,195
Col de la Seigne (Chapiu to Courmayeur), bridle-path	8,327
Col du Mont Tondu (Contamines to Allée Blanche), glacier	9,204
Col de Miage (Contamines to Courmayeur), glacier	11,076
Col du Géant (Chamouni to Courmayeur), glacier	11,030
Col du Tour (Chamouni to Orsières), glacier	11,213
Col de Ferrex (Courmayeur to Orsières), bridle-path	8,320
Great St Bernard Pass (Orsières to Aosta), bridle-path	8,120
Col de Fenêtre (Chables to Aosta), bridle-path	9,141
Col de Colon (Aosta to Evolena), glacier	10,269
Col de la Val Pellina (Aosta to Zermatt), glacier	11,687
Col de Vessona (Oyace to St Barthelemi), footpath ......about	8,600
Col de Vacornère (Prarayen to Val Tournanche), snow	10,335
Col de Chermontane (Chermontane to Evolena), glacier	10,349
Col d'Hérens (Evolena to Zermatt), glacier	11,418
Col de Torrent (Evolena to Vissoie), footpath	9,593
Pas du Bœuf (St Luc to Turtmanthal), footpath	9,154
Augstbord Pass (Grüben to St Niklaus), bridle-path	9,515
Trift Joch (Zinal to Zermatt), glacier	11,614
Col de St Théodule (Zermatt to Val Tournanche), glacier	10,899
Schwarz Thor (Zermatt to Val d'Ayas), glacier	12,777
Lys Joch (Zermatt to Val de Lys), glacier	14,050
Weiss Thor (Zermatt to Macugnaga), glacier	11,851
Betta Furke (Val d'Ayas to Val de Lys), footpath	8,639
Col d'Ollen (Gressonay to Alagna), bridle-path	9,544
Col di Val Dobbia (Gressonay to Riva), bridle-path	8,360
Turlo Pass (Alagna to Macugnaga), snow	9,088
Col di Barranca (Varallo to Ponte Grande), bridle-path	5,749
Alphubel Joch (Zermatt to Saas), glacier	12,474
Adler Pass (Zermatt to Distel Alp), glacier	12,461
Monte Moro (Saas to Macugnaga), snow	9,390
Saas Pass, or Passo d'Antrona (Saas to Val Antrona), glacier	9,331
Zwischbergen Pass (Saas to Gondo), glacier	10,732
Simplon Pass (Brieg to Domo d'Ossola), carriage road	6,595
Col de Balme (Chamouni to Martigny), bridle-path	7,231
Col d'Anterne (Servoz to Sixt), bridle-path	7,612
Col de Sesanfe (Champéry to Martigny), footpath	7,940

6. *Bernese Alps.*—There is no considerable mass of Alpine summits whose boundaries are better defined than that which is generally known as the group of the Bernese Alps. By the number and height of the peaks, that rise far above the limits of perpetual snow, it ranks next in importance to the Pennine group; and its position with reference to that group has largely contributed to the fame of the region which they occupy for a marvellous and almost unique combination of grandeur and variety. The most characteristic feature in the orography of Switzerland is the great valley system that extends in a nearly direct line from Martigny to Coire—interrupted, it is true, by two passes (the Furka and Oberalp) of small elevation compared to the surrounding heights. On the opposite sides of this great trench the chief groups of the central Alps are arranged in masses that, amid much apparent irregularity, approach to parallelism with the direction of the central valley. Hence the traveller who attains any considerable height on either side sees over against him the dominant summits of the opposite group in constantly varying combination. The highest groups (the Pennine and Bernese) are so placed that the chief peaks on the one side are rarely more than 20 miles apart from their rivals in the opposite chain, and the projecting summits of the secondary ridges between them afford panoramic views of wonderful beauty and grandeur. What may be called the main chain of the Bernese Alps, forming the boundary between the Swiss cantons of Bern and Valais, extends parallel to the course of the Rhone, from the glacier which is the main source of that river, to Martigny, a distance of about 70 miles; and we must regard as a dependency of that chain the mountain district that lies on its northern side, between the upper course of the Aar and the head of the Lake of Geneva. Desiring to adhere to the divisions of the Alps admitted by ancient geographers, many modern writers have included the Bernese group among the Lepontine Alps; but this arrangement is not consistent with any rational criterion that can be applied. The only question admitting of doubt is as to the eastern limit of this group. The Aar issues from its parent glacier at a point very near to the chief source of the Rhone, and separated only by a comparatively deep and broad depression, the Grimsel Pass; and it might appear that the Bernese Alps should be defined as the group enclosed between those rivers. But some ten miles east of the Grimsel Pass the range lying north of the great valley of Switzerland is completely cut through by the valley of the Reuss, where that stream descends towards the Lake of Lucerne through the famous defile of the Devil's Bridge; and as it would be inconvenient to reckon the comparatively small group that lies between the head waters of the Reuss and those of the Aar as a separate division, we prefer to include this as a portion of the Bernese Alps.

Chief Peaks of the Bernese Alps.

Grand Moveran	10,043	Aletschhorn	13,803
Diablerets	10,666	Jungfrau	13,671
Wildhorn	10,722	Mönch	13,438
Wildstrubel	10,715	Eiger	13,045
Balmhorn	12,100	Finsteraarhorn	14,026
Doldenhorn	11,965	Schreckhorn	13,394
Blümlis Alp (Blümlisalp-horn)	12.041	Wetterhorn (Mittelhorn)	12,166
		Rizlihorn	10,774
Bietschhorn	12.969	Eggischhorn	9,649

Löffelhorn	10,138	Titlis	10,627
Galenstock	11,956	Uri Rothstock	9,620
Dammastock	11,920	Niesen	7,763
Sustenhorn	11,519	Brienzer Rothhorn	7,917
Gross Spannort	10,515	Pilatus (Oberhaupt)	7,290

Chief Passes in the Bernese Alps.

Col de Cheville (Bex to Sion), bridle-path	6,680
Sanetsch Pass (Sion to Saanen), bridle-path	7,369
Rawyl Pass (Sion to Zweisimmen), bridle-path	7,943
Gemmi Pass (Kandersteg to Leuk), bridle-path	7,553
Lötschen Pass (Kandersteg to Turtman), glacier	8,796
Tschingel Pass (Kandersteg to Lauterbrunnen), glacier	9,252
Petersgrat (Lauterbrunnen to Kippel), glacier	10,550
Lotschen Lücke (Kippel to the Æggischhorn), glacier	10,512
Kleine Scheidegg (Lauterbrunnen to Grindelwald), bridle-path	6,768
Grosse Scheidegg (Grindelwald to Meyringen), bridle-path	6,910
Mönch Joch (Grindelwald to Viesch), glacier	about 11,600
Strahleck Pass (Grindelwald to the Grimsel), glacier	10,994
Brünig Pass (Brienz to Sarnen), carriage road	3,648
Engelberger Joch (Meyringen to Engelberg), bridle-path	7,244
Susten Pass (Meyringen to Wasen), carriage road (?)	7,440
Triftlimmi (Trift Glacier to Grimsel), glacier	about 10,200
Geschenenlimmi (Geschenen to Stein Alp), glacier	about 10,170
Surenen Pass (Engelberg to Altdorf), bridle-path	7,562

7. *North Swiss Alps.*—Attention has already been called to the great line of valley that traverses Switzerland from Martigny to Coire. The range of high peaks lying on the north side of this valley is interrupted at one point only, where the Reuss flows through the deep defile of the Devil's Bridge from Andermatt to Altdorf, and this breach in the continuity of the range has been here regarded as the eastern limit of the Bernese Alps. The range extending eastward from that boundary to the neighbourhood of Coire might perhaps be considered as a prolongation of the range of the Bernese Alps; but independently of the inconvenience of assigning such wide boundaries to a single group, there are geologic as well as orographic grounds for preferring to class this along with the dependent ranges lying further north as a separate division of the Alps. With regard to the latter ranges, those lying between the valley of the Reuss and the Lake of Lucerne, on one side, and the ancient valley of the Rhine, which included the lakes of Wallenstadt and Zurich, on the other, manifestly correspond to the outer ranges of central Switzerland, which we regard as appendages of the Bernese Alps. The case is somewhat different as regards the small detached group culminating in the Hoh Sentis, and lying in the angle between the ancient course of the Rhine and the modern Rhine valley from Sargans to the Lake of Constance. This is so far separated orographically and by geological structure that it might properly rank as a separate division, but it is on the whole more convenient to reckon it as an outlying portion of this group. The Oberalp Pass, a few miles east of Andermatt, forms the watershed between the Reuss and the main branch of the Rhine, and the waters meet again at the confluence with the latter of the united streams of the Aar and the Reuss at Waldshut, so that the entire territory comprehending this division of the Alps is enclosed between the two first-named rivers.

Chief Peaks of the North Swiss Alps.

Crispalt (Piz Giuf)	10,164	Kärpfstock	9,180
Oberalpstock (Piz Cotschen)	10,925	Saurenstock	10,026
Tödi	11,887	Scheibe	9,587
Piz Tumbif, or Brigelserhorn	10,663	Mythen (higher peak)	6,244
Bifertenstock, or Piz Durgin	11,237	Glärnisch (highest peak, Bächistock)	9,584
Hausstock	10,355	Mürtschenstock	8,012
Segneshorn	10,870	Mageren	8,294
Calanda	9,213	Churfirsten (highest peak, Scheibenstoll)	7,554
Bristenstock	10,089	Faulfirst	7,916
Scheerhorn	11,142	Hoh Sentis	8,215
Claridenstock	10,709		
Selbsanft	9,921		

Chief Passes of the North Swiss Alps.

Oberalp Pass (Dissentis to Andermatt), carriage road	6,732
Kreuzli Pass (Dissentis to Amsteg), footpath	7,710
Sand Grat Pass (Dissentis to Stachelberg), glacier	9,138
Clariden Grat (Amsteg to Stachelberg), glacier	9,842
Kisten Pass (Ilanz to Stachelberg), snow	8,281
Panixer Pass (Ilanz to Elm), bridle-path	7,907
Segnes Pass (Reichenau to Elm), snow	8,612
Sardona Pass (Elm to Vättis), glacier	about 9,500
Ramin Pass (Elm to Sargans), footpath	6,772
Klausen Pass (Altdorf to Stachelberg), bridle-path	6,437
Pragel Pass (Schwyz to Glarus), bridle-path	5,062
Kamor Pass (Weissbad to Rüti), bridle-path	about 5,300

8. *Lepontine Alps.*—The portion of the Alpine chain lying between the Simplon and Splügen passes, and forming the boundary between the tributaries of the Po and those of the Rhine, presents some peculiar orographic characteristics. The line of watershed is pretty nearly parallel to that great line of depression traced across Switzerland by the valley of the Rhone, the Urserenthal, and the valley of the Vorderrhein; and a tendency to parallelism with the same system may be traced in many parts of this group. But the dominant direction of the secondary valleys and ridges is that of the meridian; and on the south side we find a series of long valleys running from north to south, with occasional slight distortions. The most considerable of these are partly occupied by the two famous Lombard lakes—Maggiore and Como—which have from an early period attracted the admiration of strangers to this region. Ancient geographers limited the term Lepontine Alps to the portion of this group that sends its drainage on the south side to the river Ticino; but the ranges between the Splügen and Bernardino passes, and between the lakes Maggiore and Como, evidently belong to the same system, and must be united in any natural arrangement of the Alps. On considering a tolerably correct model, it is impossible not to be struck by the fact that all the valleys that contain the most considerable streams of the central Alps appear to radiate from the neighbourhood of the St Gotthard Pass. If we measure from the summit of that pass to the head valleys of the Rhone, the Aar, the Reuss, the Vorderrhein, the Ticino, and the Toccia, we find that the most distant lies within 9 English miles from that point. This fact has doubtless a significance which we are not yet able fully to appreciate, but scarcely suffices to justify the view of those who regard the St Gotthard Pass as in some special sense the central point of the whole system of the Alps. It is worth remarking that, so far from being distinguished by superior height, the neighbouring peaks are surpassed by all the surrounding groups, and that the valleys are much deeper than in many other districts, and especially than those of eastern Switzerland.

Chief Peaks of the Lepontine Alps.

Monte Leone	11,696	Piz Vial, or Gallinario	10,337
Wasenhorn	10,628	Piz Valrhein	11,148
Ofenhorn, or Punta d'Arbola	10,728	Vogelberg	10,564
Blinnenhorn	10,932	Piz Terri	10,338
Monte Basodine	10,748	Piz Cavel	9,659
Pizzo Rotondo	10,489	Fanellahorn	10,243
Pizzo di Campo Tenca	10,096	Löchliberg	9,990
Pioda di Crana	7,959	Piz Beverin	9,843
Cima di Laurasca	7,264	Tambohorn	10,748
Badus, or Six Maduna	9,616	Cima di Balniscio	9,967
Scopi	10,499	Monte Camoghè	7,304
Cima Camadra	10,509		

Chief Passes in the Lepontine Alps.

Ritter Pass (Viesch to Isella), snow	8,854
Albrun Pass (Viesch to Premia), bridle-path	8,005
Gries Pass (Obergestelen to Formazza), bridle-path	8,050
Nufenen Pass (Obergestelen to Airolo), bridle-path	8,009
Passo di San Giacomo (Formazza to Airolo), bridle-path	7,572
Furka Pass (Obergestelen to Hospenthal), carriage road	7,992
St Gotthard Pass (Hospenthal to Airolo), carriage road	6,936
Criner Furka (Locarno to Val Formazza), footpath	7,631
Passo di Narret (Locarno to Airolo), footpath	8,013
Passo dell' Uomo (Dissentis to Airolo), footpath	7,257
Lukmanier Pass (Dissentis to Olivone), bridle-path	6,289
Greina Pass (Trons to Olivone), bridle-path	7,743
Disrut Pass (Ilanz to Olivone), footpath	7,953
Scaradra Pass (Ilanz to Ghirone), snow	9,088
Passo di Buffalora (Val Calanca to Mesocco), bridle-path	6,686
Bernardino Pass (Hinterrhein to Val Mesocco), carriage road	6,769
Valserberg Pass (Ilanz to Hinterrhein), bridle-path	8,225
Löchliberg Pass (Reichenau to Splügen), footpath	8,165

Splügen Pass (Splügen to Chiavenna), carriage road	6,945
Passo di Balniscio (Campodolcino to Mesocco), footpath	7,715
Passo della Forcola (Chiavenna to Roveredo), footpath	7,274
Passo di San Jorio (Gravedona to Bellinzona), footpath	6,417

9. *The Rhætian Alps.*—The older geographers included under the term Rhætian Alps a vast mountain region extending over 6° of long., from the east side of the Lago Maggiore to the left bank of the Salza, and through 2½° of lat., from the neighbourhood of Brescia to the plain of Bavaria. There is no assignable reason for uniting in a single division mountain groups so distinct as many of those included within this wide space—scarcely less than that occupied by all the divisions hitherto enumerated—save the fact that at an early period they received a common designation from writers who had a most imperfect acquaintance with their topography. It might be expedient to discard a term to which it is difficult to assign a limited meaning without incurring the risk of confusion; but general usage has so constantly applied the term Rhætia to the mountain region of Switzerland lying east of the Rhine, with the adjoining portion of Tyrol, that it seems best to preserve the ancient name while endeavouring to restrict it within juster limits. With that object it is necessary to take account of one of the most remarkable features in the orography of the Alps—the great breach in the continuity of the main chain shown in the upper valley of the Adige. On a general view of western Tyrol it is apparent that the lakes which feed the head of that stream lie on the northern side of the axis of elevation of the main chain, and in fact several streams draining the northern slopes of the central mass are borne southward to the Adriatic through that opening. This is not the place to take into consideration the important influence that this breach in the line of defence between Italy and the north, and the equally deep opening of the Brenner Pass at the head of the other main branch of the Adige, has had on the history of Europe, nor to discuss the geological significance of the same depression throughout an incalculably longer period; but it is sufficiently clear that this should be taken as the eastern limit of the group to which the term Rhætian Alps most properly applies. On the west the limit, as we have already seen, is marked by the valley of the Rhine, and the line of depression over which the Splügen road is carried to the head of the lake of Como. In the space between these boundaries the chief mountains of the Rhætian Alps appear as islands of crystalline rock, divided by intervening masses of palæozoic and older secondary strata; but on the south side lies a district which differs considerably in geological structure, and is cut off by a distinct orographic boundary. A straight line drawn from the head of the lake of Como to Cles in Tyrol, will throughout lie close to a trench formed by the valley of the Adda, the low pass of Aprica, the head of Val Camonica, the Tonale Pass, and the Tyrolese Val di Sole. On the south side of this trench, and parallel to it, extend in succession a broad band of palæozoic rock and a still broader zone of trias, bordered on the southern slope by a narrow girdle of jurassic rocks which decline towards the plain of Lombardy. Towards the east these are interrupted by a great mass of very peculiar granite, the most considerable tract of true granite to be found in the Alps. Beyond this the ridges and valleys no longer preserve the direction from east to west, but become parallel to the lake of Garda and the valley of the Adige. The district thus limited is enumerated hereafter as a distinct division under the designation *Lombard Alps*, the boundary between this and the Rhætian division being the trench above described, which is prolonged from near Cles over the low Gampen Pass to the neighbourhood of Meran. On the northern side the Rhætian Alps are divided from the Vindelician by a well-marked trench closely corresponding with the northern limit of the crystalline rocks of the Silvretta group, formed by the valley of the Ill, the Vorarlberg Pass, and the course of the Rosanna. Within the limits here assigned the Rhætian Alps occupy an area measuring about 80 miles by 60. The entire mass is divided into two nearly equal portions by the upper valley of the Inn, known in Switzerland as the Engadine.

Chief Peaks of the Rhætian Alps.

Piz d'Emet	10,502	Ofen Wand	11,558
Pizzo Stella	10,266	Venezia Spitze	11,095
Pizzo della Duana	10,279	Hasenohr	10,673
Piz Margna	10,355	Pallon della Mare	12,038
Piz Güz	11,066	Tresero	11,636
Piz Tremoggia	11,326	Monte Confinale	11,076
Piz Roseg	12,936	Monte Sobretta	about 11,000
Piz Bernina	13,294	Piz Curver	9,761
Piz Cambrena	11,835	Piz Starlera	10,001
Punta Trubinesca	11,106	Piz Platta	11,109
Cima del Largo	11,162	Gravasalvas (Piz Lungen)	10,421
Monte della Disgrazia	12,074	Piz d'Aela	10,893
Pizzo di Verona	11,358	Piz d'Err	11,139
Corno di Campo	10,843	Cima da Flix	10,947
Monte Foscagno	10,148	Piz Munteratsch	11,106
Piz Languard	10,715	Piz Ott	10,660
Piz Quatervals	10,359	Piz Uertsch	10,738
Piz Murterol	10,424	Piz Kesch	11,211
Pizzo di Sena	10,099	Piz Vadred	10,610
Corno di Dosdè	10,597	Schöne Bleise	9,794
Piz Pisoch	10,427	Scesa Plana	9,738
Piz Scesvenna	10,568	Blankahorn	10,382
Piz Umbrail	9,954	Piz Linard	11,208
Monte Cristallo	11,370	Fluchthorn	11,142
Orteler Spitze	12,814	Muttler	10,824
Königs Spitze	12,646	Piz Mondin	10,377
Monte Cevedale	12,505	Vesulspitz	10,154
Pederspitz (highest peak)	11,349		

Chief Passes in the Rhætian Alps.

Passo di Madesimo (Campo Dolcino to Avers Thal), footpath	7,480
Passo della Duana (Casaccia to Avers Thal), glacier	8,720
Septimer Psss (Casaccia to Molins), bridle-path	7,582
Maloya Pass (Casaccia to Silvaplana), carriage road	5,942
Passo di Zocca (Casaccia to Val Masino), glacier	8,957
Muretto Pass (Casaccia to Sondrio), snow	8,616
Bernina Pass (Pontresina to Poschiavo), carriage road	7,658
Passo di Canciano (Chiesa to Poschiavo), footpath	8,366
Lavirum Pass (Ponte to Val Livigno), snow	9,249
Passo di Val Viola (Poschiavo to Bormio), footpath	about 7,900
Foscagno Pass (Bormio to Zernetz), bridle-path	6,329
Ofen Pass (Zernetz to Santa Maria), carriage road	7,070
Umbrail Pass (Bormio to Santa Maria), footpath	8,342
Stelvio Pass (Bormio to Prad), carriage road	9,213
Passo Cevedale (Sta. Catarina to Latsch), glacier	10,765
Passo di Vios (Sta. Catarina to Pejo), glacier	10,868
Passo di Sforzellina (Val Gavia to Pejo), glacier	9,950
Gavia Pass (Sta. Catarina to Val Camonica), bridle-path	about 8,600
Hohenferner Joch (Martell Thal to Val della Mare), glacier	9,904
Saënt Pass (Martell Thal to Rabbi), glacier	9,954
Kirchberger Joch (Ulten Thal to Rabbi), footpath	8,134
Julier Pass (Molins to Silvaplana), carriage road	7,503
Albula Pass (Bergün to Ponte), carriage road	7,589
Sertig Pass (Scanfs to Bergün), footpath	9,062
Strela Pass (Coire to Davos), bridle-path	7,739
Laret Pass (Bergün to Klosters), carriage road	5,338
Scaletta Pass (Davos to Scanfs), snow	8,613
Fluëla Pass (Davos to Süs), carriage road	7,891
Vereina Pass (Klosters to Süs), footpath	8,133
Silvretta Pass (Klosters to Guarda), glacier	9,928
Cavell Joch (Bludenz to Seewis), footpath	7,562
Schweizerthor (Vadans to Schiersch), footpath	7,120
Drusenthor (Schruns to Schiersch), footpath	7,822
Schlappiner Joch (St Gallenkirch to Klosters), bridle-path (?)	7,185
Fermunt Pass (Pattenen to Guarda), glacier	9,206
Bieler Joch (Montafun to Paznaun Thal), bridle-path	about 6,000
Fimber Joch (Ischgl to Remüs), snow	8,547
Vignitz Pass (Kappel to Samnaunthal), snow	8,855

10. *Lombard Alps.*—The limits of the Lombard Alps have been already pointed out. They are enclosed on the east and west sides by the Adige and the lake of Como, extending through about 90 miles from near Meran to Lecco. Their northern boundary is the great orographic trough that stretches from the head of the lake of Como along the valley of the Adda to Tresenda, thence by the low Aprica Pass to the upper Val Camonica, and over the Tonale Pass to the Val di Sole. Where that valley bends abruptly to SSE., the trough still keeps its original direction across the Gampen Pass, to the right bank of the Adige below Meran. In spite of the zeal with which

travellers have of late years explored the unfrequented parts of the Alps, this group continues to be very imperfectly known, although it offers abundant attractions to the naturalist and the lover of picturesque and grand scenery.

Chief Peaks of the Lombard Alps.

Legnone	8,568	Crozzon di Laris	10,889
Pizzo dei Tre Signori, about	8,600	Monte Adamello	11,832
Grigna (Monte Codeno)	7,908	Carè Alto	11,352
Corno Stella	8,845	Presanella, or Cima di Nardis	11,688
Aralalta	6,585	Cima delle Rochette	10,777
Monte Arera	8,255	Brenta Alta (?)	10,771
Monte Redorta	9,980	Monte Baldo (highest peak—La Colma)	7,212
Pizzo del Diavolo	9,574	Mendola (Monte Roen)	6,919
Pizzo di Cocca	9,705	Monte Bondone	7,412
Monte Presolana	8,202		
Monte Frerone	8,676		
Monte Blumone	9,321		

Chief Passes in the Lombard Alps.

Passo di San Marco (Morbegno to Val Brembana), bridle-path	5,997
Passo del Salto (Sondrio to Val Seriana), footpath about	7,500
Presolana Pass (Castione to Val di Scalve), footpath	4,265
Aprica Pass (Sondrio to Edolo), carriage road	4,052
Tonale Pass (Edolo to Val di Sole), carriage road	6,483
Gampen Pass (Cles to Meran), bridle-path about	4,000
Croce Domini Pass (Breno to Lodron), bridle-path about	6,500
Passo di S. Valentino (Val di Fum to Tione), snow about	9,300
Passo del Lago Ghiacciato (Ponte di Legno to Pinzolo), snow	9,437
Passo di Lares (Pinzolo to Val di Fum), glacier	9,230
Ginevrie Pass (Pinzolo to Val di Non), bridle-path	5,200
Bocca di Brenta (Pinzolo to Molveno), snow	8,502
Mendelscharte (Cles to Botzen), bridle-path	4,964

11. *Vindelician Alps.*—Reference has already been made to the contrast offered by the orderly arrangement of the Eastern Alps, as compared with the far more complicated and irregular disposition of the masses that make up the Western and Central Alps. In the former we have a broad zone of crystalline or metamorphic palæozoic rocks, extending from the upper valley of the Adige to the frontier of Hungary, flanked on either side by a parallel zone of secondary rocks, which rise into peaks that do not much exceed the limit of perpetual snow. The northern zone extends for a distance of fully 260 miles from the lake of Constance to the neighbourhood of Vienna, with an average width varying from 30 to 40 miles. For the greater part of that distance this is separated from the central range by broad and deep valleys, through which the Inn, Salza, and Enns flow from west to east, till each of them, turning abruptly northward, runs through an opening that cuts across the general strike of the stratification to reach the plain of South Germany. In geological structure and general aspect the mountains of this tract show many common characteristics, and convenience supplies the only good reason for dividing it into two main groups, separated by the valley of the Inn, the greatest of the tributaries which the Alps send to the Danube. Of the western portion of this region the larger part belongs to Bavaria, but a considerable share lies in the Austrian provinces of Tyrol and Vorarlberg; and on this account the designations *Bavarian Alps* and *North Tyrol Alps* are open to objection, and have the further disadvantage of excluding the Alpine districts of Bavaria and North Tyrol lying east of the Inn. The name *Suabian* Alps is liable to the serious objection that none but a very small part of this district was ever included in the circle of Suabia. On the whole, it seems that the region lying north of the Vorarlberg road and the valley of the Inn, between the lake of Constance and the latter river, may best be termed the Vindelician Alps. The whole was included within the territory of the *Vindelici* before that powerful tribe was conquered by the Romans, and their territory joined to that of the Rhætians to form a single Roman province. In height the mountains of this division fall considerably short of those hitherto enumerated, not more than four or five exceeding 9000 feet. It is impossible to consider a map of this region without being struck by the fact, that although the general slope inclines northward towards the plain of Bavaria, or southward towards the Ill and the Inn, nearly all the ridges and minor valleys lie east and west parallel to the course of those rivers and to the outcrop of the sedimentary strata, which is equally the direction of the line of depression followed by the Vorarlberg road forming the southern boundary of this group.

Chief Peaks of the Vindelician Alps.

Mittagspitz	6,851	Miemingergebirge (highest)	8.856
Rothewand	8,842	Karwändlspitz	8,259
Schafberg	8,774	Kreuzspitz	7,156
Mädelegabel	8,674	Solstein	8,649
Biberkopf	8,543	Edkorspitz	8,911
Widderstein	8,294	Lavatscherspitz	9.081
Hoch Vogel	8,501	Vomperjoch	7,505
Stanzerkopf	9,041	Soiernspitz	7,303
Muttekopf	9,077	Juifen	7,144
Zugspitz	9,716		

Chief Passes in the Vindelician Alps.

Arlberg Pass (Bludenz to Landeck), carriage road	5,902
Haldenwanger Eck (Schrecken to Oberstdorf), footpath	6,070
Schrofen Pass (Oberstdorf to Steg in Lechthal), bridle-path	5,569
Mädelejoch (Oberstdorf to Holzgau), footpath about	7,000
Kaiserjoch (Steg to Petneu in Stanzerthal), footpath about	7,000
Zamserjoch (Elbigen Alp to Landeck or Imst), footpath about	7,000
Fern Pass (Lermoos to Telfs), carriage road	4,063
Seefeld Pass (Partenkirch to Zirl), carriage road	3,900
Geissel Pass (Mittenwald to Lermoos), footpath	4,258
Stempeljoch (Scharnitz to Hall), footpath	7,346
Haller Anger (Scharnitz to Schwaz), footpath	5,835
Plumserjoch (Hinter-Riss to Pertisau), bridle-path	5,492
Pfans Joch (Fall to Pertisau), footpath about	5,800
Stockeralp Pass (Schliersee to Brixlegg), bridle-path about	4,000
Hörhag Pass (Bairisch-zell to Kufstein), bridle-path about	4,000

12. *Northern Noric Alps.*—We have already spoken of the broad mountain zone extending from the Inn to the neighbourhood of Vienna, and bearing a general resemblance in orographic and geological character to the group last described. For reasons given hereafter, it seems impossible to preserve the ancient designation *Noric Alps* for any portion of the central chain of the Eastern Alps, but the name *Northern Noric Alps* seems the most suitable for a region which was altogether included in the Roman province of *Noricum*, and which closely coincides with the northern half of the Alpine district known to them as *Alpes Noricæ*. The boundaries of this division are easily determined. To the north and east the mountains subside towards the valley of the Danube. To the west it is bounded by the Inn, which bends first to north-east, then to north, to enter the plain of Bavaria. On the south side the boundary runs from the Inn through a part of the Zillerthal, over the low Gerlos Pass, and along the valleys of the Salza and the Enns, evidently forming a single line of depression; but where the Enns enters the defile of Gesaüse, a broad and low valley, through which runs the road from Rottenmann to Leoben, seems to form the most natural division between this and the central chain. The line of separation is completed by the valley of the Mur and the depression of the Semmering Pass, over which the railroad is carried to Vienna. The highest peaks of the Dachstein group form the most considerable prominence in the entire range of the Northern Alps; but the average height of the mountains of this division does not exceed that of the Vindelician Alps.

Chief Peaks of the Northern Noric Alps.

Thorhelm	8,548	Thorstein	9,677
Hohe Salve	5,993	Dachstein	9,845
Rettenstein	7,750	Sarstein	6,558
Scheffauer Kaiser	7,611	Grimming	7,700
Birnhorn	8,635	Grosser Priel	8,238
Staufen	5,950	Waschenegg	8,112
Watzmann	8,988	Buchstein	7,269
Untersberg (highest point)	6,467	Hochthor	7,478
Hohe Göll	8,266	Eisenerzer Reichenstein	7,082
Hochkalter	8,595	Kaiserschild	6,817
Uebergossene Alp or Hochkönig	9,643	Oetscher	6,320
Tannengebirge (Raucheck)	7,947	Brandstein	6,542
Schafberg	5,837	Hochschwab	7,441
Höllkogl	5,754	Raxalp	6,575
Traunstein	5,538	Schneeberg	6,809

Chief Passes in the Northern Noric Alps.

Gerlos Pass (Jenbach to Mittersill), bridle-path	4,717
Pass Thurn (Kitzbühel to Mittersill), carriage road	4,371
Salza Joch (Kelschau to Wald), footpath	6,533
Waidring Pass (St Johann to Lofer), carriage road	2,518
Hochfilzen Pass (St Johann to Saalfelden), bridle-path ......about	3,200
Schwarzbachwacht (Reichenhall to Ramsau), carriage road	2,907
Hirschübel Pass (Berchtesgaden to Saalfelden), carriage road	3,896
Diesbach Scharte (Königssee to Frohnwies), footpath	6,679
Weissbach Scharte (Königssee to Saalfelden), footpath	7,462
Torrener Joch (Berchtesgaden to Golling), footpath	5,697
Urschlauerscharte (Werfen to Saalfelden), footpath	6,889
Filzen Sattel (Saalfelden to Lend), bridle-path	3,953
Wagram Sattel (St Johann im Pongau to Radstadt), carriage road	2,933
Pass Gschütt (Abtenau to Gosau), carriage road	3,247
Pyrhn Pass (Windischgarsten to Lietzen), carriage road	3,162
Prebichel Pass (Eisenerz to Leoben), carriage road	4,014
Eisenerzer Höhe (Eisenerz to Wildalpen), bridle-track	4,760
Kastenriegel Pass (Weichselboden to Wegscheid), bridle-path	3,556
Seeberg Pass (Mariazell to Aflenz), carriage road	4,099
Niederalpl (Mariazell to Mürzsteg), carriage road	3,994
Semmering Pass (Bruck-an-der-Mur to Wiener Neustadt), c. rd.	3,256

13. *Central Tyrol Alps.*—To the eye of the geologist, taking a cursory view of the Eastern Alps, it may appear that the great central zone, extending from the upper valley of the Adige eastward to the neighbourhood of Gratz, forms but a single district of tolerably uniform structure. He will, however, remark that about the centre of the range the prevailing crystalline rocks—gneiss and mica-schist—give place to metamorphic schists, probably of palæozoic age, that rise into several of the highest peaks of the entire mass. Those who are disposed to regard the above-named crystalline rocks as merely extreme forms of metamorphic sedimentary strata, may not attach much importance to this circumstance; but it is a still more significant fact that at a short distance east of the same extension of the metamorphic rocks we have proof of the former existence of a depression which seems to have cut completely through the central range. On the north side triassic rocks extend from the Enns to the upper valley of the Mur, and the presence of miocene deposits at several points in the latter valley, the Lieserthal and the Maltathal, seems to show that at a much later period this portion of the chain underwent great relative depression as compared with those on either side. Another and more obvious character that distinguishes the western from the eastern portion of the central zone, is the fact that in the latter the great range that extends like a vertebral column from the Weisskugel to the Hochalpenspitz forks into two branches of inferior height, that enclose between them the upper valley of the Mur. Ancient geographers divided the main mass of the Alps between the Bernardine Pass and the frontier of Hungary into two vast divisions, respectively called the Rhætian and Noric Alps, placing the boundary between these at or about the Dreiherrnspitz, at the head of the Ahrenthal, and their example has been followed by some modern geographers. Nothing in the form or structure of the chain justifies the adoption of that arbitrary boundary between two main divisions of the Alps. We have already assigned reasons for fixing the western boundary of the Rhætian Alps at the upper valley of the Adige, and we propose to retain the designation Central Tyrol Alps for the portion of the main chain extending thence to the head of the Malta Thal in Carinthia, nearly the whole of which lies within the limits of Tyrol. The exact boundaries of this division are, on the north, the course of the Inn from Landeck to the opening of the Zillerthal, the track thence over the Gerlos Pass to the head of the Pinzgau, and the valley of the Salza to the opening of the Gross Arl Thal; to the east, the way through the latter valley, over the Arlscharte, through the Malta Thal to Gmünd, and the road thence to Villach; on the south, the continuous trough extending from near the latter town to Mühlwald, on the Reinz, through the Gail Thal, the Lessach Thal, the head of the Drauthal and the upper valley of the Rienz. From Mühlwald the tortuous course of the Eisack forms the boundary as far as Botzen, whence the high road running N.W. along the Adige and though the Finstermünz completes the western boundary. Although the region thus limited does not present many prominent peaks, it is remarkable for the great average height of the main chain which forms the watershed between the affluents of the Danube on one side, and those of the Adige and the Drave on the other. In a distance of 120 miles—which would be much increased if measured along the sinuosities of the main chain—there is but a single low pass, that of the Brenner, none other being below 8000 feet in height, or suited for the construction of a carriage road. The Brenner is the lowest pass in the entire range of the Alps, and has from a remote period afforded the easiest access from middle Europe to the plains of northern Italy, but is properly described as a pass rather than as a breach in the continuity of the chain.

Chief Peaks of the Central Tyrol Alps.

Karls-spitz	10,253	Löffelspitz	11,108
Glockenthurm	10,998	Reichenspitz	10,866
Portles-spitz	10,066	Wildgerlos-spitz	10,771
Rems-spitz	10,511	Eidechsberg, or Hegedex	8,975
Blickspitz	11,045	Dreiherrnspitz	11,494
Weiskugel	12,277	Rödtspitz	11,459
Wildspitz	12,390	Gross Dürreck	10,325
Anichspitz	11,654	Gross Venediger	12,053
Similaun	11,810	Hohe Fürleg	11,114
Rothbergspitz (The "Röthenspitz" of Sonklar)	11,904	Lasörling	10,171
Texelspitz	10,890	Hochgall, or Rieser	11,284
Birkkogel	9,281	Schneebige Nock, or Ruthnerhorn	11,068
Grieskogel (highest peak)	10,638	Tauernkogel	9,790
Ruderhofspitz	11,393	Kitzsteinhorn	10,482
Schrankogl	11,474	Johannisberg	11,425
Serles-spitz, or Waldrasterspitz	8,898	Gross Glockner	12,405
Schaufelspitz	10,924	Hoch Schober	10,628
Wilder Pfaff (Zuckerhütl)	11,512	Petzeck	10,761
Sonklarspitz	11,410	Vischbachhorn	11,738
Habicht	10,746	Fuscherkahrkopf	10,957
Sarner Scharte	8,255	Hochnarr	10,692
Rittnerhorn	8,064	Ankogl	10,674
Glungetzer	8,781	Hochalpenspitz	11,026
Gilfertsberg	8,201	Säuleck	10,108
Olperer Fuss-stein	11,451	Kreuzkofel	8,979
Hochfeiler	11,535	Dobratch, or Villacher Alp	7,067

Chief Passes of the Central Tyrol Alps.

Reschen Scheideck (Landeck to Meran), carriage road	4,596
Weisse See Joch (Glurns to Kaunser Thal), glacier	9,657
Langtauferer Joch (Mallag to Fend), glacier	10,335
Hoch Joch (Fend to Kurzras), glacier	9,515
Nieder Joch (Fend to Obervernagt), glacier	9,847
Gebatsch Joch (Fend to Kaunser Thal), glacier ......about	10,800
Timbler Joch (Oetzthal to Meran), bridle-path	8,298
Langthaler Joch (Gurgl to Pfelders Thal), glacier	9,939
Gruben Joch (Pfelders to Schnalser Thal), glacier	9,548
Gurgl Joch (Gurgl to Schnalser Thal), glacier	9,956
Pitzthaler Jöchl (Pitzthal to Sölden), glacier	9,806
Jaufen Pass (Meran to Sterzing), bridle-path	6,872
Penser Joch (Botzen to Sterzing), footpath	7,040
Gries Joch (Selrain to Lengenfeld), snow	8,652
Mutterberger Joch (Neustift to Lengenfeld), glacier	9,893
Bildstöckl Pass (Neustift to Sölden), glacier	10,294
Grub Joch (Pfiersch to Oberbergthal), footpath	7,021
Brenner Pass (Innsbruck to Sterzing), carriage road	4,588
Pfitscher Joch (Sterzing to Mayrhofen), bridle-path	7,297
Tuxer Joch (Stafflach to Lanersbach), footpath	7,618
Lappacher Joch (Lappach to Ahrenthal), footpath	7,763
Hörndl Joch (Mayrhofen to Steinhaus), snow	8,368
Heiligengeist Jöchl (Mayrhofen to Kasern), footpath	8,309
Krimmler Tauern (Krimml to Kasern), snow	9,071
Dorfer Sulzbach Thörl (Pregratten to Wald), glacier	9,438
Velber Tauern (Windisch Matrey to Mittersill), footpath	8,024
Vorder Umbal Thörl (Pregratten to Kasern), glacier	9,723
Troyer Thörl (Pregratten to Defereggen), snow	4,845
Mulitz Thörl (Virgen to Defereggen), snow	8,911
Klamml Joch (Defereggen to Taufers), footpath	7,606
Staller Sattel (Defereggen to Antholz), bridle-path	6,738
Gsiesser Joch (Defereggen to Gsiess), footpath	7,353
Kalser Tauern (Kals to Uttendorf), snow	8,410
Kapruner Thörl (Stubachthal to Kaprun), glacier	8,740
Riffelthor (Kaprun to Heiligenblut), glacier	9,958
Pfandelscharte (Ferleiten to Heiligenblut), glacier	8,817
Fuscher Thörl (Ferleiten to Seidelwinkelthal), footpath	7,998
Hoch Thor (Bucheben to Heiligenblut), footpath	8,551
Berger Thörl (Kals to Heiligenblut), footpath	7,971

Auf der Stanz (Buoneben to Gastein), bridle-path	6,920
Tramerscharte (Rauris to Döllach), glacier	8,391
Klein Zirknitzscharte (Rauris to Fragant), snow	8,855
Mallnitzer Tauern (Gastein to Mallnitz), bridle-path	8,038
Arlscharte (St Johann in Pongau to Gmünd), footpath	7,499
Klein Elendscharte (Gastein to Gmünd), glacier	8,231
Dössner Scharte (Gmünd to Ober Vellach), snow	8,748
Toblacher Feld (Bruneck to Lienz), carriage road	3,951
Zochen Pass (Lienz to Maria Lukau), footpath	7,394
Kötschach Sattel (Oberdrauburg to Kötschach), carriage road	3,210

14. *Styrian Alps.*—The boundary between the central range of lofty peaks that extends through Tyrol and the adjacent province of Salzburg, and the much lower masses that spread eastward through Styria to the frontier of Hungary, has been already fixed at the Arlscharte. On the east side of that pass the mass whose conspicuous summits are the Markkahrspitz and the Hafnereck is divided into two parallel branches that enclose between them the upper valley of the Mur. The northernmost of these ranges is cut through by the broad and deep valley, traversed by the road that leads from Liesing on the Enns to Leoben, which we have regarded as the limit between the Northern Noric Alps and the central mass. The eastern boundary of this division, which we at the same time regard as the proper limit of the Alps, is marked by the river Mur, which, after flowing eastward for about 100 miles to Bruck-an-der-Mur, turns southward, and finally joins the Drave in Hungary. The eastern limit of the Alps is completed by the depression between Spielfeld and Marburg, over which is carried the railway from Vienna to Trieste. The southern boundary of the central range is unmistakably marked by the great valley of the Drave. The whole of this region was, along with large portions of the adjoining divisions, included under the term Noric Alps by ancient geographers; but as the retention of that designation can only lead to confusion, we readily adopt the name *Styrian Alps*, proposed by Karl v. Sonklar, whose writings have done so much to increase our knowledge of the Eastern Alps. It must, however, be remarked that the region above defined also includes a considerable district of Carinthia, along with a small part of the province of Salzburg, which extends to the head of the valley of the Mur. Excepting the comparatively high mass in which that river takes its source, the summits of this region do not attain nearly so great a height as those of the other main divisions of the Alps, and only two or three reach the limit of perpetual snow.

Chief Peaks of the Styrian Alps.

Markkahrspitz	9,245	Eisenhut	8,008
Hafnereck	10,044	Wöllaner Nock	7,019
Faschauner Nock	9,130	Sirbitzkogel	7,863
Hoch Golling	9,383	Sau Alp	6,800
Predigtstuhl	8,834	Kor Alp	7,010
Knallstein	8,511	Rappenkogel	6,310
Bösenstein	8,018	Obdacher Speikkogel	6,625
Hoch Reichart	7,900	Gleinalpen Speikkogel	6,508
Königstuhl	7,648		

Chief Passes in the Styrian Alps.

Radstädter Tauern (Radstadt to St Michael), carriage road	5,703
Katschberg (St Michael to Gmünd), carriage road	5,261
Windsfeld (Flachau to Zederhaus), footpath	7,037
Waldhornthörl (Schladming to Tamsweg), footpath	7,437
Sölkerscharte (Gröbming to Murau), bridle-path	5,767
Rottenmanner Tauern (Rottenmann to Judenburg), c. road...about	4,900
Turrach Pass (Feldkirchen to Tamsweg), carriage road	5,825
Fladnitz Pass (Friesach to Stadl), bridle-path...about	5,000
Perchauer Pass (Friesach to Scheifling), carriage road	3,274
Obdacher Sattel (Wolfsberg to Judenburg), carriage road	3,174
Stubalp Pass (Köflach to Weisskirchen), carriage road	5,130
Die Pack (Köflach to Wolfsberg), carriage road	3,870
Gleinalp Pass (Peggau to Knittelfeld), footpath...about	5,500

15. *South Tyrol and Venetian Alps.*—It has been seen that the mountain zone on the northern side of the main range of Tyrol extends from the lake of Constance to near Vienna, with a remarkable uniformity both of general aspect and of geological structure, so that no reason much more valid than convenience could be assigned for forming it into two separate divisions. The same remark does not hold good on the southern side of the main range. There is, indeed, a general similarity between the northern and southern zones, especially in their geological structure, so far as regards the sedimentary rocks; but in the western portion of the latter—in the region lying between the Adige and the sources of the Piave—the intrusion of igneous rocks on a large scale, and the accumulation of deposits formed from ejected volcanic matter, have profoundly modified the structure and outward aspect of the country. Nowhere else in the Alps do the peaks rise so abruptly and with so little apparent connection, and nowhere are the contrasts depending on differences of geological structure so marked as those which strike the mere passing traveller, when, beside rounded masses of red and black porphyry, he sees white and pink crystalline dolomite limestone rising in towers and pinnacles of extraordinary height and steepness. Dolomite limestone is found in many other parts of the Alps, but nowhere else is it developed on so grand a scale, and the exquisite beauty of this region has of late years led an increasing number of travellers to spots that before were scarcely known even to the inhabitants of adjoining valleys. Though there are abundant grounds for regarding the district here spoken of as a separate division of the Alps, it is very difficult to assign to it a satisfactory designation. The larger portion of the region has long been politically connected with Tyrol, and is partly inhabited by a German-speaking population, while the remainder has been politically connected with Venice, and the inhabitants are thoroughly Italian in language and manners. Were it not for a reluctance to introduce new and unfamiliar terms, the present division might be denominated *Cimbric Alps*, as, according to ancient tradition, the Cimbri, after their final defeat by Marius, sought and found a refuge in this part of the Alps; but for the present it seems best to designate as *South Tyrol and Venetian Alps* the region lying between the valley of the Adige and the sources of the Drave and the Piave, and south of the great valley traversed by the Eisack and the Rienz between Botzen and Innichen. The eastern limit may best be fixed by the track leading through the Sextenthal from Innichen to San Stefano in the head valley of the Piave, and by the road from that place to Conegliano.

Chief Peaks of the South Tyrol and Venetian Alps.

Schlern	8,405	Cima delle Dodici	7,651
Rosengarten	10,163	Cima d'Asta	9,132
Langkofel	10,392	Monte Pavione, or Col di Luna	7,877
Marmolata (?)	11,045	Palle di S. Martino (?)	10,643
Monte Tofana	10,724	Cimon della Pala ...about	11,000
Croda Rossa, or Hohe Gaisl	10,262	Monte Civetta	10,440
Monte Cristallo	10,644	Pelmo	10,377
Drei Zinnen, or Cima di Lavaredo ...above	10,300	Sorapis	10,798
Dreischusterspitz	10,368	Antelao	10,679
Cima di Posta	7,547	Marmarolo ...above	10,000
Covelalto ...about	7,500		

Chief Passes in the South Tyrol and Venetian Alps.

Piano delle Fugazze (Roveredo to Schio), carriage road	4,117
Passo di Manazzo (Asiago to Levico), bridle-path	4,662
Caressa Pass (Botzen to Vigo di Fassa), bridle-path	5,966
Mahlknecht Pass (Völs to Campidello), bridle-path	7,016
Fedaya Pass (Val di Fassa to Caprile), footpath	6,884
La Costonzella (Paneveggio to Primiero), carriage road	6,657
Passo di Valles (Paneveggio to Cencenighe), bridle-path	6,877
Grödner Joch (St Ulrich to Bruneck), bridle-path	7,042
Campolungo (Corfara to Araba), bridle-path	6,200
Pordoi Pass (Gries to Araba), bridle-path	7,396
Passo dei Tre Sassi (Andraz to Cortina), carriage road	7,073
Monte Giau, or P. di Falzarego (Caprile to Cortina), bridle-path	7,511
Peutelstein Pass (Niederndorf to Cortina), carriage road...about	5,000
Passo delle Tre Croci (Cortina to Auronzo), bridle-path	5,970
Forcella Grande (Auronzo to San Vito), footpath	7,536
Kreuzberg (Innichen to S. Stephano), carriage road	5,361

16. *South-Eastern Alps.*—Ancient geographers, and those who have followed their example, use the terms Carnic Alps and Julian Alps to designate two of the main divisions of the Alps; but the latter of these at least has

been applied in a vague and inconsistent way. In point of fact, the south-eastern portion of the Alps, which includes both the groups above specified, presents three principal groups which are very closely connected together. The first of these—the Carnic Alps, properly so called—have been defined as including the region between the upper valley of the Drave and the plain of Friuli. But to the orographer the true head of the Drave valley is the Gailthal, which extends in an almost straight and broad trench from near Innichen to Villach, while the main stream flows through a sinuous and contracted valley. For this reason we have taken the Gailthal as the boundary between the Central Tyrol and the Carnic Alps. Almost continuous with the Carnic Alps is a range, very similar in geological structure, which divides the Drave from the northern branch of the Save, and includes the mountains locally known as the Karawankas and the Sulzbacher Alps. Throughout these, which may be called the main range of the South-Eastern Alps, palæozoic rocks, probably of carboniferous age, extend in a narrow band for a distance of fully 100 miles, giving place at the eastern extremity to the small granitic mass that forms the hills of the Bacher Gebirge near Marburg. On the south side of the main range of the Carnic Alps two mountain masses, mainly formed of triassic rocks and Dachstein limestone, attain a considerable height in the Monte Cavallo on the west, and the Monte Canin on the east side of Friuli. In a similar position as regards the Karawankas is a still loftier mass which is crowned by the Terglou—the highest peak of the South-Eastern Alps. This group is referred by geographers to the Julian Alps, which are said to divide the Save and its tributaries from the Adriatic. As has been already said, there is no range to which the term Alps can properly be applied forming such a boundary. The plateau of the Karst, though rising here and there into hills of moderate height, has an average elevation of about 2000 feet above the sea, and cannot correctly be spoken of as a mountain chain. The orographer, if seeking an eastern prolongation to the Terglou group, would prefer the hilly region between the Save and the southern Gurk; but the low country through which the railway is carried from Marburg to Laybach, and the road thence to Gorizia, may for all practical purposes be taken as the south-eastern limit of the Alps and of the division here described.

Chief Peaks of the South-Eastern Alps.

Monte Paralba	9,097	Ovir	.,001
Kellerwand ....about	9,500	Grintouz	8,386
Monte Cridola	8,474	Oistritza	7,701
Monte Premaggiore	8,127	Bacher Gebirge (Velka Kappa)	5,041
Monte Cavallo	7,377	Mangart	8,776
Monte Crostis	7,384	Terglou	9,371
Jof di Montasio ....about	9,000	Krn	7,358
Monte Canin (Prestrelenick)	8,711	Kuk	6,829
Stou	7,326		
Koschutta	6,895		

Chief Passes of the South-Eastern Alps.

Kartischer Joch (Sillian to Tilliach), carriage road	5,363
Passo di Mauria (Ampezzo to Pieve di Cadore), carriage road	4,191
Piano di Sappada (San Stefano to Forno Avoltri), car. road, about	4,100
Giogo Veranis (Forno Avoltri to Lorenzen), footpath	7,521
Wolaver Joch (Forno Avoltri to Kötschach), footpath	6,563
Monte Croce (Tolmezzo to Kötschach), bridle-path	4,337
Nosfeld Pass (Pontebba to Hermagor), footpath.....about	5,000
Saifnitz Pass (Pontebba to Tarvis), carriage road	2,682
Predil Pass (Tarvis to Flitsch), carriage road	3,822
Wurzener Berg (Villach to Wurzen), carriage road	3,497
Loibl Pass (Neumarktl to Unterbergen), carriage road	4,445
Seeberg Pass (Krainburg to Kappel), carriage road	3,976
St Leonhard Sattel (Kappel to Sulzbach), bridle-path	4,666
Schkaria Pass (Sulzbach to Stein), footpath	6,198
Worschez Sattel (Flitsch to Kronau), footpath	5,254
Kerma Pass (Moistrana to Feistritz), footpath	6,332
Skarbinja Joch (Tolmino to Feistritz), footpath.....about	6,000

Climate of the Alps. It is well known that as we rise from the sea-level into the upper regions of the atmosphere the temperature decreases. The effect of mountain chains on prevailing winds is to carry warm air belonging to the lower region into an upper zone, where it expands in volume at the cost of a proportionate loss of heat, often accompanied by the precipitation of moisture in the form of snow or rain. The position of the Alps about the centre of the European continent has profoundly modified the climate of all the surrounding regions. The accumulation of vast masses of snow, which have gradually been converted into permanent glaciers, maintains a gradation of very different climates within the narrow space that intervenes between the foot of the mountains and their upper ridges; it cools the breezes that are wafted to the plains on either side, but its most important function is to regulate the water supply of that large region which is traversed by the streams of the Alps. Nearly all the moisture that is precipitated during six or seven months is stored up in the form of snow, and gradually diffused in the course of the succeeding summer; and even in the hottest and driest seasons the reserves accumulated during a long preceding period of years in the form of glaciers are available to maintain the regular flow of the greater streams. Nor is this all; the lakes that fill several of the main valleys on the southern side of the Alps are somewhat above the level of the plains of Lombardy and Venetia, and afford an inexhaustible supply, which, from a remote period, has been used for that system of irrigation to which they owe their proverbial fertility. Six regions or zones, which are best distinguished by their characteristic vegetation, are found in the Alps. It has been a common error to suppose that these are indicated by absolute height above the sea-level. Local conditions of exposure to the sun, protection from cold winds, or the reverse, are of primary importance in determining the climate and the corresponding vegetation.

Zones of Vegetation. 1. *Olive Region.*—The great plain of Upper Italy has a winter climate colder than that of the British Islands. The olive and the characteristic shrubs of the northern coasts of the Mediterranean do not thrive in the open air, but the former valuable tree ripens its fruit in sheltered places at the foot of the mountains, and penetrates along the deeper valleys and the shores of the Italian lakes. The evergreen oak is wild on the rocks about the lake of Garda; and lemons are cultivated on a large scale, with partial protection in winter. The olive has been known to survive severe cold when of short duration, but it cannot be cultivated with success where frosts are prolonged, or where the mean winter temperature falls below 42° Fahr.; and to produce fruit it requires a heat of at least 75° Fahr. during the day, continued through four or five months of the summer and autumn.

2. *Vine Region.*—The vine is far more tolerant of cold than the olive, but to produce tolerable wine it demands, at the season of ripening, a degree of heat not much less than that needed by the more delicate tree. These conditions are satisfied in the deeper valleys of the Alps, even in the interior of the chain, and up to a considerable height on slopes exposed to the sun. The protection afforded by winter snow enables the plant to resist severe and prolonged frosts, such as would be fatal in more exposed situations. Along with the vine, many wild plants characteristic of the warmer parts of middle Europe are seen to flourish. A mean summer temperature of at least 68° Fahr. is considered necessary to produce tolerable wine, but in ordinary seasons this is much exceeded in many of the great valleys of the Alps.

3. *Mountain Region, or Region of Deciduous Trees.*—Many writers take the growth of corn as the characteristic of this region; but so many varieties of all the common species are in cultivation, and these have such different climatal requirements, that they do not afford a satisfactory criterion. A more natural limit is afforded by the presence

of the chief deciduous trees—oak, beech, ash, and sycamore. These do not reach exactly to the same elevation, nor are they often found growing together; but their upper limit corresponds accurately enough to the change from a temperate to a colder climate that is further proved by a change in the wild herbaceous vegetation. This limit usually lies about 4000 feet above the sea on the north side of the Alps, but on the southern slopes it often rises to 5000 feet, sometimes even to 5500 feet. It must not be supposed that this region is always marked by the presence of the characteristic trees. The interference of man has in many districts almost extirpated them, and, excepting the beech forests of the Austrian Alps, a considerable wood of deciduous trees is scarcely anywhere to be found. In many districts where such woods once existed, their place has been occupied by the pine and Scotch fir, which suffer less from the ravages of goats, the worst enemies of tree vegetation. The mean annual temperature of this region differs little from that of the British islands; but the climatal conditions are widely different. Here snow usually lies for several months, till it gives place to a spring and summer considerably warmer than the average of our seasons.

4. *Subalpine Region, or Region of Coniferous Trees.*—This is the region which mainly determines the manner of life of the population of the Alps. On a rough estimate, we may reckon that, of the space lying between the summits of the Alps and the low country on either side, one quarter is available for cultivation, of which about one-half may be vineyards and corn-fields, and the remainder produces forage and grass. About another quarter is utterly barren, consisting of snow-fields, glaciers, bare rock, lakes, and the beds of streams; and there remains about one-half, which is divided between forest and pasture, and it is the produce of this which mainly supports the relatively large population. For nearly half the year the flocks and herds are fed on the upper pastures; but the true limit of the wealth of a district is the number of animals that can be supported during the long winter, and while one part of the population is engaged in tending the beasts and in making cheese and butter, the remainder is busy cutting hay and storing up winter food. The larger villages are mostly in the mountain region, but in many parts of the Alps the villages stand in the subalpine region at heights varying from 4000 to 5500 feet above the sea, more rarely extending to about 6000 feet. The most characteristic feature of this region is the prevalence of coniferous trees, which, where they have not been artificially reduced, form vast forests that cover a large part of the surface. These play a most important part in the natural economy of the country. They protect the valleys from destructive avalanches, and, retaining the superficial soil by their roots, they mitigate the destructive effects of heavy rains. In valleys where they have been rashly cut away, and the waters pour down the slopes unchecked, every tiny rivulet becomes a raging torrent, that cuts away and carries off the grassy slopes and devastates the floor of the valley, covering the soil with gravel and debris. In the pine forests of the Alps the prevailing species are the common spruce and the silver fir; on siliceous soil the larch flourishes, and surpasses every other European species in height. The Scotch fir is chiefly found at a lower level, and rarely forms forests. The Siberian fir is found scattered at intervals throughout the Alps, but is not common. The mughus, creeping pine, or *Krummholz* of the Germans, is common in the Eastern Alps, and sometimes forms on the higher mountains a distinct zone above the level of its congeners. In the Northern Alps the pine forests rarely surpass the limit of 6000 feet above the sea, but on the south side they commonly attain to 7000 feet; and the larch, Siberian fir, and mughus often extend above that elevation.

5. *Alpine Region.*—Throughout the German Alps the word *alp* is used specifically for the upper pastures, where cattle are fed in summer, but this region is held to include the whole space between the uppermost limit of trees and the first appearance of permanent masses of snow. It is here that the characteristic vegetation of the Alps is developed in its full beauty and variety. Shrubs are not wanting. Three species of rhododendron vie with each other in the brilliancy of their masses of red or pink flowers; the common juniper rises higher still, along with three species of bilberry; and several dwarf willows attain nearly to the utmost limit of vegetation. The upper limit of this region coincides with the so-called limit of perpetual snow, which demands further explanation.

6. *Glacial Region.*—On the higher parts of lofty mountains more snow falls in each year than is melted on the spot. A portion of this is carried away by the wind before it is consolidated; a larger portion accumulates in hollows and depressions of the surface, and is gradually converted into glacier-ice, which descends by a slow secular motion into the deeper valleys, where it goes to swell perennial streams. As on a mountain the snow does not lie in beds of uniform thickness, and some parts are more exposed to the sun and warm winds than others, we commonly find beds of snow alternating with exposed slopes covered with brilliant vegetation; and to the observer near at hand there is no appearance in the least corresponding to the term *limit of perpetual snow*. But the case is otherwise when a high mountain chain is viewed from a distance. Similar conditions are repeated at many different points, so that the level at which large snow-beds show themselves along its flanks is approximately horizontal. But this holds good only so far as the conditions are similar. On the opposite sides of the same chain the exposure to the sun or to warm winds may cause a wide difference in the level of permanent snow; but in some cases the increased fall of snow on the side exposed to moist winds may more than compensate the increased influence of the sun's rays. Still, even with these reservations, the so-called line of perpetual snow is not fixed. The occurrence of favourable meteorological conditions during several successive seasons may and does increase the extent of the snow-fields, and lower the limit of seemingly permanent snow; while an opposite state of things may cause the limit to rise higher on the flanks of the mountains. From these remarks it may be inferred that all attempts to fix accurately the level of perpetual snow in the Alps are fallacious, and can at the best approach only to local accuracy for a particular district. In some parts of the Alps the limit may be set at about 8000 feet above the sea, while in others it cannot be placed much below 9500 feet. As very little snow can rest on rocks that lie at an angle exceeding 60°, and this is soon removed by the wind, some steep masses of rock remain bare even near the summits of the highest peaks, but as almost every spot offering the least hold for vegetation is covered with snow, few flowering plants are seen above 10,000 feet. There is reason to think, however, that it is the want of soil rather than climatal conditions that checks the upward extension of the Alpine flora. Increased direct effect of solar radiation compensates for the cold of the nights, and in the few spots where plants have been found in flower up to a height of 12,000 feet, nothing has indicated that the processes of vegetation were arrested by the severe cold which they must sometimes endure. The climate of the glacial region has often been compared to that of the polar regions, but they are widely different. Here, intense solar radiation by day, which raises the surface when dry, to a temperature approaching 80° Fahr.,

alternates with severe frost by night. There, a sun which never sets sends feeble rays that maintain a low equable temperature, rarely rising more than a few degrees above the freezing-point. Hence the upper region of the Alps sustains a far more varied and brilliant vegetation.

Population of the Alps. At the earliest period of which records are preserved the Alps appear to have been mainly inhabited by Celtic tribes, some of which, before they were subjugated by the Romans, had made considerable progress in the knowledge of the useful arts. The Rhætians and Vindelicians especially, in whom a primitive Turanian stock seems to have been amalgamated with a dominant Celtic race, readily assimilated the civilisation of Rome; and the language of the conqueror, modified by peculiarities of pronunciation and the retention of some native terms, still survives in Eastern Switzerland, and in a few isolated valleys of Tyrol. Throughout by far the larger part of the Alps, however, the flood of Teutonic invasion either exterminated or drove into exile the previous population. The Alemanni and other kindred tribes settled in the main valleys of the Eastern Alps, and finally became masters of the greater part of Switzerland, leaving to the original Celtic population the Western Alps and both slopes of the great Pennine chain. At a later period the invasion of Slavonic hordes threatened to substitute a new nationality throughout the same region, but after prolonged contests these tribes were restricted to its south-eastern portion, being nearly confined to the upper valleys of the Drave and the Save, with their tributaries. The Italian valleys of the Alps, from the Val d'Ossola to the Tagliamento, inhabited by people of mixed race, have, with a few exceptions, preserved the language of Italy, much varied in the local dialects; while the western districts, in which the Celtic element remained predominant, have for the most part clung to the French tongue. The estimates formed of the present population of the Alps are uncertain, because they usually include towns and populous districts lying without the mountain region. It is usually reckoned that there are about 1,500,000 of Celto-Gallic stock in the French and Savoy Alps, western Switzerland, and some valleys of Piedmont; about 4,000,000 of Teutonic origin in the Swiss and German Alps; about 1,000,000 of Slavonic stock, chiefly Slovenes; and about 1,000,000 of Italians in the valleys of Northern Italy, the Swiss cantons of Tessin and Grisons, and in the Italian Tyrol, making an aggregate of 7,500,000. To these should be added about 70,000 people speaking some dialect of the Rhæto-Roman or Romansch. All these numbers excepting the last are excessive, if we would restrict the estimate within the proper limits of the Alps.

Fauna of the Alps. Mammalia. Although no conspicuous species of quadruped or bird is known to be exclusively confined to the Alps, they have afforded an asylum to many animals that have become rare or extinct elsewhere. The great urus, the elk, and the wild swine have disappeared since the Roman period, and the beaver in more recent times; but the brown bear, the lynx, the wild cat, and the wolf still survive. Among Ruminants, the red deer, fallow deer, and roebuck, chiefly found in the lower forest region, are common to other mountain districts. More characteristic of the Alps is the chamois, which is found elsewhere only in the Carpathians, Pyrenees, and the mountains of European Turkey, and is the sole representative of the antelopes in this part of the world. Much rarer is the ibex or bouquetin, which still lives in the higher Alpine region of the Graian Alps, and possibly also in some recesses of the Pennine chain. Unlike the chamois, which descends at night to find sustenance as low as the verge of the pine forests, this fine animal remains, at least in the summer, in the upper region, on the verge of the snow-fields, or on the rocks that rise amidst the glaciers. The massive horns of the male are often a yard or more in length. Closely allied species are found in the Pyrenees and other mountain ranges of the Iberian peninsula, and in the Caucasus, but the true ibex seems to be now confined to this small corner of the Alps. The few endemic species of Mammalia found in the Alps are chiefly small Rodentia and Insectivora, which alone can multiply rapidly in the midst of a large and increasing human population. The marmot, which is the most characteristic of the Rodentia, maintains its ground in the stony recesses of the Alpine region, and does not diminish in numbers as most other wild animals have done. The most singular of this group is the snow-vole (*Arvicola nivalis*), whose nearest ally is a native of East Siberia. Several forms (varieties or sub-species) are found in various parts of the Alps. They ascend through the Alpine region to the rocks of the glacial zone, at least as far as 12,000 feet above the sea; and, unlike other animals framed to endure severe cold, they continue in activity throughout the long winter. There is at least one species of shrew (*Sorex alpinus*) peculiar to the Alps. The Cheiroptera are represented by numerous forms, which, with one exception (*Vesperugo maurus*), are not confined to this region; but the Alps form a limit to the distribution of many of this order: some species of middle Europe do not cross the main range, while several species of the Mediterranean region find their northern limit in the valleys on the southern side.

Birds. The Birds of the Alps are proportionately very numerous. Many southern species find a home in the warmer Italian valleys, and there meet northern forms that descend during the winter and spring, but return to the upper zone in the warm season. Of the more conspicuous species of the high Alps, the lämmergeyer (*Gypaëtos barbatus*)—once common, but now become very rare—is pre-eminent. It is also found in Algeria, in Syria, and in Northern Asia, but is one of those animals that is threatened with extinction by the progress of civilisation. The rock chough (*Pyrrhocorax alpinus*), distinguished by golden-yellow bill and feet, builds on rocks in the glacial region as high as 10,000 feet above the sea. Several song birds, such as the snow lark and snow finch, ascend to the limits of vegetation. The Gallinaceæ are well represented. The cock of the woods (*Tetrao urogallus*), the grouse, ptarmigan, blackcock, gelinotte, and rock partridge (*Caccabis saxatilis*), are the most remarkable. The first, which is somewhat rare and extremely shy, surpasses the dimensions of an ordinary well-grown fowl.

Reptiles. Several Reptiles are found even in the upper region of the Alps, though none are very common. Of three venomous species of viper, *Vipera berus* ascends to about 8000 feet; and the black viper (*V. prester*) also reaches the Alpine region. *V. Redii* is confined to the warmer Italian valleys. The snakes and lizards frequent the lower zones, excepting *Lacerta pyrrhogastra*, which is sometimes seen in the upper region.

Batrachians. Batrachians are more common than true reptiles. An Alpine frog attains the extreme limit of vegetation, and a toad ascends nearly as far. These have been considered by some as distinct species, by others as varieties of the common animals. At least one triton (*T. Wurfbeinii*) is peculiar to the Alps. The spotted salamander is common in the sub-Alpine region, but in the Eastern Alps it is replaced by *S. atra*, which is entirely black. This is sometimes found far above the limit of the pine forests.

Fishes. The great lakes of the Alps are very rich in Fish, not only as regards the number of individuals, but in species also. Thus in the Chiemsee, at the northern foot of the Bavarian Alps, thirty-three species have been found, in the lake of Constance twenty-six species, and twenty-four

in the lake of Lucerne. The most esteemed are those of the trout and salmon tribe, whose specific differences have not yet been fully investigated by ichthyologists. First in rank is the saibling (*Salmo salvellinus*), which flourishes in lakes between 2000 and 4000 feet above the sea, and occasionally extends to those of the Alpine region between 6000 and 7000 feet. The fish of the northern side of the Alps are fully described in Siebold's *Süsswasser-Fische Mitteleuropas*. Those of the waters running to the Mediterranean have not been so fully investigated. Two or three peculiar species have been found in the lake of Geneva. In some of the Lombard lakes, the *agone*, a small fish of the herring tribe (*Clupea finta*), is a much esteemed article of diet.

Invertebrata.

In the classes hitherto noticed the number of species peculiar to the Alps is very small. This rule is reversed among the Invertebrata, especially as regards the Articulata and Mollusca. The number of insects is very great, and a considerable proportion extend to the limit of perpetual snow. Oswald Heer has pointed out several peculiarities in the insect fauna of the higher Alps. In ascending from the mountain region the proportion of the carnivorous tribes rapidly increases, and the families that feed on living vegetable matter either disappear or are much reduced in numbers. Beetles and other insects either lose their wings in the upper region, or are represented by allied wingless species. Along with the tendency to lose the power of flight, a diminution of brilliancy of colour appears, the prevailing hues being black or dingy grey. These peculiarities are to be explained by the fact that in the upper Alpine zone most insects live under stones, and the power of flight generally proves injurious to animals liable to be carried by the wind and upward air-currents over the snow-fields, whence they are unable to return. This is often seen to occur to butterflies and a few moths, which ascend as far as the highest flowering plants. The snow-fields and glaciers are not devoid of insect life. Several species of snow-flea have been detected; and further observation will probably bring to light other minute animals living in the pools that form on the surface of glaciers, or on the snow-beds, although their activity is often interrupted by the freezing of the surface.

The Arachnida are eminently characteristic of the fauna of the high Alps, where they abound both in species and individuals. Spiders ascend to the utmost limit of vegetation, and are even to be found on the bare rocks that rise out of the snow up to a height of 11,000 feet.

Although most of the orders of Articulata are represented in the Alps by numerous forms, these are far outnumbered by the total number of European species of that class; but among land and fresh-water Mollusca the proportion is reversed, and as many as seven-eighths of all the species known in middle Europe, and a large proportion of those of the Mediterranean region, have been found in the Alps. Still more remarkable is the large proportion of endemic species. In the important group of the Heliceæ fully one hundred species, or four-tenths of the whole number, are peculiar to the Alps. Between thirty and forty species only have been found in the Alpine zone, and of these but five—*Vitrina diaphana*, *V. glacialis*, *Helix glacialis*, *H. fœtens*, and *Vertigo Charpentieri*—attain the upper limit of vegetation.

The Annulosa and Radiata of the Alps, so far as they are known, do not offer any points of special interest; and the study of the minute organisms, which have been proved to exist as high as 12,000 feet above the sea, is still in its infancy.

Flora of the Alps.

In describing the several regions which are found in ascending from the low country to the snow-clad summits of the Alps, and whose existence is due to climatal differences, it was necessary to refer to the characteristic vegetation of each zone, inasmuch as this affords the chief apparent distinction which climatal conditions impress on the earth's surface. The most cursory observation suffices to show that within each of the zones thus broadly sketched out there exist marked differences in the vegetable population, so that a comparison of the local floras in two spots possessing a similar climate as regards temperature may exhibit but few points of agreement along with many marked contrasts. This partly depends on external conditions, of which the most important are differences in the amount and distribution of moisture in the air and the soil, and differences in the composition and state of aggregation of the soil itself. But a more important element in determining the flora of any particular district depends upon the causes which have operated throughout the whole period since it has become dry land to facilitate migration for certain species, and to impede it for others. The subject of the distribution of Alpine plants, so far as regards the eastern half of the chain, has been very well discussed in an essay by Dr A. Kerner in the 1st vol. of the 2d edit. of Schaubach's *Deutsche Alpen*, although some of the conclusions of the writer may not bear careful criticism. He divides the natural floras of the Alps into four—named respectively *Arctic*, *Baltic*, *Pontic*, and *Mediterranean*, the term Baltic referring to the region that includes Germany, Southern Scandinavia, and North-Western Russia; while Pontic comprehends the region north and west of the Euxine—the northern provinces of Turkey and the whole space between the Carpathians and the Crimea. It does not appear that the writer holds that the plants existing in the Alps have actually migrated to their present homes from the geographical regions corresponding to the above denominations, but merely that they belong to the types of vegetation characteristic of each of them. It must be borne in mind that the Alps, and especially the mountain and sub-Alpine regions, produce a large number of peculiar forms, many of which have no near allies in the other mountain regions of Europe, while at the same time the differences are seldom so wide as to place these in distinct generic groups; and it seems quite inadmissible to suppose that the flora has been altogether formed by colonisation from surrounding districts. No space can be here found for details, but it may broadly be said that while the highest zone of all, lying close to the limit of permanent snow, exhibits throughout the whole chain an approach to uniformity, several of the most conspicuous species being common to this and to Arctic flora, the zone immediately below this, as well as those lower down, shows a large admixture of quite distinct elements. This is especially true of the southern slopes. In truth, but a very few of the well-marked endemic species of the Alps are confined to the north side of the main chain. A considerable number are common to both slopes, and a still larger proportion are restricted exclusively to the southern side. Of the larger groups which are represented in the Alps by numerous well-marked endemic species, the genera Alsine, Androsace, Arabis, Campanula, Crepis, Gentiana, Pedicularis, Primula, and Saxifraga may be especially noted. Without attempting to enter into details, it may be said that, along with a general Alpine flora, which extends throughout the entire chain, there are three large districts where, along with species common to all, we find a considerable number of others either absolutely local and endemic, or else representative in the Alps of the floras of other distant mountain groups. Only a few of the more remarkable species characteristic of each can be cited. The *West Alpine Flora* is found in Dauphiné, South Savoy, and Western Piedmont, as far north as the group of the Graian Alps. In the following list of the more remark-

able species those which are either identical with or nearly allied to Pyrenean forms have an asterisk prefixed:—

*Arabis pedemontana, Huguenina tanacetifolia, *Dianthus neglectus, Silene cordifolia, *Saponaria lutea, *Hypericum nummulariafolium, Astragalus alopecuroides, Saxifraga florulenta, S. diapensioides, *S. pedemontana, *Asperula hexaphylla, Cephalaria alpina, Achillea Herbarota, Berardia subacaulis, Campanula Allionii, C. elatines, Primula marginata, P. Allionii, *Erinus alpinus, Veronica Allionii, Thymus piperella,* and *Alopecurus Gerardi.*

The *Lombard Flora* is marked by a considerable number of very distinct species that are limited to the southern declivity of the Alps, between the Lago Maggiore and the lake of Garda. Most of these are absolutely confined within these boundaries, but a few extend some distance east of the lake of Garda. The following deserve to be specified:—

Viola Comollia, V. heterophylla, Silene Elizabethæ, Arenaria grineensis, Cytisus glabrescens, Sanguisorba dodecandra, Saxifraga Vandellii, S. arachnoidea, Laserpitium nitidum, Telekia speciosissima, Leontodon tenuiflorus, Hieracium porrifolium, Campanula Raineri, C. elatinoides, Daphne rupestris, Euphorbia variabilis, and *Carex baldensis.*

The *East Alpine Flora*, extending through the region east of the valley of the Adige, is characterised by a large number of peculiar species, and by a perhaps equal number of plants not seen elsewhere in the Alps, but also natives of the Carpathians, or of the region lying between Servia and the Adriatic. In the following list those included in he latter category are marked with an asterisk:—

*Arabis vochinensis, *A. Scopoliana, *Cardamine trifolia, Braya alpina, Cochlearia brevicaulis, Silene pumilio, S. alpestris, Dianthus alpinus, *Genista sericea, Medicago Pironæ, *Potentilla Clusiana, Saxifraga Burseriana, S. tenella, *S. petræa, *S. hieracifolia, *Hacquetia Epipactis, Astrantia carniolica, Hladnikia golacensis, Anthemis alpina, Achillea Clusiana, *Senecio abrotanifolius, Centaurea alpina, C. rupestris, *Saussurea pygmæa, Phyteuma comosum, Campanula pulla, *C. alpina, C. morettiana, C. Zoysii, Rhododendron chamæcistus, Gentiana imbricata, *G. frigida, G. Fröhlichii, *Primula minima, P. glutinosa, Androsace Hausmanni, Pæderota Bonarota, P. Ageria, Wulfenia carinthiaca, Sesleria sphærocephala,* and *S. microcephala.*

It is worthy of remark that the central and highest part of the Alpine chain, including the Pennine and Bernese groups, the Lepontine Alps, and those of North Switzerland, produce scarcely a well-marked species—with the doubtful exceptions of *Rumex nivalis* and of *Potentilla grammopetala*, which is confined to a small district southeast of Monte Rosa—that does not spread throughout the rest of the chain.

Glaciers of the Alps.

The phenomena of glaciers have been chiefly studied in the Alps, but they are not especially characteristic of the mountains of central Europe. The investigation of their origin and structure, and the laws of their motion, fall within the province of the physical philosopher, and are discussed elsewhere. See GLACIERS.

Geology of the Alps.

The geological structure of the Alps is a subject that has occupied the labours of many eminent men of science, especially during the last thirty years, yet it may be safely asserted that it will continue to offer new problems to the researches of at least another generation. There is scarcely a single difficult question regarding the nature and mode of deposition of the strata that make up the earth's crust, the mode of elevation of mountain chains, the causes of the formation of valleys and lake basins, the action of meteoric forces, of rivers and ice-streams, that must not be decided before we can give a rational account of the structure of the Alps. Along with these, and scarcely less important, is the study of the various agencies involved in the phenomena of metamorphism, and that of the part played by volcanic action in some parts of the chain. The study of the organic remains embedded in the rocks is not so constantly the duty of the geologist in the Alps as it is in most other mountain districts; but of late years this has been actively pursued, and has tended to clear up many difficulties, while much room is left for further investigation. The reader is referred to the article GEOLOGY, and, with reference to detailed information as to the structure of the Alps, to the list of works on alpine geology given below.

Bibliography of the Alps.

The number of publications relating to the Alps has been so largely increased during the last quarter of a century that a bare catalogue would fill a considerable space. The majority of these are of a narrative and descriptive character, and do not add much to our knowledge of the Alps, either topographically or scientifically. It will suffice to give here a brief list of the chief works that may fairly be considered to have achieved that object. Works of exclusively scientific character, especially those relating to Alpine geology, are separately enumerated.

Scheuchzer (J. J.), Itinera Alpina, Leyden, 1723. Grüner, Die Eisgebirge des Schweizerlandes, Bern, 1760. Saussure (H. B. de), Voyages dans les Alpes, Neuchâtel, 1803–6. Hugi (J. J.), Naturhistorische Alpenreise, Solothurn, 1830. Agassiz (L.), Etudes sur les Glaciers, Neuchâtel, 1840; Système Glacaire, ou Nouvelles Etudes, &c., Paris, 1847. Forbes (J. D.), Travels through the Alps of Savoy, &c., Edinburgh, 1843. Desor (E.), Excursions et Séjours dans les Glaciers et les Hautes Régions des Alpes; 2 series, Neuchâtel, 1844–5. Saluzzo (A. di), Le Alpi che cingono l'Italia, 1ma. Parte, Torino, 1845. Schlagintweit (H. und A.), Untersuchungen über die Physicalische Geographie die Alpen; 2 series, Leipzig, 1850–4. Tyndall (J.), The Glaciers of the Alps, London, 1860. Berlepsch (H. A.), Die Alpen in Natur- und Lebensbildern dargestellt, Leipzig, 1861. Browne (Rev. G. F.), Ice-caves of France and Switzerland, London, 1865. Morell, Scientific Guide to Switzerland, London, 1866. Sonklar (Karl von), Die Oetzthaler Gebirgsgruppe, &c., Gotha, 1860; Die Gebirgsgruppe der Hohen Tauern, &c., Wien, 1866. Schaubach Die Deutsche Alpen; 2d edition, Jena, 1865–71. Bonney (Rev. T. G.), The Alpine Regions of Switzerland and the neighbouring countries, Cambridge and London, 1868. Ball (J.), The Alpine Guide; new edition, in ten parts, London, 1873. Considerable additions to our knowledge of the Alps are also to be found in the periodical publications of the English, Swiss, Austrian, Italian, and German Alpine Clubs; and also in papers that have appeared in Petermann's *Geographische Mittheilungen.*

No general zoological works of a purely scientific character relating exclusively to the fauna of the Alps can be quoted; but much valuable information, conveyed in a popular form, will be found in Tschudi's Thierleben der Alpenwelt, of which translations have appeared in English and French. The want of a compact work containing descriptions of all the plants of the Alps has been much felt by botanists. Those of Switzerland and the Eastern Alps are included in Koch's Synopsis Floræ Germanicæ et Helveticæ, a work of high authority, written in Latin; but it does not comprehend the species peculiar to Piedmont and the Western Alps. An illustrated work, by J. C. Weber, Die Alpenpflanzen Deutschlands und der Schweiz, may also be recommended. Of numerous books and memoirs connected with the geology of the Alps, the following deserve special mention:—L. von Buch, Geologische Beobachtungen auf Reisen, 1802. Sir R. I. Murchison, On the Geological Structure of the Alps, the Apennines, and the Carpathians, Quart. Journal Geol. Soc. of London, vol. v.; a translation of this important memoir into Italian, with an appendix, by P. Savi and G. Meneghini, Florence, 1851. Sedgwick and Murchison, On the Geology of the Eastern Alps, Trans. Geol. Soc. Lond. 1832. J. de Charpentier, Essai sur les Glaciers et sur le Terrain Erratique du Bassin du Rhone, 1841. B. Studer, Geologie der Schweiz, 1853; Id. Index der Petrographie und Stratigraphie der Schweiz, &c., Bern, 1872. A. Stoppani, Studii Geologichi e Paleontologichi sulla Lombardia, 1857. C. Lory, Description Géologique du Dauphiné, 1860. Gümbel, Geologie des Königreichs Bayern, 1861. O. Heer, Die Urwelt der Schweiz, Zürich, 1865. E. Desor, Der Gebirgsbau der Alpen, &c., Wiesbaden, 1865. A. Favre, Recherches Géologiques dans les Parties de la Savoie, &c.; Voisines du Mont Blanc, Genève, 1867. L. Rütimeyer, Ueber Thal- und Seebilding, Basel, 1869. A copious collection of facts and observations bearing on the physics and recent geology of the Alps will be found in a work by M. Dollfuss-Ausset, Matériaux pour l'Etude des Glaciers, of which nine volumes have appeared. Many important contributions to Alpine geology are scattered through the Proceedings of scientific societies. The *Bulletin* of the French Geological Society contains valuable papers by Collegno, Dausse, Gras, Huber, Mortillet, Omboni, Rozet, and others. The geology of the Austrian Alps is illustrated by numerous papers in the Jahrbuch der k. k. Reichsanstalt. The memoirs of A. Sismonda and B. Gastaldi, in the Memorie della R. Academia di Torino, must be consulted by those who would study the geology of Piedmont. The phenomena of the motion and structure of glaciers have been discussed in numerous

papers that have appeared in the *London and Edinburgh Philosophical Magazine* during the last thirty years. The important memoirs of Professor Tyndall were published in the *Philosophical Transactions* for 1857, 1858, and 1859 ; and those of the late Mr Hopkins in the *Transactions of the Cambridge Philosophical Society*, vol. viii. Various contributions to illustrate and enforce the views first set forth by the late Principal Forbes in his *Travels through the Alps* were published in a collected form by Messrs Black, Edinburgh, in 1859.

Cartography of the Alps.

With the exception of special maps of small districts, the only maps of the Alps founded on actual survey are those which have been published under the authority of the governments whose territory is concerned. Among these the first place is due to the federal map of Switzerland, executed under the direction of General Dufour, on the scale $\frac{1}{100000}$, in 25 sheets. Considering the difficulty of the task, this is unsurpassed both for accuracy and skill in execution. The Austrian War Office has brought out, during the last sixty years, a series of maps, executed on a large scale, of the several states of the empire. These are of very unequal merit. That of the kingdom of Venetian Lombardy, in 42 sheets, on the scale of $\frac{1}{86400}$, has considerable merit, but falls short of the standard of the Swiss map. A new map of Tyrol is in preparation, and will doubtless sustain the reputation of Austrian cartographers. The general map of Piedmont, in 91 sheets, on the scale $\frac{1}{50000}$, is sufficiently correct as regards the inhabited districts, but quite unsatisfactory as regards the higher region. Until lately there existed no tolerable map of the Alpine provinces of France. The general map of France, on the scale $\frac{1}{80000}$, has of late years been extended to the greater part of Dauphiné, and will before long include the newly-acquired departments of Savoy and Nice. The portion already published is quite on a level with modern requirements, and reflects credit on the French war department. The only tolerable map that includes the entire chain of the Alps is that compiled by J. G. Mayr. It is on a small scale ($\frac{1}{450000}$), and is not free from serious errors. A map published by Wörl, in 48 sheets, on a scale $\frac{1}{200000}$, entitled "Atlas von Südwest Deutschland und dem Alpenlande," is very unsatisfactory. Scheda's general map of the Austrian Empire and adjoining territories, in 20 sheets, is an excellent compilation. It includes the Alps as far west as Monte Rosa and the lake of Thun, but the scale ($\frac{1}{576000}$) is inconveniently small.

Of geological maps including any considerable portion of the Alps the following deserve to be specified :—

Favre (A.), Carte Géologique des Parties de la Savoie, &c., Voisines du Mont Blanc. Gümbel, Geognostische Karte des Königreichs Bayern. Hauer (F. von), Geologische Uebersichtskarte der Oesterreichischen Monarchie ; sheets 5 and 6 include the Austrian Alps. Lory (C.), Carte Géologique du Dauphiné. Morlot, Uebersichtskarte der Nordöstlichen Alpen. Sismonda (A.), Carta Geologica di Savoja, Piemonte, e Liguria. Société Géologique de France, Carte Géologique de la Savoie. Studer (B.) u. Escher v. d. Linth, Carte Géologique de la Suisse. (J. B.)

ALPUJARRAS, or ALPUXARAS, a mountainous district in the south of Spain, in the province of Andalusia, lying between the Sierra Nevada and the Sierras Lugar and Contraviesa, and consisting principally of valleys, which descend at right angles from the crest of the Sierra Nevada. These valleys are among the most beautiful and fertile in Spain. They contain a rich abundance of fruit trees, especially vines, oranges, lemons, and figs, and in some parts present scenes of almost Alpine grandeur. The inhabitants are the descendants of the Moors, who vainly sought to preserve the last relics of their independence in their mountain fastnesses, and many of the names of places in the district are of Moorish origin. The principal villages are Lanjaron, Orgiba, Trevelez, and Ugijar, all situated at a considerable elevation—the highest, Trevelez, being 5333 feet above the sea—and containing from 1500 to 4000 inhabitants.

ALREDUS, ALURED, or ALUREDUS, of Beverley, one of the earliest English historians, was born at Beverley, in Yorkshire. He wrote in the reign of Henry I., but little is known with certainty of his life. It is generally believed that he was educated at Cambridge, and afterwards became one of the canons and treasurer of the church of St John's at Beverley. We learn from a note in Bishop Tanner's *Bibliotheca Brit.-Hib.* that, for the sake of improvement, he travelled through France and Italy, and at Rome became domestic chaplain to Cardinal Othoboni. He died in the year 1128 or 1129. His chief work, entitled *Annales sive Historia de gestis Regum Britannicæ*, was edited by Thomas Hearne from a manuscript belonging to Thomas Rawlinson, and was published at Oxford in 1716. It contains an outline of the history of England from Brutus to Henry I., written in elegant Latin, and with remarkable accuracy as to facts and dates, though, of course, much of the earlier portion is fabulous. A manuscript entitled *Libertates Ecclesiæ S. Johannis de Beverlæ*, in the Cottonian library, is also ascribed to him, but on doubtful authority. It is a collection of records relative to the church of Beverley, translated from the Saxon.

ALRESFORD (NEW), a market town in Hampshire, so named from a ford on the river Arle, a tributary of the Itchin, on which it is situated. It is 58 miles distant from London and 7 from Winchester. It suffered severely from a series of conflagrations, and partly on this account and from the decline of a small manufacture of linseys, it is now a place of little importance. Alresford House, the seat of the Rodney family, is in the neighbourhood, and the naval hero of that name was interred in New Alresford church in 1792. Miss Mitford was a native of Alresford. Alresford is a station on the L. and S.-W. Railway. Population of the parish of New Alresford (1871), 1623.

ALSACE (Germ. *Elsass*), a former province of France, divided after the Revolution into the departments of Haut Rhin and Bas Rhin, and incorporated since the war of 1870 with the German empire. It is bounded on the north by the Rhine palatinate, on the east by the Rhine, on the south by Switzerland, and on the west by the Vosges Mountains; and it comprises an area of 3344 English square miles. The district possesses many natural attractions, and is one of the most fertile in central Europe. There are several ranges of hills, but no point within the province attains a great elevation. The only river of importance is the Ill, which falls into the Rhine after a course of more than 100 miles, and is navigable below Colmar. The hills are generally richly wooded, chiefly with fir, beech, and oak. The agricultural products are corn, flax, tobacco, grapes, and various other fruits. The country has a great wealth of minerals, silver having been found, and copper, lead, iron, coal, and rock-salt being wrought with profit. There are considerable manufactures, chiefly of cotton and linen. The chief towns are Mühlhausen and Colmar in the upper district, and Strasburg in the lower. The province is traversed from east to west by the railway from Strasburg to Nancy, and the main line north and south runs between Basle and Strasburg.

From a very early period and for many ages Alsace has been a disputed territory, and has suffered in the contentions of rival races. It formed part of ancient Gaul, and was therefore included in the Roman empire. The Romans held it nearly five hundred years, and on the dissolution of their power it passed under the sway of the Franks and of the early French monarchs, by whom it was governed until the time of Otho I., Emperor of Germany, who reigned about the middle of the 10th century. It was at that period that Alsace became German : its original population of Celtic tribes, which had been first Romanised and then further qualified by a Frankish element, was now to a great extent supplanted by a purely Teutonic stock. By Otho II. the province was erected into a landgraviate, and it subsequently came into the possession of the House of Austria, which succeeded in 1273 to the imperial dignity of Germany. This state of things continued until 1648, when a large part of Alsace was ceded to France by the treaty of Münster. In the war which preceded this peace (generally known as the Thirty Years' War) Alsace had been so terribly devastated by the French that the German emperor found himself unable to hold it. The population was greatly reduced in numbers, and much of the

land was left uncultivated. In the subsequent war between France and the empire of Germany, arising out of the attempt of Louis XIV. to seize Holland, that part of Alsace which remained to Germany was again overrun by the French. Although this war was terminated in 1678 by the treaty of Nimeguen, the French monarch was desirous of incorporating a still larger amount of Rhine territory; and accordingly, in 1680 he laid claim to a number of territories, belonging to princes of the empire, which he alleged had been dismembered from Alsace. It was ordered that these territories should be at once restored to that province under the crown of France, and several independent sovereigns were cited to appear before two chambers of inquiry which Louis had established at Brissac and Metz. The princes appealed to the German emperor and to the Diet; but the previous wars had so exhausted the power of the former that nothing could be done to resist the aggression. In 1681 the French troops under Louvois seized Strasburg, aided by the treachery of the bishop and other great men of the city. A further war broke out, but by the treaty of Ratisbon in 1684, Strasburg was secured to France. Again the war was renewed in 1688, and continued for nine years, when, at the peace of Ryswick, in 1697, another considerable portion of Alsace was ceded to France. Some remaining territories of small extent were acquired by the French after the revolution of 1789.

It will be seen from the foregoing sketch that Alsace was originally French, that it then became German, and then French again. From the middle of the tenth century, however, the population has in the main been Teutonic; and the French conquests of the seventeenth century, while modifying this element, still left it predominant. The people continued to use German as their native tongue, though the educated classes also spoke French. Protestantism was professed by a large number of the inhabitants; and in many respects their characteristics identified them rather with the race to the east than that to the west of the Rhine. In process of time, however, they considered themselves French, and lost all desire for re-annexation to any of the German States.

Alsace suffered a good deal in the war of 1870–71. The earlier battles of the campaign were fought there; Strasburg and other of its fortified towns were besieged and taken; and its people were compelled to submit to very severe exactions. The civil and military government of the province, as well as that of Lorraine, was assumed by the Germans as soon as they obtained possession of those parts of France, which was very shortly after the commencement of the war. The Alsatian railways were reorganised and provided with a staff of German officials. German stamps were introduced from Berlin; the occupied towns were garrisoned by the Landwehr; and requisitions on a large scale were demanded, and paid for in cheques which, at the close of the war, were to be honoured by whichever side should stand in the unpleasant position of the conquered. The people, notwithstanding their German origin, showed a very strong feeling against the invaders, and in no part of France was the enemy resisted with greater stubbornness. It was evident from an early period of the war, however, that Prussia was resolved to reannex Alsace to German territory. When the preliminaries of peace came to be discussed at Versailles in February 1871, the cession of Alsace, together with what is called German Lorraine, was one of the earliest conditions laid down by Count Bismarck and accepted by M. Thiers. This sacrifice of territory was afterwards ratified by the National Assembly at Bordeaux, though not without a protest from the representatives of the departments about to be given up; and thus Alsace once more became German. By the bill for the incorporation of Alsace and German Lorraine, introduced into the German Parliament in May 1871, it was provided that the sole and supreme control of the two provinces should be vested in the Emperor of Germany and the Federal Council until January 1st, 1873, when the constitution of the German empire was to be established. Bismarck admitted the aversion of the populace to Prussian rule, but said that everything would be done to conciliate the people. This policy appears really to have been carried out, and it was not long in bearing fruit. Many of the inhabitants of the conquered districts, however, still clung to the old connection, and on the 30th of September 1872—the day by which the people were required to determine whether they would consider themselves German subjects and remain, or French subjects and transfer their domicile to France—45,000 elected to be still French, and sorrowfully took their departure. The German system of compulsory education of every child above the age of six was introduced directly after the annexation. The population in 1871 amounted to upwards of 1,060,000.

ALSEN, an island in the Baltic, situated off the coast of Schleswig, in the Little Belt. It formerly belonged to Denmark, but, as a result of the Danish war of 1864, was incorporated with Germany. Its area is 105 square miles; the length nearly 20, and the breadth from 3 to 12 miles. The island is fertile, richly wooded, and yields grain and fruit. Sonderburg, the capital, a town of 5475 inhabitants, with a good harbour and a considerable trade, is situated on the narrow channel that separates Alsen from the mainland. Population, 22,500.

ALSOP, Vincent, a celebrated Nonconformist divine, was educated in St John's College, Cambridge. He received deacon's orders from a bishop, whereupon he settled as assistant-master in the free school of Oakham, Rutland. He was recovered from indifferent associates here by a very worthy minister, the Rev. Benjamin King. Subsequently he married Mr King's daughter, and "becoming a convert to his principles, received ordination in the Presbyterian way, not being satisfied with that which he had from the bishop." He was presented to the living of Wilby in Northamptonshire; but was thence ejected by the Act of Uniformity in 1662. After his ejection he preached privately at Oakham and Wellingborough, sharing the common pains and penalties of Nonconformists—*e.g.*, he was imprisoned six months for praying with a sick person. A book against Sherlock, called *Antisozzo* (after Socinus), written in the vein of Andrew Marvell's *Rehearsal Transprosed*, procured him much celebrity as a wit. Dr Robert South, who cannot be supposed to have been favourably disposed towards the Nonconformists, publicly pronounced that Alsop had the advantage of Sherlock in every way. Besides fame, *Antisozzo* procured for its author an invitation to succeed the venerable Mr Cawton in Westminster. He accepted the call, and drew great multitudes to his chapel. The other books he published showed a fecundity of wit, a playful strength of reasoning, and a provoking indomitableness of raillery. Even with Dr Goodman and Dr Stillingfleet for antagonists, he more than held his own. His *Mischief of Impositions* in answer to the latter's *Mischief of Separation*, and *Melius Inquirendum* in answer to the former's *Compassionate Inquiry*, remain historical landmarks in the history of Nonconformity. Later on, from the entanglements of a son in alleged treasonable practices, he had to sue for and obtained pardon from King James II. This seems to have given a somewhat diplomatic character to his closing years, inasmuch as, while remaining a Nonconformist, he had a good deal to do with proposed political-ecclesiastical compromises. He died May 8, 1703. (A. B. G.)

ALSTED, Johann Heinrich, a German Protestant divine, and one of the most voluminous writers of the 17th century, was born in 1588. He was some time professor of philosophy and divinity at Herborn, in the county of Nassau, and afterwards at Weissenburg in Transylvania, where he continued till his death in 1638. His *Encyclopædia*, the most considerable of the earlier works of that class, was long held in very high estimation. It was published in 1630, in two large folio volumes, the whole having been composed by himself. His *Thesaurus Chronologiæ* has gone through several editions. He published in 1627 a treatise, *De Mille Annis*, in which he asserted

that the reign of the saints on earth was to begin in 1694.

ALSTON, Charles, M.D., a botanical and medical writer, was born in the west of Scotland in the year 1683. He began his studies at the university of Glasgow; and on the death of his father, prosecuted them under the patronage of the Duchess of Hamilton. After studying at Leyden under Boerhaave, along with Alexander Monro (1716–19), he returned to Edinburgh, and shared with Monro, Rutherford, Sinclair, and Plummer, the honour of laying the foundation of the renowned school of medicine there. He lectured on botany and materia medica with increasing reputation till his death in November 1760. He was a man of great ability, and an assiduous student of science. His most valuable work is his *Lectures on Materia Medica*, 2 vols., 1770.

ALSTROEMER, Jonas, a Swedish industrial reformer, was born at Alingsaes, in West Gothland, on the 7th Jan. 1685. He left his native village at an early age, and in 1707 became clerk to Alberg, a merchant of Stockholm, whom he accompanied to London. After carrying on business for three years, Alberg failed, and Alström (as the clerk then called himself) engaged in the business of shipbroker on his own account, which eventually proved very successful. After travelling for several years on the Continent, he was seized with the patriotic desire to transplant to his native country some of the industries he had seen flourishing in Britain. He accordingly returned to Alingsaes, and in 1724 established a woollen factory in the village, which after preliminary difficulties was completely successful. He next established a sugar refinery at Gothenburg; introduced improvements in the cultivation of potatoes and of plants suitable for dyeing; and directed attention to improved methods in shipbuilding, tanning, and the manufacture of cutlery. But his most successful undertaking was the importation of sheep from England, Spain, and Angora. In return for his services he received many marks of distinction. He was created (1748) knight of the order of the North Star; and a few years later received letters of nobility, with permission to change his name to Alströmer. He died June 2, 1761, leaving several works on practical industrial subjects. A statue was erected to his honour in the exchange at Stockholm. One of his sons, Clas (*i.e.*, Claude), was a naturalist of considerable eminence.

ALT, or Aluta, a tributary of the Danube, which, rising in the eastern Carpathian mountains, flows through Transylvania and Wallachia, entering the latter by the pass of Rothenthurm, and joins the Danube opposite Nicopoli, after a course of more than 300 miles.

ALTAI MOUNTAINS, a group of mountains in central Asia, separating the table-lands of Mongolia from Siberia. The irregular chains of which the group consists extend from 85° to 103° E. long., and from 48° to 34° N. lat. The great Siberian rivers, the Obi, Irtish, and Yenesei, take their rise in these mountains, which are said to abound in scenes of picturesque beauty. The highest summits exceed 12,000 feet. The range is rich in mineral productions, particularly silver, copper, and iron. See Asia, and Geography, Physical.

ALTAMURA, a cathedral town in the south of Italy, province of Terra di Bari, 28 miles S.W. of Bari. It is situated in a fertile country, which produces wine and oil, and is said to occupy the site of the ancient *Lupatia*. Population, 17,365.

ALTAR, in *Classical Antiquity*, was a solid base or pedestal on which supplication was made and sacrifice offered to the gods and deified heroes. According to this difference in the service for which they were employed, altars fell into two classes, of which the one, smaller and lower so that the suppliant could kneel upon it, stood inside temples, in front of the sacred image; while the other, destined for burnt sacrifice, was placed in the open air, and, if connected with a temple, in front of the entrance. Possibly altars of the former class were substitutes for, and rendered the same service in historical times as, in an early age, the base of the sacred image within a temple. In this case the altar of Apollo at Delphi, on which Neoptolemus is frequently represented on the Greek vases as taking refuge from Orestes, might be regarded as the pedestal of an invisible image of the god, and as fulfilling the same function as did the base of the actual image of Minerva in Troy, towards which Cassandra fled from Ajax. The other class of altars, called βωμοί by the Greeks and *altaria* by the Romans, appear to have originated in such temporary constructions as heaps of earth, turf, or stone, made as occasion offered for kindling a fire for sacrifice. The next step was to allow the bones and ashes of the victims sacrificed to accumulate, and upon this to kindle new fires. Altars so raised were viewed with particular sanctity, the most remarkable recorded instances of them being the altars of Juno at Samus and at Olympia (Pausanias, v. 14, 5; v. 15, 6), of Apollo at Thebes (Pausanias, ix. 11, 5), and of Jupiter at Olympia. The last-mentioned stood on a platform (πρόθυσις) measuring 125 feet in circumference, and led up to by steps, the altar itself being 22 feet high. Women were excluded from the platform. Where hecatombs were sacrificed, the πρόθυσις necessarily assumed colossal proportions, as in the case of the altar at Parion, where it measured on each side 600 feet. The altar of Apollo at Delos (ὁ κεράτινος βωμός) was made of the horns of deer believed to have been slain by Diana; while at Miletus was an altar composed of the blood of victims sacrificed. The altar used at the festival in honour of Dædalus on Mount Cithæron was of wood, and was consumed along with the sacrifice (Pausanias, ix. 3, 2). Others, of bronze, are mentioned; but while these were exceptional, the usual material of an altar was marble, and its form, both among the Greeks and Romans, either square or round; polygonal altars, of which examples still exist, being exceptions. When sculptured decorations were added they frequently took the form of imitations of the actual festoons with which it was usual to ornament altars, or of symbols, such as crania and horns of oxen, referring to the victims sacrificed. As a rule, the altars which existed apart from temples bore the name of the person by whom they were dedicated, and the names of the deities in whose service they were; or, if not the name, some obvious representation of the deity. Such is the purpose of the figures of the Muses on an altar to them in the British Museum. An altar was retained for the service of one particular god, except where, through local tradition, two or more deities had become intimately associated, as in the case of the altar at Olympia to Diana and Alpheus jointly, or that of Neptune and Erechtheus in the Erechtheum at Athens, and others. Such deities were styled

Greek and Roman Altars.

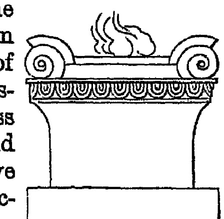


Fig. 1.—Greek altar: usual form.

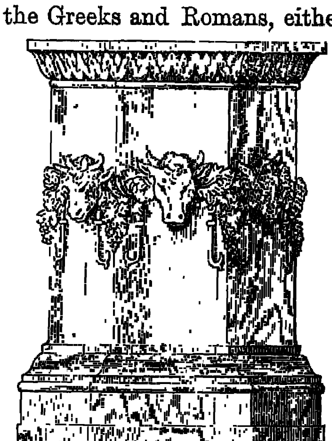


Fig. 2.—Polygonal Greek Altar.

σύμβωμοι, each having a separate part of the altar, if we may judge from that at the Amphiareum at Oropos (Pausanias, i. 34, 2). Deities of an inferior order, who were conceived as working together—*e.g.*, the wind gods—had an altar in common. In the same way, the "unknown gods" were regarded as a unit, and had in Athens and at Olympia one altar for all (Pausanias, i. 1, 4; v. 14, 5; Acts of Apostles, xvii. 18). An altar to all the gods is mentioned by Æschylus (Suppl. v. 225). Among the exceptional classes of altars are also to be mentioned those on which fire could not be kindled (*βωμοὶ ἄπυροι*), and those which were kept free from blood (*βωμοὶ ἀναίμακτοι*), of which in both respects the altar of Zeus Hypatos at Athens was an example. The *ἑστία* was a round altar; the *ἔσχαρα*, one employed apparently for sacrifice to inferior deities or heroes, or on comparatively unimportant occasions, as was also the *ara* among the Romans; though *ara* is sometimes used with the same signification as *altare*, and etymologically would have the same meaning if it is correctly derived from *ἀείρω*, not from *ardere;* while *altare* is connected with *altus*, "high."

Egyptian Altars.

Egyptian altars were monoliths, in the form of a truncated cone about four feet in height. Some are extant, made of granite, others of green basalt; in almost every case they bear hieroglyphical inscriptions. In the temple of Jupiter at Babylon there was an altar of massive gold. Assyrian, Egyptian, and Persian altars were either square or oblong.

Biblical Altars.

The most ancient altars of which any record has been preserved are those mentioned in the Bible. As sacrifice implies an altar, there must have been altars for those of Cain and Abel; but the first which is mentioned is that which Noah after the flood "builded unto Jehovah" (Gen. viii. 20). The three patriarchs, Abraham, Isaac, and Jacob, are repeatedly said to have built an altar in the different parts of the land of Canaan in which they sojourned; and though it is not stated expressly, yet it may be inferred from there having evidently been a place where Abraham was accustomed to "stand before Jehovah" (*ibid.* xix. 27), that, once built, it remained during the whole period of the encampment at the particular place, and was frequently used for the purpose of sacrificing.

But the most remarkable altar mentioned in the book of Genesis is that which Abraham built for the sacrifice of his son Isaac, from which we glean several particulars relative to the patriarchal worship. The altar was evidently something distinct from the wood by whose fire the sacrifice was to be burnt, for Abraham "built an altar and laid the wood in order," which he had brought with him from Beersheba, as if he could not count upon finding it at the place. The victim also was bound, laid upon the wood, and there slain. This was contrary to the practice under the Levitical dispensation, when the fire on the top of the altar was kept continually burning, and the animal was killed before being carried up to it; but it is probably alluded to in a verse of the Psalms, which has given much trouble to commentators, who have tried to reconcile it with the precepts of the Mosaic law—"Bind the sacrifice with cords unto the horns of the altar" (Ps. cxviii. 27). To this simple patriarchal ritual belong also the rules about the construction of altars given to the Israelites shortly after they left Egypt (Exod. xx. 24–26). While sojourning in that country they do not seem to have offered any sacrifice to Jehovah, till, just as they were leaving it, they were commanded to sacrifice the passover. It is not unlikely that they might have despised the simple altars of their forefathers, and tried to imitate those which they had seen in Egypt, as they so soon copied their late oppressors in a still graver matter, the making a supposed likeness of the Deity. They were therefore ordered to make their altars of earth. Stones might also be used, but they were not to be hewn, nor were the altars to be so high as to require the offerer to go up by steps to arrange the sacrifices upon them.

The first altar that is mentioned as having been built after these directions were given, was the one for the solemn covenanting sacrifice between God and the Israelites (Ex. xxiv. 4–8). There it is mentioned that Moses "builded an altar under the hill, and twelve pillars, according to the twelve tribes of Israel." Its being *under* the hill may have been a significant protest against the prevalent heathen error of localising the Deity in the sky, and the twelve pillars or rough blocks of stone appear to have been a principal part of the materials used in constructing it. They may be compared with the "twelve stones, according to the number of the tribes of the sons of Jacob," with which Elijah built his altar on Carmel (1 Kings xviii. 31). We seem to learn from these examples that when an altar was to be constructed for a special occasion, it was fitting that it should bear a symbolism of all in whose name the sacrifice was offered. It is to be observed that this precept about making altars of earth or of unhewn stones was anterior to the Levitical ceremonial, and was superseded by it. After the sin of making the golden calf, the whole ceremonial of the worship of the Israelites was altered. According to the new ritual, two different altars were required, and they were permanent, being carried about in the people's wanderings, and replaced by others, similar, but larger and more costly, when the ark was placed in the temple on Mount Moriah.

The first of these altars was that for *burnt offerings.* For the tabernacle this was hollow, made of boards of shittim-wood, covered with brass. It was three cubits or about five feet high, and five cubits or eight feet square. It had a horn at each corner, and was carried about by means of staves. The corresponding altar in the temple was of greatly larger dimensions, ten cubits or about 18 feet high, and in the first temple 20 cubits square, and in the second 24 cubits. The tradition of the Jews is, that it was 32 cubits (about 50 feet) square at the base, contracting to 24 at the top, by several ledges round it at different heights. It must therefore have been an immense structure, and though called "an altar of brass," was probably built of stones, and merely covered with plates of that metal. From the account of the building of the altar in the second temple given in 1 Macc. iv. 45–47, it is probable that it consisted merely of a mass of masonry of the proper form. Ezekiel, in his vision of the temple, gives a description of the altar of burnt-offerings, from which we learn that it was surrounded by several ledges or steps, each a cubit broad. The uppermost of these was two cubits (about 3 feet) below the top of the altar, so that, standing upon it, the priest was able to arrange the sacrifice upon the fire, which was kept always burning, to supply it with fuel, and to remove the ashes. The lower ledges were to enable him to sprinkle the blood on the sides of the altar, which (according to the Levitical ritual) was sometimes to be done on the upper part of the altar, and sometimes on the lower part. The lowest step is said to have had a raised ledge on the outside, by which the blood poured upon it was confined till it ran through a hole into a subterranean pipe.

One of the most difficult questions about the Levitical altars is their having horns; for these do not seem to have been used in that ritual, yet they are specially ordered to be made, not only in the altar of burnt-offerings, but also in that of incense; and on certain solemn occasions they were sprinkled with blood, as if they were not mere appendages or ornaments of the altar, but had a special significance of their own. From the way they are spoken of in the book of Exodus, we see that they must then have been

well known, and it might almost be thought that they were retained from the older ritual, according to which they were used to bind the victim that was slain upon the altar.

The second temple having suffered greatly in the wars between the kings of Syria and Egypt, and been plundered by the Romans, was almost rebuilt by Herod, the restoration occupying forty-six years. The altar of burnt-offering erected then is thus described by Josephus (*De Bell. Jud.* v. 5, 6):—"Before this temple stood the altar, 15 cubits high, and equal both in length and breadth, each of which dimensions was 50 cubits. The figure it was built in was a square: it had corners like horns, and the passage up to it was by an insensible acclivity from the south. It was formed without any iron tool, nor did any iron tool so much as touch it at any time." A pipe was connected with the south-west horn, through which the blood of the victims was discharged by a subterraneous passage into the brook Kedron. Under the altar was a cavity to receive the drink-offerings. This was covered with a marble slab, and cleansed from time to time. On the north side of the altar several iron rings were fixed to fasten the victims. Lastly, a red line was drawn round the middle of the altar to distinguish between the blood that was to be sprinkled above and below it.

The second altar belonging to the Jewish worship was *the altar of incense*, the golden altar (Ex. xxx. 1). It was placed in the holy place, between the table of shew-bread and the golden candlestick. This altar, in the tabernacle, was made of shittim-wood overlaid with gold plates, 1 cubit in length and breadth, and 2 cubits in height. It had horns of the same materials; and round the flat surface was a border of wrought gold, underneath which were the rings to receive "the staves, made of shittim-wood overlaid with gold, to bear it withal;" (Exod. xxx. 1–5; Joseph. *Antiq.* iii. 6, 8). The altar in Solomon's temple was similar in form, but made of cedar overlaid with gold (1 Kings vi. 20). It is a question whether it was hollow or filled up with stones, the construction of the Hebrew being doubtful, but the former supposition appears the more probable. The altar in the second temple was taken away by Antiochus Epiphanes (1 Macc. i. 21), and restored by Judas Maccabæus (1 Macc. iv. 49). The archangel Gabriel stood at the right side of this altar when he announced the birth of John the Baptist to Zacharias, who was burning incense upon it (Luke i. 11); and it is alluded to in the vision shown to St John (Rev. viii. 3), where it is immediately "before the throne," the veil, which under the Mosaic dispensation had separated it from the holy of holies, having been rent asunder at the crucifixion.

On this altar incense was offered twice every day, and this was the only use of incense under the Levitical ritual; for though the word "censer" is repeatedly used in our common translation of the Old Testament, neither in the Hebrew nor the Greek has the word any connection with incense, but denotes the fire-pan in which the burning charcoal was carried from the brazen altar to be emptied out upon that of incense. The true equivalent for censer is only used of sinful or heathen worship (2 Chron. xxvi. 14; Ezek. viii. 11, and perhaps 2 Chron. xxx. 14). The fire-pans used as censers in the story of Korah, and of the atonement subsequently made by Aaron burning incense among the people, do not belong to the Levitical ritual, but were to prove whether it was to be observed or not.

The single exception to the exclusive use of the golden altar for incense was on the great day of atonement, when the high priest went into the holy of holies, carrying a fire-pan containing lighted charcoal from the great altar, and having set it down, threw incense upon it, and left it for some time before the ark while he went and came back once and again to sprinkle it with the blood of the sacrifices. This fire-pan is accordingly called a golden censer by the author of the Epistle to the Hebrews (ix. 4); but even this is no precedent for the swinging censers which have been used for so many centuries in the Latin churches. Incense, indeed, was put on the loaves of shew-bread; but it does not appear that it was burned upon that table, which is nowhere called an altar. More probably, when the loaves were taken away, the incense was burnt on the proper altar. But the shew-bread was so completely special an appointment of the Mosaic ritual that it is impossible to class it among sacrifices.

Christian altars.

Among the early Christians, alike in the East and West, that on which the bread and wine were put in the celebration of the Eucharist appears to have been regarded as an altar, and accordingly sacrificial words were used in connection with it, such as "offering," "unbloody sacrifice." It should be observed, however, that the Greek fathers scarcely ever apply the word βωμός to Christian altars, confining themselves to θυσιαστήριον; while in the West there seems to have been a preference for *altare* rather than *ara*, though the latter term is often found. As the Christians generally shrunk from disclosing to the heathen the details of their worship, their enemies used to taunt them with having neither temples nor altars, and some of the apologists admit this; but all they meant by this was that they had no such altars as the heathen had, altars for slain beasts and for the burning of their bodies.

From the privacy with which the early believers had to meet, their altars at first would naturally be simple and unobtrusive. We have seen that the Levitical altars were four-square, but Christian altars seem to have been always longer than they were broad, and to have been placed "athwart" the length of the basilica or church, so as to present one of the broad sides and both the sacred vessels to the eyes of the great body of the worshippers.

There does not seem to have been any rule as to the material of which altars might be made. At first they appear to have been mostly of wood, as being easily procured and fashioned. But when the persecutions ceased, and the Christians began to erect churches for worship, there seems to have sprung up some diversity of usage, each province following its own traditional custom, which perhaps was affected in some degree by the nature of the building-stone found there, and the use commonly made of it. It seems that in Egypt and the region afterwards called Barbary the altars were of wood; and there is a tradition that this was also the case originally at Rome. On the other hand, in the latter half of the 4th century, they were made of stone in Asia Minor. Early in the 6th century a council, held at Epaone in Burgundy, ordered that only altars made of stone should be consecrated with the chrism, which shows that wooden altars also were still made in that province. In England the change from wood to stone seems to have taken place about the time of the Norman Conquest, Wulfstan, bishop of Worcester, being mentioned as having introduced it in his diocese. No doctrinal significance can be ascribed to the change, which was simply in keeping with the greater costliness of the whole structure, when the cessation of the inroads of the Scandinavian sea-kings allowed the nations of Western Europe to accumulate wealth, of which a portion was dedicated to religion. A few exceptional instances are mentioned of altars of silver, and they were sometimes even covered in part with plates of gold; but the current set in steadily in favour of stone as the most suitable material, and by degrees the legislation of the Latin church on this point grew more definite. The altar could only be of stone; not that it was necessary that the whole structure should be so, for it was enough if there was a slab of

stone on the top large enough for the sacred vessels to stand upon; the upper face of the altar must have five crosses incised in the stone; before being used, it must have been consecrated by the bishop with the chrism, according to the ritual prescribed in the pontificals, which by degrees grew more elaborate; and at first a plain cross, and afterwards a crucifix, was placed erect upon it.

At the Reformation the altars in churches were looked upon as symbols of the old Catholic doctrine, in those countries where the struggle lay between the Catholics and the "Reformed" or Calvinists, who on this point went much further than the Lutherans. In England the name "altar" was retained in the Communion Office in English, printed in 1548, and in the complete English Prayer-book of the following year, known to students as the First Book of Edward. But orders were given soon after that the altars should be destroyed, and replaced by movable wooden tables; while from the revised Prayer-book of 1552 the word "altar" was carefully expunged. The short reign of Mary reversed all this, but the work was resumed on the accession of Elizabeth, and has been carried out so thoroughly that the industry of recent antiquaries has only been able to find about thirty cases in all England where the old stone altar-slabs still exist, and of these that at Arundel is almost the only one which is still used.

The name "altar" has been all along retained in the Coronation Office of the kings of England, where it occurs frequently. It was also recognised in the canons of 1640, and an important change was then made in the position of the communion tables, which has become universal throughout the Church of England. In primitive times the position of the Christian altar seems to have been such that, like the Jewish and patriarchal altars, they could be surrounded on all sides by the worshippers. The chair of the bishop or celebrant was on their west side, and the assistant clergy were ranged on each side of him. But in the Middle Ages the altars were placed against the east wall of the churches, or else a screen, called a *reredos* (generally much decorated with carving), was erected close to the east of the altar, so as to cut off any one on that side from joining in the worship, and the celebrant was brought round to the west side, to stand between the people and the altar; while there were often curtains on the north and south sides. When tables were substituted for altars in the English churches, these were not merely movable, but at the administration of the Lord's Supper were actually moved into the body of the church, and placed table-wise as it was called—that is, with the long sides turned to the north and south, and the narrow ends to the east and west—the officiating clergyman standing at the north side. In the time of Archbishop Laud, however, the present practice of the Church of England was introduced. The communion table, though still of wood and movable, is, as a matter of fact, never moved; it is placed altar-wise—that is, with its longer axis running north and south, and close against the east wall, with for the most part a *reredos* behind it; it is also fenced in by rails, within which the laity do not enter.

When, under the superintendence and partly at the charge of the Camden Society, the church of Saint Sepulchre at Cambridge, founded 1101, was restored, a stone altar, consisting of a flat slab resting upon three other upright slabs, was presented to the parish, and set up in the church at the east wall of the chancel. This circumstance was brought before the Court of Arches in 1845, and Sir H. Jenner Fust (*Faulkner* v. *Lichfield and Stearn*) ordered it to be removed, on the ground that a stone structure so weighty that it could not be moved, and seeming to be a mass of solid masonry, was not a communion-table within the meaning of the Church of England. No attempt has been made to obtain a reversal of this judgment; but from other decisions some infer that only such altars as cannot also be considered as tables are forbidden.

Few particulars have come down to us regarding the construction of the wooden altars used by the Christian Church in early times, except that several circumstances indicate that they were hollow. Gregory of Tours applies the word "arca" or "chest" to them; and in other cases they must have been simply like ordinary tables supported by legs, since we read of persons taking refuge beneath them. There is nothing, therefore, either in the matter or the form of the ordinary English communion-tables, to prevent them serving as altars. The stone altars at first were probably only one or more blocks of rough hewn stone; but by degrees they were ornamented, and this produced two different types. Either the altar remained a solid mass of masonry, but had its front richly panelled (in later times it had figures in bas-relief), or the upper slab was supported by from one to five columns, often of highly-polished stone. It was in the 16th century that a new fashion was introduced in France, according to which the altar was regarded as being itself a tomb or sarcophagus, and to which are due the unsightly altars which now disfigure the wonderfully beautiful mediæval churches of that country. So complete was the change, that now, perhaps, there are not more ancient altars in France than there are in England.

In early times, before the altars were placed close to the east wall or to a large *reredos*, they were often surmounted by a canopy or baldacchino, supported by four pillars rising from the ground just beyond the corners of the altar.

At first there was but one altar in a church; but for many centuries this rule has been disregarded in the Latin churches, and almost every large church contains several altars dedicated in honour of different saints, and sometimes appropriated to the use of particular guilds, or endowed for a series of masses for the repose of the founder. These, however, must not be confounded with the principal altar, called the high altar or *maître autel*, situated towards the east end of the choir or chancel. A few cases occur where there are two high altars, the second being placed near the west end of the church.

Altars are "vested" during service; that is, covered with cloths of various kinds. There is often a frontal, richly embroidered, whose colour depends upon the ecclesiastical season or the particular festival; but in all cases the uppermost cloth on the top is of linen, to represent that in which the body of the Lord was wrapped in the sepulchre.

Since the age of Bede, portable altars have been used in the Latin Church; but the East has never adopted them, and they quite put out of sight the symbolism of the form of an altar. They consist simply of a small slab of stone, large enough to support the chalice and paten. This must bear the incised crosses and must have been consecrated by the bishop. They may be carried about on a journey by a bishop or priest in a heathen or heretical country, as now it is not allowed to say mass except on a duly consecrated altar, and they are also used in oratories attached to private houses.

Those who wish to investigate the matter further may be referred to the standard works on church ritual and ecclesiastical architecture. For the altars of the Israelites, much information will be found in Lightfoot's two treatises on the Temple Service, and in Carpzov's notes to his translation of Godwin's *Moses and Aaron*. Christian altars are described by Bona, Martene, and Bingham; but the standard work on the subject is probably that by the Lutheran Voigt, published after his death by J. A. Fabricius. Nearly twenty years ago an Essay on Christian Altars, by Laib

and Schwartz, appeared at Rottenburg; while for France, the Abbé Thiers' Dissertation on the subject is full of curious information, like all his works. Drawings of mediæval altars which have been preserved will be found in many works on architecture. Parker's *Glossary* gives the most noticeable preserved in England; but the *Dictionnaire de l'Architecture* of Viollet le Duc is much superior, and, with its beautiful illustrations and careful descriptions, has nearly exhausted the subject so far as regards French examples, to which it is almost exclusively confined. (G. H. F.)

ALTDORF, or ALTORF, a town in Switzerland, capital of the canton of Uri, situated at the northern end of the pass of St Gotthard, near the lake of Lucerne. It contains the oldest Capuchin monastery in Switzerland, but is otherwise of little interest, except as the place pointed out by tradition where William Tell shot the apple from his son's head. The lime tree, under which it is alleged the boy stood, has disappeared, but a fountain still marks the spot. There is also an old tower, with rude frescoes commemorating the feat. Bürglen, a village in the neighbourhood, is Tell's reputed birthplace. Population, 2724.

ALTDORFER, ALBRECHT, a painter and engraver of the early German school, was born at Regensburg, not later than 1480, and died in 1538. His paintings are remarkable for minute and careful finish, and for close study of nature. The most important of them are to be found in the Pinakothek at Munich. A representation of the battle of Arbela, included in that collection, is usually considered his chief work. His engravings on wood and copper are very numerous, and rank next to those of Albert Dürer.

ALTENBURG, a town in Germany, capital of the duchy of Saxe-Altenburg, situated near the river Pleisse, about 24 miles south of Leipsic. The town, from its hilly position, is irregularly built; but many of its streets are wide, and contain a number of large and beautiful buildings. Its ancient castle is picturesquely situated on a lofty rock, and is memorable as the place from which, in 1455, Kunz von Kaufungen carried off the young princes Albert and Ernest, the founders of the present royal and ducal families of Saxony. Altenburg is the seat of the higher courts of the duchy, and possesses a cathedral and several churches, a gymnasium, a library, a gallery of pictures and a school of art, several elementary schools, an infirmary, and various learned societies. There is considerable traffic in grain and cattle brought from the surrounding district; twice a year there are large horse fairs; and the book trade is extensive. Cigars, woollen goods, gloves, hats, and porcelain are among the chief manufactures. Population (1871), 19,966.

ALTEN OETTING, or ALTOETTING, a small market town in Upper Bavaria, situated on the Mörn, not far from its junction with the Inn. It has long been famous as a place of pilgrimage to which Roman Catholics resort in very large numbers, especially from Austria, Bavaria, and Swabia, on account of a celebrated image of the Virgin Mary in one of the churches. Another church contains the tomb of Tilly. Population, 1500.

ALTENSTEIN, a castle upon a rocky mountain in Saxe-Meiningen, on the south-western slope of the Thüringer Wald, not far from Eisenach. It is the summer residence of the dukes of Meiningen, and is surrounded by a noble park, which contains, among other objects of interest, a remarkable underground cavern, 500 feet long, through which flows a large and rapid stream. Boniface, the apostle of the Germans, lived and preached at Altenstein in 724; and near the castle is the place from which, in 1521, Luther was seized, to be carried off to the Wartburg. There used to be an old beech called "Luther's tree," which association connected with the Reformer, but it was blown down in 1841, and a small monument now stands in its place.

ALTIN, a lake of Siberia, which gives rise to the Bija, one of the head streams of the Obi, is situated among the Altai mountains, 320 miles south of the city of Tomsk. It is about 80 miles long, and its greatest breadth is about 50 miles; but the large quantities of melted snow which flow down from the surrounding mountains make it larger in summer than in winter. It is remarkable that in winter the northern part is frozen so hard as to be passable on sledges, while the southern is never covered with ice.

ALTING, HEINRICH, a German divine, was born at Embden in 1583. His father, Menso Alting, was minister of Embden, and early destined his son to the same profession. He studied with great assiduity and success at the universities of Herborn and Gröningen. In 1608 he was appointed tutor of Frederick, afterwards elector-palatine, at Heidelberg, and in 1612 accompanied him to England. Returning in 1613 to Heidelberg after the marriage of the elector with the Princess Elizabeth of England, he was appointed professor of theology, and in 1616, director of the *Collegium Sapientiæ*. In 1618, along with Scultetus, he represented the university in the synod of Dort. When Count Tilly took the city of Heidelberg, and handed it over to plunder, Alting found great difficulty in escaping the fury of the soldiers. He first retired to Schorndorf; but in 1623 he removed with his family to Embden, and afterwards followed to the Hague his late pupil, the Elector Frederick, who had been compelled to flee from his new kingdom of Bohemia. Such was the regard this prince had for Alting that he made him preceptor to his eldest son, and prevented him from accepting the charge of the church at Embden, and likewise a professorship in the university of Franeker. In 1627, Alting, with some difficulty, obtained leave from his patron to remove to Gröningen, where he was appointed to the chair of divinity; and there he continued to lecture, with increasing reputation, until his death, which took place in 1644. Alting was a man of great ability and extensive learning. Among the productions of his pen are:—*Notæ in Decadem Problematum Jacobi Behm*, Heidelberg, 1618; *Scripta Theologica Heidelbergensia*, Amst. 1662; *Exegesis Augustanæ Confessionis*, Amst. 1647.

ALTING, JACOB, son of the preceding, was born at Heidelberg in 1618. He studied theology and the Oriental languages at Gröningen, and in 1638 he put himself under the tuition of a Jewish rabbi at Embden. In 1640 he went to England, and was admitted to clerical orders by Dr Prideaux, bishop of Worcester; but an offer of the Hebrew professorship in the university of Gröningen induced him to return to Holland in 1643. In 1667 he was appointed professor of theology in the university. In this office he gave great offence to his colleague, Samuel Desmarets, by his disuse of the scholastic method of teaching. Desmarets preferred a charge of heresy against him; but the divines at Leyden pronounced that Alting was not guilty of anything more serious than imprudent fondness for innovation. Alting died of a fever in 1679. The fondness which he showed for rabbinical learning gave birth to the general report that he was inclined to become a Jew. His opinions, which seem to have excited more general attention than they deserve, may be seen in his writings, which were collected a few years after his death, and published in five volumes folio, by his pupil, the well-known Balthasar Bekker.

ALTON, a town of Hampshire, on the Wey, 17 miles E. of Winchester, and 47 S.W. of London by road; by the London and South-Western Railway it is 60 miles from London. Large markets and fairs are held for corn, hops,

cattle, and sheep; and the town contains some highly reputed ale breweries, besides paper manufactories and an iron foundry. The church, a fine old building, was the scene of a fierce conflict between the royalist and parliamentary troops in 1643. Population in 1871, 4092.

ALTON, a town in Madison county, Illinois, United States, stands on a high bluff on the left bank of the Mississippi, 21 miles above St Louis, and 3 above the mouth of the Missouri. It is a place of considerable importance, and carries on a thriving export trade in the produce of the surrounding country—grain, hay, fruit, coal, and lime. It has an excellent wharf, and good means of communication by railway, the two great lines from Chicago and Indianopolis having their junction at Alton. The town contains a Roman Catholic cathedral, about ten other churches belonging to various sects, and several schools. It has also a printing trade, with daily and weekly newspapers. Population in 1870, 8665.

ALTONA, the richest and most populous city of the Prussian province of Schleswig-Holstein, is situated on the north bank of the Elbe, so close to Hamburg that the two cities are virtually one. The rise of Altona to its present position has been rapid, at least for a continental city, and is mainly due to the fostering care of the Danish government, who established it as a rival to Hamburg. In 1640, when it became the property of Denmark, it was a small fishing village; in 1871 it contained 74,131 inhabitants. After the war of 1864 it ceased to belong to Denmark, and eventually became part of Prussia, although, with Hamburg, it is not included in the Zollverein. It carries on a large trade with Britain, France, the West Indies, and other countries; but it has by no means succeeded in depriving Hamburg of its commercial pre-eminence—great part of the business of Altona being, indeed, transacted on the Hamburg exchange. Tobacco is probably the chief manufacture, but there are also breweries, tanneries, oil-works, soap-works, and linen factories. Altona is a well-built modern town, really dating from 1713 (when the Swedes burnt it to the ground), with a higher situation than that of Hamburg, and consequently a purer and healthier atmosphere. It contains an observatory of some celebrity, several churches, two synagogues, a gymnasium, and an infirmary. It is the terminus of the Altona-Kiel Railway, which places it in connection with the principal towns of Schleswig-Holstein.

ALTOONA, a town of the United States, in Blair county, Pennsylvania, on the Central Railway, 244 miles west of Philadelphia, situated near the eastern base of the Alleghany Mountain, where the railroad begins to ascend it. It contains extensive locomotive and railway carriage manufactories belonging to the Pennsylvania Central Railway Company. Near Altoona is the famous "Horse Shoe Bend," where trains of but ordinary length are seen to be moving in opposite directions at the same time. The line of railway, in its ascent between Altoona and Cresson, winds round the side of the mountain, affording some of the finest mountain scenery on the continent. Population in 1870, 10,610.

ALTO-RILIEVO (*high relief*) is the term applied to sculpture that projects from the plane to which it is attached to the extent of more than one-half the outline of the principal figures. It is thus distinguished from *basso-rilievo*, in which there is a greater or less approximation to the pictorial method, the figures being made to appear as projecting more than half their outline without actually doing so. See RELIEF and SCULPTURE.

ALTRINGHAM, or ALTRINCHAM, a market town in the north of Cheshire, 8 miles south of Manchester, with which it is connected by railway. It is a neat, clean place, surrounded by villas of Manchester manufacturers, who are attracted by its healthy climate and pleasant situation. It has no parish church, but there is a chapel of ease belonging to the parish of Bowdon, in which it is situated, and also a Roman Catholic and several dissenting places of worship. Yarn, worsted, and cotton are the chief manufactures; and large quantities of fruit and vegetables are sent to the Manchester market. Population in 1871, 8478.

ALUM, a compound salt employed in dyeing and various other industrial processes. It is soluble in water, has an astringent, acid, and sweetish taste; reddens vegetable blues, and crystallises in regular octahedrons. When heated, it liquefies; and if the heat be continued, the water of crystallisation is driven off, the salt frothes and swells, and at last a white matter remains, known by the name of *burnt alum.*

Its constituents are sulphuric acid, alumina, an alkali, and water. The alkali may be either *potash, soda,* or *ammonia.* Hence there are three distinct species of alum, depending upon the nature of the alkali which each contains. *Potash alum* (in which the alkali is potash) is the common alum of this country, although both soda alum and ammoniacal alum are manufactured. The term alum is now used in chemistry as a generic one, and is applied to the class of double salts formed by the union of the sulphates of alumina, chromium, or iron with the sulphates of the alkalies. The composition of the ordinary potash alum is represented by the formula $AlK(SO_4)_2 \cdot 12H_2O$.

The progress made by chemists in the discovery of the constitution of alum was very slow. The species first investigated was potash alum. That it contained sulphuric acid as a constituent was known even to the alchemists. Pott and Marggraff demonstrated that alumina was another constituent. Pott, in his *Lithogeognosia*, showed that the earth of alum, or the precipitate obtained when an alkali is poured into a solution of alum, is quite different from lime and chalk, with which it had been confounded by Stahl. Marggraff went much farther. He not only showed that alumina is one of the constituents of alum, but that this earth possesses peculiar properties, is different from every other substance, and is one of the ingredients in common clay ("Expériences faites sur la Terre d'Alun," Marggraff's *Opusc.* ii. 111). Marggraff showed likewise, by many experiments, that crystals of alum cannot be obtained by dissolving alumina in sulphuric acid, and evaporating the solutions. The crystals formed are always soft, and quite different in their appearance from alum crystals. But when a solution of potash or ammonia is dropt into this liquid, it immediately deposits perfect crystals of alum ("Sur la Régénération de l'Alun," Marggraff's *Opusc.* ii. 86). He mentions likewise that manufacturers of alum in general were unable to procure the salt without a similar addition, that at first it had been customary to add a quantity of putrid urine, and that afterwards a solution of carbonate of potash was substituted in its place. But subsequent chemists do not seem to have paid much attention to these important observations of Marggraff: they still continued, without any rigid examination, to consider alum as a sulphate of alumina.

Bergmann indeed had observed that the addition of potash or ammonia made the alum crystallise, but that the same effect was not produced by the addition of soda or of lime ("De Confectione Aluminis," Bergmann's *Opusc.* i. 225). He had observed likewise that sulphate of potash is frequently found in alum. He decomposed the solution of alum by means of ammonia, evaporated the filtered liquid to dryness, and exposed the residue to a red heat. A quantity of sulphate of potash often remained behind in the crucible (*ibid.*, p. 326). From these facts he drew

the conclusion that sulphate of potash readily combines with sulphate of alumina.

After Klaproth had discovered the existence of potash as an ingredient in *leucite* and *lepidolite*, it occurred to Vauquelin that it was probably an ingredient likewise in many other minerals. He recollected that alum crystals often make their appearance during the analysis of stony bodies; and, considering that alum cannot be obtained in crystals without the addition of potash, he began to suspect that this alkali constituted an essential ingredient in the salt. A set of experiments, undertaken on purpose to elucidate this important point, soon satisfied him that his conjecture was well-founded. Accordingly, in the year 1797 he published a dissertation demonstrating that alum is a double salt, composed of sulphuric acid, alumina, and potash (*Annales de Chimie*, xxii. 258). Soon after, Chaptal published the analysis of four different kinds of alum, namely, Roman alum, Levant alum, British alum, and alum manufactured by himself. This analysis led to the same result as that of Vauquelin (*Ann. de Chim.* xxii. 280).

Since that time alum has been admitted by chemists to be a triple salt, and various analyses of it have been made to determine its constituents. Vauquelin (*Ann. de Chim.* l. 167), Thenard and Roard (*ibid.*, tom. lix. 72), Curaudau (*Journal de Physique*, lxvii. 1), and Berzelius (*Ann. de Chim.* lxxxii. 258), successively published the results of their experiments. These analyses gradually led to an accurate knowledge of the composition of this salt.

One of the most remarkable differences between the three species of alum is the solubility of each in water. At the temperature of 60°, 100 parts of water dissolve—

9·37 parts of ammoniacal alum,
14·79 parts of potash alum,
327·6 parts of soda alum.

This great solubility of soda alum renders the manufacture of it very difficult. It does not easily crystallise; indeed, when the weather is hot, crystals of it can hardly be obtained. Its great solubility would render it more convenient and more economical for dyers and calico-printers, provided it could be furnished at the same rate with common alum. But the greater difficulty attending the making of it would probably prevent it from being saleable at a price sufficiently low to make it available as a mordant.

Soda alum was first mentioned by Mr Winter in 1810, in his account of the Whitby alum processes (Nicholson's *Jour.* xxv. pp. 254, 255); but before that time it had been made by Mr Charles Macintosh of Crossbasket. Mr William Wilson, at Hurlet, near Glasgow, afterwards made it in considerable quantities. Specimens of it have been sent by Dr Gillies from the neighbourhood of Mendoza, in South America, where it occurs native in considerable quantity.

These three different species of alum differ also somewhat from each other in their specific gravities, which are as follows:—

Ammoniacal alum	1·56
Potash alum	1·75
Soda alum	1·88[1]

The word *alumen*, which we translate *alum*, occurs in Pliny's *Natural History*. In the 15th chapter of his 35th book he gives us a detailed description of it. By comparing this with the account of στυπτηρία given by Dioscorides in the 123d chapter of his 5th book, it is obvious that the two are identical. Pliny informs us that alumen was found naturally in the earth. He calls it *salsugo terræ*. Different substances, he informs us, were distinguished by the name of alumen; but they were all characterised by a certain degree of astringency, and were all employed in dyeing and medicine. The light-coloured alumen was useful in brilliant dyes, the dark-coloured only in dyeing black or very dark colours. One species was a liquid, which was apt to be adulterated; but when pure it had the property of striking a black with the juice of the pomegranate. This property seems to characterise a solution of sulphate of iron in water. It is quite obvious that a solution of our alum would possess no such property. Pliny says that there is another kind of alum which the Greeks call *schistos*. It forms in white threads upon the surface of certain stones. From the name *schistos*, and the mode of formation, there can be little doubt that this species was the salt which forms spontaneously on certain slaty minerals, as alum slate and bituminous shale, and which consists chiefly of sulphate of iron and sulphate of alumina. Possibly in certain places the sulphate of iron may have been nearly wanting, and then the salt would be white, and would answer, as Pliny says it did, for dyeing bright colours. Several other species of alumen are described by Pliny, but we are unable to make out to what minerals he alludes.

The alumen of the ancients, then, was not the same with the alum of the moderns. It was most commonly a sulphate of iron, sometimes probably a sulphate of alumina, and usually a mixture of the two. But the ancients were unacquainted with our alum. They were acquainted with sulphate of iron in a crystallised state, and distinguished it by the names of *misy, sory, chalcanthum* (Pliny, xxxiv. 12). As alum and green vitriol were applied to a variety of purposes in common, and as both are distinguished by a sweetish and astringent taste, writers, even after the discovery of alum, do not seem to have discriminated the two salts accurately from each other. In the writings of the alchemists we find the words *misy, sory, chalcanthum*, applied to alum as well as to sulphate of iron; and the name *atramentum sutorium*, which ought to belong, one would suppose, exclusively to green vitriol, applied indifferently to both.

When our alum was discovered is entirely unknown. Beckmann devoted a good deal of attention to the history of this salt, and published a curious dissertation on the subject; but his attempts to trace its origin were unsuccessful. The manufacture of it was discovered in the East, but at what time or place is totally unknown. It would appear that, about four or five hundred years ago, there was a manufactory of it at Edessa in Syria, at that time called Rocca,—hence, it is supposed, the origin of the term *rock alum*, commonly employed in Europe; though others allege that the term originated at Civita Vecchia, where alum is made from a yellow mineral which occurs in the state of a hard rock.

Different alum works existed in the neighbourhood of Constantinople. About the time of the fall of the Grecian empire the art of making alum was transported into Italy, at that period the richest and most manufacturing country in Europe. Bartholomew Pernix, a Genoese merchant, discovered alum ore in the island of Ischia, about the year 1459. Nearly at the same time John di Castro, who was well acquainted with the alum works in the neighbourhood of Constantinople, suspected that a mineral fit for yielding alum existed at Tolfa, because it was covered with the same trees that grew on the alum mineral near Constantinople. His conjecture was verified by trials, and the celebrated manufactory at Tolfa established. Another was begun in the neighbourhood of Genoa; and the manufacture flourished in different parts of Italy. To

[1] The soda alum whose specific gravity is here given was the native, from the province of St Juan, on the north of Mendoza. It contains less water, and therefore is probably heavier than common soda alum.

this country it was confined for the greater part of a century. Various manufactories of it were established in Germany by the year 1544.

England possessed no alum works till the reign of Charles I. Thomas Chaloner, son of Dr Chaloner, who had been tutor to Charles, while hunting on a common in Yorkshire took notice of the soil and herbage, and tasted the water. He found them similar to what he had seen in Germany where alum works were established. In consequence of this he got a patent from Charles for an alum work. Since that time various alum works have been established in different parts of Great Britain,—the most important now in operation being the Whitby works, originally established by Mr Chaloner; and the works at Pendleton, near Manchester, and Goole, Yorkshire, and at Hurlet and Campsie, both in the neighbourhood of Glasgow.

Several alum works exist in Sweden, particularly in West Gothland. There is one, for example, at Hænsæter, near the borders of the Wener Lake. But for a description of the Swedish works we refer to Bergmann's *Opuscula*, i. 284, or English translation, i. 342.

Various minerals are employed in the manufacture of alum, but by far the most important of them are the following three: *alum-stone, alum-slate, bituminous shale.*

Alum-stone or Alunite was first observed at Tolfa, near Rome, in the 15th century, and afterwards in Hungary and several other places, chiefly in trachyte or other volcanic rocks. It appears to be produced by the action of sulphureous vapours on the felspars they contain, and generally occurs in compact, granular, or earthy masses, mixed with quartz or felspar. Small crystals are found in cavities, and are either rhombohedrons with angles of 89° 10′, and thus nearly cubes, or these with the polar angles replaced by the basal plane. The specific gravity ranges from 2·58 to 2·752, the compact varieties being the lighter. Its hardness is 3·5 to 4, or rather softer than fluor spar. It has a distinct cleavage perpendicular to the axis of the rhombohedron, and conchoidal fracture in other directions. The pure varieties are white and colourless, but it is often coloured greyish, yellowish, or reddish. The crystals decrepitate before the blowpipe, but are infusible, as well as the compact alunite. The alum is extracted from this mineral by repeated roasting and treating with water. The absence of iron accounts for the superior purity for which the Roman alum was long celebrated.

Alum-slate is a far more abundant substance, occurring in beds in different formations. Thus it is common in the older Palæozoic or Silurian strata of Scandinavia and Scotland. Generally it is distinctly slaty, but sometimes forms rounded balls or concretions. It contains much carbonaceous matter, and hence its colour is greyish or bluish-black. It has a dull lustre, is soft and sectile. It contains much disseminated iron pyrites, and on decomposition in the air yields sulphate of iron, and alum as an efflorescence on the surface.

Many of the shales or slate clays in the coal formation also contain much iron pyrites, and thus also produce alum when acted on by the atmosphere. Such are those used for manufacturing alum at Campsie and other places near Glasgow. Where they contain much bituminous matter they show a shining resinous streak and greyish-black colour, and are named bituminous shales. These burn when heated, with a pale flame and sulphureous odour

The alum slates at Whitby in Yorkshire belong to the Lias, and are used in the alum works in that neighbourhood. In other places, as in many parts of Germany, similar beds are found in Tertiary formations, particularly in connection with the brown coal deposits. When fresh dug they often show no trace of alum, which only appears after exposure to the air, or when the decomposition of the iron pyrites is assisted by the action of heat.

Several native varieties of sulphate of alumina and soda alum occur in South America, some of the most remarkable of which it may be proper to specify.

1. Sulphate of alumina, or Alunogene, was first found at Rio Saldanha, but is now obtained from several places in Europe and America. The colour is white, here and there tinged yellow, obviously from external impurities. It occurs in fine crystalline needles; lustre silky; taste that of alum, but stronger; specific gravity, 1·6 to 1·7; soft; before the blowpipe behaves like alum.

2. Soda-alum. It occurs native in the province of St Juan, situated to the north of Mendoza, on the east side of the Chilian Andes, at about 30° S. lat. The alum is white, and composed of fibres adhering longitudinally, and having a certain breadth, but very thin. It bears some resemblance to fibrous gypsum, but it is harder, not being scratched by the nail, though the knife scratches it with great ease. It is sectile. The outer fibres are white and only slightly translucent, as if they had lost a portion of their water; but the internal fibres are transparent, and have a silky aspect. It tastes precisely like alum, and is very soluble, water at the temperature of 62° dissolving 3·773 parts of it, and boiling water dissolving any quantity whatever. When exposed to heat, it behaves very nearly as common alum.

3. There is a mineral called *aluminite*, which was observed in the environs of Halle many years ago, and which was afterwards detected by Mr Webster in clay resting on chalk at Newhaven in Sussex. This, if it were sufficiently abundant, would constitute an excellent material for the manufacture of alum. Its colour is snow-white. It occurs in reniform pieces of greater or smaller size; fracture fine earthy; dull; streak glistening; opaque; adheres feebly to the tongue; soils very slightly; very soft; feels fine, but meagre; specific gravity, 1·7054. It consists of alumina, sulphuric acid, and water.

Four different processes are employed in the manufacture of alum, according to the nature of the mineral from which the alum is to be extracted.

The process employed at Tolfa is the simplest of all. If the Tolfa stone be kept constantly moistened with water for about two months, it falls to powder of itself, and yields alum by lixiviation. But this is not the process employed by the manufacturers. The alum-stone is broken into small pieces, and piled on the top of a perforated dome, in which a wood fire is kindled. The smoke and flame of the wood penetrate through the pieces of alum-stone, and a sulphureous odour is disengaged, owing to the decomposition of a portion of the sulphuric acid in the stone. This roasting is twice performed; the pieces of ore which the first time were at the edge of the dome, being the second time put in the middle. The process of roasting this stone requires considerable attention. If the heat be too great, the quality of yielding alum is destroyed: if the heat be too small, the stone does not readily fall to powder. There can be little doubt that the unroasted stone would yield more alum than the roasted; but probably the additional labour requisite in the latter case would more than swallow up the increase of product.

The roasted stone, which has now acquired a reddish colour, is placed in rows between trenches filled with water. This liquid is so frequently sprinkled on it that the stone is always moist. In two or three days it falls to powder, like slacked quicklime; but the daily watering is continued for a month. The success of this part of the operation is said to depend very much on the weather. When the weather is rainy, the alum is all washed

out, and little or nothing left for the manufacturer to extract.

When the stone has by this process been reduced to a sufficiently fine powder, it is thrown into a leaden boiler filled two-thirds with water. During the boiling the powder is frequently stirred up, and the water that evaporates is replaced. When the boiling has been continued for a sufficient time, the fire is withdrawn, and time allowed for the earthy matter to subside to the bottom. A cock is then opened, which allows the clear liquor to flow out into deep wooden square vessels, so made that they can be easily taken to pieces. Here the alum gradually crystallises, and attaches itself to the sides and bottom of the vessel. The mother liquid is then drawn off into shallower wooden troughs, where more alum crystals are deposited. The liquid has now a red colour, and is muddy; and the last alum crystals are mixed with this red matter. They are washed clean in the mother liquor, which is finally pumped into a trough, and used in subsequent processes.

The alum obtained at Tolfa is known by the name of *Roman alum*, and is in very high estimation. It is always mixed with a little reddish powdery matter, which is easily separated from it.

Alum-slate, being very different in its composition, requires a different treatment to fit it for yielding alum. If the alum-slate contain a notable quantity of lime or magnesia, it does not answer the purposes of the manufacturer so well. The essential ingredients in alum-slate, for the alum-makers, are alumina and iron pyrites.

The first process is to roast the ore. In Sweden, where the fuel is wood, and consequently expensive, it is customary to use the alum-slate itself as fuel for roasting the ore. For this purpose a small layer of brushwood is covered with pieces of alum-slate, and set on fire; and, as the combustion proceeds, new layers of alum-slate are added. It is usual to place alternate layers of roasted and unroasted alum-slate. The combustion continues for a month or six weeks. At Whitby, coal is employed for roasting the alum-slate. Indeed the alum-slate of Whitby is lighter coloured than that of Sweden, and probably would not burn of itself. So great is the quantity of combustible matter in the Swedish alum-slate that it is employed as fuel for burning limestone. Great quantities of limestone are burnt in this manner at Hunneberg, near the south side of the lake Wener. The roasted ore has usually a brown colour. When it is red the quantity of alum which it yields is considerably diminished.

By this roasting the pyrites is oxidised into sulphate of iron and sulphuric acid, thus:—

$$FeS_2 + O_7 + H_2O = FeSO_4 + H_2SO_4.$$

The sulphuric acid as it is produced is, however, at once neutralised by the large excess of alumina producing sulphate, so that the result of the action is to produce a mixture of the sulphates of iron and alumina.

The roasted ore has an astringent taste, owing to the sulphate of iron and sulphate of alumina which it contains. The next process is to lixiviate it with water, in order to dissolve these salts. For this purpose it is put into reservoirs made of wood or masonry, with a stop-cock at the bottom to draw off the water. The usual method is to keep the water for twelve hours in contact with ore that has been twice lixiviated; then to draw it off, and allow it to remain for an equal period on ore that has been once lixiviated. Lastly, it is run upon fresh ore, and allowed to remain on it for twelve hours longer. If the specific gravity of the liquid thus treated be 1·25 at the temperature of 55°, it may be considered as saturated with sulphate of alumina and sulphate of iron; but probably this specific gravity is not often obtained.

The liquid, thus impregnated with salt, is now boiled down in leaden vessels to the proper consistency for crystallisation. In Sweden the fuel employed for this purpose is alum-slate. By this means a double effect is produced—the liquid is evaporated, and the alum-slate is roasted. During the boiling abundance of oxide of iron falls, mixed with selenite, if lime be one of the constituents of the alum-slate. When the liquid is sufficiently concentrated it is let into a square reservoir, in order to crystallise. Great quantities of sulphate of iron crystals are usually deposited in this vessel. These are collected by drawing the liquid off into another reservoir. When all the sulphate of iron that can be obtained has been separated, a quantity of sulphate of potash or ammonia, muriate of potash, or putrid urine, is mixed with the liquid. The sulphate of potash is procured from the sulphuric acid makers, and the muriate of potash from the soap-makers. By this addition alum is formed in the liquid, and it gradually deposits itself in crystals on the sides of the vessel. These crystals are collected, and dissolved in the smallest quantity of boiling water that will take them up. This solution is poured into large wooden casks. In a fortnight or three weeks the alum crystallises, and covers the sides and bottom of the cask. The hoops are now taken off, and the staves of the cask removed. A mass of alum crystals, having the shape of the cask, remains. This mass is pierced, the mother liquor allowed to run out, and preserved for a subsequent process. The alum, being now broken in pieces, is fit for sale.

The manufacture of alum from bituminous shale and slate-clay bears a considerable resemblance to the manufacture from alum-slate, but differs in several particulars. We shall give a sketch of the processes followed in two works of this kind that are in operation in the neighbourhood of Glasgow. The bituminous shale and slate-clay employed are obtained from old coal-pits, which are very extensive near Glasgow. The air in these coal-pits is moist, and its average temperature about 62°. The shale having been exposed for many years, has gradually opened in the direction of its slaty fracture, so as to resemble in some respects a half-shut fan; and all the chinks in it are filled with a saline efflorescence in threads. This salt is white, with a shade of green, has a sweetish astringent taste, and consists of a mixture of sulphate of iron and sulphate of alumina. In order to obtain these salts in a state of solution, nothing more is requisite than to lixiviate this shale with water. The lixiviated ore being left exposed to the weather, forms more salt, which is gradually washed out of it by the rain-water, and this water is collected and preserved for use.

The next step in the process is to boil down the liquid to a sufficient state of concentration. At Campsie all the boilers are composed of stone, and the heat is applied to the surface. This is a great saving, as leaden vessels are not only much more expensive, but require more frequent renewal. When the liquid is raised to a sufficiently high temperature in the stone reservoir, pounded sulphate of potash, or muriate of potash, as they can be procured, is mixed with it; and there is an agitator in the vessel, by which it is continually stirred about. This addition converts the sulphate of alumina into alum. The liquid is now let into another trough, and allowed to remain till it crystallises. In this liquid there are two salts contained in solution—viz., sulphate of iron and alum; and it is an object of great consequence to separate them completely from each other. The principal secret consists in drawing off the mother liquor at the proper time; for the alum is much less soluble in water than the sulphate of iron, and therefore crystallises first. The first crystals of alum formed are very impure. They have a yellow colour, and

seem to be partly impregnated with sulphate of iron. They are dissolved in hot water, and the solution poured into troughs, and allowed to crystallise a second time. These second crystals, though much purer, are not quite free from sulphate of iron; but the separation is accomplished by washing them repeatedly with cold water; for sulphate of iron is much more soluble in that liquid than alum. These second crystals are now dissolved in as small a quantity of hot water as possible, and the concentrated liquid poured while hot into large casks, the surface of which is covered with two cross beams. As the liquor cools, a vast number of alum crystals form on the sides and surface. The casks are allowed to remain till the liquid within is supposed to be nearly of the temperature of the atmosphere. This, in winter, requires eleven days; in summer, fourteen or more. The liquid, after standing eleven days in summer, has been observed to be still above blood heat. The hoops are then removed, precisely as in the manufacture of alum from alum-slate.

There always remains in the boilers a yellowish substance, consisting chiefly of peroxide of iron. This is exposed to a strong heat in a reverberatory furnace, and it becomes red. In this state it is washed, and yields more alum. The red residue is ground to a fine powder, and dried. It then answers all the purposes of Venetian red as a pigment. By altering the temperature to which this matter is exposed, a yellow ochre is obtained instead of a red.

In France, where alum ores are by no means abundant, alum is manufactured from clay. This method of making the salt was first put in practice by Chaptal when professor of chemistry at Montpellier. His methods have been since gradually improved, and brought to a state of considerable perfection. The first process tried was this: The clay was reduced to a fine powder in a mill, and then mixed with sulphuric acid. After remaining some days, it was exposed for twenty-four hours to a temperature of about 130°. It was then lixiviated, and the liquid mixed with urine or potash. This method being found inconvenient, was abandoned for the following:—The clay being well ground, was mixed with half its weight of the saline residue from a mixture of sulphur and nitre. This residue is little else than sulphate of potash. The mixture was formed into balls about 5 inches in diameter, which were calcined in a potter's furnace. They were then placed on the floor of a chamber in which sulphuric acid was made. The acid vapour caused them to swell, and to open on all sides. In about a month they were sufficiently penetrated with the acid. They were then exposed to the air, under shades, that the saturation might become more complete. Finally, they were lixiviated, and the liquid being evaporated, yielded pure alum.

This process was considerably improved by Berard, of the Montpellier alum work. Instead of exposing the calcined balls to the fumes of sulphuric acid, he sprinkled them with a quantity of sulphuric acid of the specific gravity 1·367, equal to the weight of the clay employed; but it is obvious that the proportion must vary with the nature of the clay. The solution takes place with the greatest facility, and crystals of alum are obtained by evaporating the liquid.

Another process was put in practice by Chaptal, in the neighbourhood of Paris. A mixture is made of 100 parts of clay, 50 parts of nitre, and 50 parts of sulphuric acid of the specific gravity 1·367; and this mixture is put into a retort and distilled. Aquafortis comes over, and the residue in the retort being lixiviated with water, yields abundance of excellent alum.

For chemical constitution and relations of the alums, see CHEMISTRY.

ALUMBAGH, the name of a large park or walled enclosure, containing a palace, a mosque, and other buildings, as well as a beautiful garden, situated about 4 miles from Lucknow, near the Cawnpore road. It was converted into a fort by the mutineers in 1857; and after its capture by the British was of importance in connection with the military operations around Lucknow. See LUCKNOW.

ALUMINIUM, a metallic substance, first separated from the chloride by Wöhler in 1828. It remained a laboratory product until Deville, about 1858, succeeded in improving the mode of production, so as to render the operations capable of management on the manufacturing scale. The process consists in heating to a red heat a mixture of the double chloride of aluminium and sodium, or the double fluoride of aluminium and sodium (cryolite), with the metal sodium. A vigorous action takes place, chloride of sodium being formed and the metal aluminium separated. On the large scale the reduction is effected by throwing a mixture of 10 parts of the double chloride, 5 parts of cryolite, and 2 parts of sodium on the hearth of a reverberatory furnace. Immediately after the action, the fused metal and slag, consisting of common salt and fluoride of aluminium, are run out, and a new quantity of the previous mixture introduced. The various patents that have been secured with reference to this manufacture have all regard to the saving of the metal sodium. The metal aluminium may be separated from the double chloride by electrolysis. For this purpose the fused salt has the electric current from ten cells of a battery passed through it, carbon poles being used. The metal appears at the negative pole in large globules, which may be collected and melted together under a layer of fused salt.

Aluminium is a white metal resembling silver in appearance. It is very malleable and ductile, and may be beaten and rolled into thin sheets, or drawn into fine wire. By hammering in the cold it becomes as hard as soft iron, but may be softened again by fusion. Being highly sonorous, it has been used for making bells. It is very light, being only $2\frac{1}{2}$ times heavier than water, and is thus four times lighter than silver. After fusion it has a specific gravity of 2·56; by hammering this may be increased to 2·67. It melts at a red heat, and is non-volatile at very high temperatures. The metal conducts heat and electricity as well as silver. Aluminium does not oxidise in air, even at a red heat, has no action on water at ordinary temperatures, and is not acted upon by sulphuretted hydrogen or sulphide of ammonium, and thus preserves its lustre where silver would be tarnished and blackened. It is not attacked by nitric acid, even when concentrated, and is not soluble in dilute sulphuric acid, but is readily soluble in dilute or concentrated hydrochloric acid with evolution of hydrogen. Solutions of caustic potash or soda dissolve the metal with great ease, forming aluminate of potash or soda, and giving off hydrogen. Aluminium forms alloys with most metals. The copper alloy called aluminium-bronze is the most important because of its colour, hardness, and malleability, and is largely used for articles of jewellery, for mounting sextants and other astronomical instruments, and for making balance beams.

ALUTA, an affluent of the Danube. See ALT.

ALVA, a village in Stirlingshire, Scotland, situated at the foot of Craigleith, one of the Ochil range, 7 miles N.E. of Stirling, with which it is connected by railway. Besides the parish church, there are places of worship belonging to the Free and United Presbyterian churches. Yarn spinning and the manufacture of shawls and tweeds are carried on to a considerable extent. Population in 1871, 4096.

ALVA, or ALBA, FERNANDO ALVAREZ DE TOLEDO, Duke of, born in 1508, was descended from one of the most illustrious families in Spain. His grandfather, Ferdinand

of Toledo, educated him in military science and politics; and he was engaged with distinction at the battle of Pavia while still a youth. Selected for a military command by Charles V., he took part in the siege of Tunis (1535), and successfully defended Perpignan against the Dauphin of France. He was present at the battle of Mühlberg (1547), and the victory gained there over John of Saxony was due mainly to his exertions. He took part in the subsequent siege of Wittenberg, and presided at the court-martial which tried the Elector and condemned him to death. In 1552 Alva was intrusted with the command of the army intended to invade France, and was engaged for several months in an unsuccessful siege of Metz. In consequence of the success of the French arms in Piedmont, he was made commander-in-chief of all the emperor's forces in Italy, and at the same time invested with unlimited power. Success did not, however, attend his first attempts, and after several unfortunate attacks he was obliged to retire into winter quarters. After the abdication of Charles he was continued in the command by Philip II., who, however, restrained him from extreme measures. Alva had subdued the whole Campagna, and was at the gates of Rome, when he was compelled by Philip's orders to negotiate a peace. One of its terms was, that the Duke of Alva should in person ask forgiveness of the haughty pontiff whom he had conquered. Proud as the duke was by nature, and accustomed to treat with persons of the highest dignity, yet such was the superstitious veneration then entertained for the papal character that he confessed his voice failed him at the interview, and his presence of mind forsook him. Not long after this (1559) he was sent at the head of a splendid embassy to Paris, to espouse, in the name of his master, Elizabeth, daughter of Henry, king of France. In 1567, Philip, who was a bigoted Catholic, sent Alva into the Netherlands at the head of an army of 10,000 men, with unlimited powers for the extirpation of heretics. When he arrived he soon showed how much he merited the confidence which his master reposed in him, and instantly erected a tribunal which soon became known to its victims as the "Court of Blood," to try all persons who had been engaged in the late commotions which the civil and religious tyranny of Philip had excited. He imprisoned the counts D'Egmont and Horn, the two popular leaders of the Protestants, brought them to an unjust trial, and condemned them to death. In a short time he totally annihilated every privilege of the people, and, with unrelenting cruelty, put multitudes of them to death. The executioner was employed in removing all those friends of freedom whom the sword had spared. In most of the considerable towns Alva built citadels. In the city of Antwerp he erected a statue of himself, which was a monument no less of his vanity than of his tyranny: he was figured trampling on the necks of two smaller statues, representing the two estates of the Low Countries. By his unusual and arbitrary demand of new supplies from the states he greatly aggravated this insult. The exiles from the Low Countries, roused to action by his oppression, fitted out a fleet of privateers, and after strengthening themselves by successful depredations, ventured upon the bold exploit of seizing the town of Breil. Thus Alva, by his cruelty, became the unwitting instrument of the future independence of the seven Dutch provinces. The fleet of the exiles having met the Spanish fleet, totally defeated it, and reduced North Holland and Mons. Many cities hastened to throw off the yoke; while the States-General, assembling at Dordrecht, openly declared against Alva's government, and marshalled under the banners of the Prince of Orange. Alva's preparations to oppose the gathering storm were made with his usual vigour, and he succeeded in recovering Mons, Mechlin, and Zutphen, under the conduct of his son Frederick. With the exception of Zealand and Holland, he regained all the provinces; and at last his son stormed Waerdan, and massacring its inhabitants, proceeded to invest the city of Haarlem, which, after standing an obstinate siege, was taken and pillaged. Their next attack was upon Alkmaar; but the spirit of desperate resistance was raised to such a height in the breasts of the Hollanders that the Spanish veterans were repulsed with great loss, and Frederick constrained reluctantly to retire. Alva's feeble state of health and continued disasters induced him to solicit his recall from the government of the Low Countries; a measure which, in all probability, was not displeasing to Philip, who was now resolved to make trial of a milder administration. In December 1573 the much oppressed country was relieved from the presence of the Duke of Alva, who, returning home accompanied by his son, made the infamous boast that during the course of six years, besides the multitudes destroyed in battle and massacred after victory, he had consigned 18,000 persons to the executioner. (For further details of his administration in the Netherlands, see HOLLAND.)

On his return he was treated for some time with great distinction by Philip. A tardy and imperfect justice, however, overtook him, when he was banished from court and confined in the castle of Uzeda for complicity in certain disgraceful conduct of his son. Here he had remained two years, when the success of Don Antonio in assuming the crown of Portugal determined Philip to turn his eyes towards Alva as the person in whose fidelity and abilities he could most confide. A secretary was instantly despatched to Alva to ascertain whether his health was sufficiently vigorous to enable him to undertake the command of an army. The aged chief returned an answer full of loyal zeal, and was immediately appointed to the supreme command in Portugal. It is a striking fact, however, that the liberation and elevation of Alva were not followed by forgiveness. In 1581 Alva entered Portugal, defeated Antonio, drove him from the kingdom, and soon reduced the whole under the subjection of Philip. Entering Lisbon, he seized an immense treasure, and suffered his soldiers, with their accustomed violence and rapacity, to sack the suburbs and vicinity. It is reported that Alva, being requested to give an account of the money expended on that occasion, sternly replied, "If the king asks me for an account, I will make him a statement of kingdoms preserved or conquered, of signal victories, of successful sieges, and of sixty years' service." Philip deemed it proper to make no further inquiries. Alva, however, did not enjoy the honours and rewards of his last expedition, for he died in January 1583, at the age of 74.

ALVARADO, PEDRO DE, one of the Spanish leaders in the discovery and conquest of America, was born at Badajoz about 1495. He held a command in the expedition sent from Cuba against Yucatan in the spring of 1518, and returned in a few months, bearing reports of the wealth and splendour of Montezuma's empire. In February 1519 he accompanied Hernando Cortez in the expedition for the conquest of Mexico, being appointed to the command of one of the eleven vessels of the fleet. (For the details of this expedition and of Hernando's share in it, see CORTEZ and MEXICO.) He was engaged (1523–4) in the conquest of Guatemala, of which he was subsequently appointed governor by Charles V. In 1534 he attempted to bring the province of Quito under his power, but had to content himself with the exaction of a pecuniary indemnity for the expenses of the expedition. During a visit to Spain, three years later, he had the governorship of Honduras conferred upon him in addition to that of Guatemala. He died in Guatemala in 1541.

ALVAREZ, FRANCISCO, born at Coimbra after 1460, a

priest and almoner to Dom Manuel, king of Portugal, was sent in 1515 as secretary to Duarte Galvão, on an embassy to David, king of Abyssinia. The expedition having been delayed by the way, it was not until 1520 that he reached Abyssinia, where he remained six years, returning to Lisbon in 1527. In 1533 he was sent to Rome on an embassy to Pope Clement VII. The precise date of his death, like that of his birth, is unknown; but it must have been later than 1540, in which year he published at Lisbon, under the king's patronage, an account of his travels, in one volume folio, entitled *Verdadeira Informaçam do Preste Joas das Indias.* This curious work was translated in Latin, under the title of *De Fide, Regione, et Moribus Æthiopum,* by Damien Goez, a Portuguese gentleman; and has often been reprinted and translated into other languages. The information it contains must, however, be received with caution, as the author is prone to exaggerate, and does not confine himself to what came within his own observation.

ALVAREZ, Don José, the foremost Spanish sculptor of modern times, was born at Priego, in the province of Cordova, in 1768, and died at Madrid in 1827. Bred to his father's trade of a stone-mason, he devoted all his spare time to drawing and modelling. In his twentieth year he became a pupil of the Academy of Granada. A work he executed soon afterwards for a fountain in his native town attracted the notice of the Bishop of Cordova, who took the young artist into his house and maintained him for several years. In 1799 he obtained from Charles IV. a pension of 12,000 reals, to enable him to visit Paris and Rome. In the former city he executed, in 1804, a statue of Ganymede, which placed him at once in the front rank of sculptors. Shortly afterwards his pension was more than doubled, and he left Paris for Rome, where he remained till within a year of his death. The most important of his numerous works, executed during this period, was a group representing Antilochus and Memnon, which was commissioned in marble (1818) by Ferdinand VII., and secured for the artist the appointment of court sculptor. It is now in the Museum of Madrid. Alvarez modelled a few portrait busts (Ferdinand VII., Rossini, the Duchess of Alba), which are remarkable for their vigour and fidelity.

ALVAREZ, Don Manuel, a Spanish sculptor, was born at Salamanca in 1727, and died in 1797. He followed classical models so closely that he was styled by his countrymen *El Griego,* "The Greek." His works, which are very numerous, are chiefly to be found at Madrid.

ALWAR, a semi-independent state of Rájputáná, and under the control of the Governor-General's agent for Rájputáná, lies between 28° 13′ 25″ and 27° 14′ 34″ N. lat., and between 77° 15′ 35″ and 76° 14′ 10″ E. long. It is bounded on the E. by the state of Bhartpur and the British district of Gurgáon, on the N. by Gurgáon district and the states of Patiálá and Nábhá, on the W. by the states of Nábhá and Jaipur, and on the S. by the states of Jaipur and Bhartpur. Its configuration is irregular, the greatest length from north to south being about 80 miles, and breadth from east to west about 60 miles, with a total area of about 3000 square miles. The total population of the state, as ascertained by a census taken in 1872, was 778,596, consisting of 598,333 Hindus, 180,225 Mahometans, and 38 Christians. The number of males was returned at 418,723, and females at 359,873, the proportion of males to the total population being 53·76 per cent. The eastern portion of the state is open and highly cultivated; the western is diversified by hills and peaks, which form a continuation of the Aravallí range, from 12 to 20 miles in breadth. These hills run in rocky and precipitous parallel ridges, in some places upwards of 2200 feet in height. The Sabhí river flows through the north-western part of the state, the only other stream of importance being the Ruparel, which rises in the Alwar hills, and flows through the state into the Bhartpur territory.

The one attempt at road-making in the state is a line which connects the chief town, Alwar, with Rájghar on the one side and with Tijará on the other. The greater portion of this road was metalled during the minority of the present rájá, but it has been neglected since he took the management of the state into his own hands, and is now said to be almost impassable, and worse than the ordinary cart tracks. The earthwork for a road from Alwar to the Bhartpur border was thrown up, but it has never been metalled, and the line is not used for traffic. The Alwar hills are rich in minerals. Iron ore is found in large quantities close to the surface. Thirty smelting furnaces are kept at work, and are capable of turning out 390 tons a-year. They give employment to a large number of people. Two copper mines have been in operation for a number of years, but with doubtful advantage to the state. Silver, lead, and sulphur are also found in small quantities, and attempts have been made to work them, but without success. The principal agricultural products are wheat and barley during the cold weather, with grain to a less extent. Joár, bajrá, and Indian corn are raised during the rains. Cotton is extensively cultivated, and exported on a considerable scale. A ten years' land settlement, which was formed by a late political resident, is now expiring, and a fresh settlement for a longer term is being made. The revenue of the state has for some time been in an unsatisfactory state. When the rájá attained his majority, and was invested with the full administration of his territory in 1863, the treasury contained a surplus of £205,000. Within seven years this surplus had dwindled away, and debts to the extent of £160,000 accumulated. Under these circumstances, the government found it necessary to place the administration of the state in the hands of the political resident, assisted by a council of management consisting of five of the principal chiefs and native gentlemen of the state. In 1870–71, the first year under the new management, the revenue of the state amounted to £213,085, and the expenditure to £135,201, leaving a surplus of £77,884, part of which was devoted to the liquidation of the state debt, the remainder being kept as a working balance. An allowance of £18,000 a-year is made for the household expenses of the rájá, besides an establishment of horses, carriages, and elephants maintained for his use. The educational institutions consist of a high school, attended in 1871–72 by 382 students; a Thákur school, for the education of the sons of chiefs and native gentlemen, and attended by 51 pupils; and sixty other schools, containing a total of 2785 pupils. Seven towns in the state are returned as containing a population of upwards of 5000 souls—namely, Alwar, 52,357; Rájghar, 12,070; Tijará, 7362; Govindgarh, 5720; Rámgarh, 5581; Rámpur, 5381; and Bahror, 5213. The only municipality is the town of Alwar. It derives its municipal revenue from a tax of 1 per cent. on the supposed income of the owners of houses. This tax yields about £800 per annum, out of which, with some assistance from the state, the city police, conservancy establishment, &c., are paid.

ALYPIUS, one of the seven Greek writers on music whose works are collected and published, with a commentary and explanatory notes, by Meibomius (*Antiquæ Musicæ Auctores Septem,* Amstel., 1652). The time in which he flourished cannot be precisely ascertained. He is said to have written before Euclid and Ptolemy; and Cassiodorus arranges his work, entitled *Introduction to Music,* between those of Nicomachus and Gaudentius. The work consists solely of a list of symbols of the various scales and modes, and is therefore probably only a fragment.

ALYPIUS of Antioch, a geographer of the 4th century, who was sent by the Emperor Julian into Britain as prefect, and was afterwards commissioned to rebuild the temple of Jerusalem. Among the letters of Julian are two (29 and 30) addressed to Alypius; one inviting him to Rome, the other thanking him for a geographical treatise, which no longer exists.

ALYTH, a town on the eastern borders of Perthshire, in a parish of the same name, situated in the valley of Strathmore, 13 miles west of Forfar. It is tolerably well built, and contains a handsome parish church, and also Free, United Presbyterian, and Scottish Episcopal churches. The chief industrial employments are linen manufacturing and wool spinning, and there is a fair nearly every month. Alyth was created a burgh of barony by James III. Population in 1871, 2134.

AMADEUS V., surnamed the *Great*, Count of Savoy, was born at Bourget in 1249, and succeeded his uncle Philip in 1285. The cautious prudence of Amadeus enabled him greatly to increase his territory by means of marriage, purchase, and donations. He gradually rose to such eminence among the European powers, that he was constituted their umpire to settle their differences—an office which he performed with much reputation to himself and advantage to them. In 1310 he was created a prince of the empire by Henry VII. When the Turks attempted to retake Rhodes from the knights of St John of Jerusalem, he acquired great renown by the valour with which he led an expedition to the relief of the island. A Maltese cross with the letters F.E.R.T. (*Fortitudo ejus Rhodum tenuit*), it is said, became the arms of Amadeus and his successors, in memory of this victory. Amadeus undertook a journey to Avignon to persuade Pope John XXII. to preach a crusade in favour of Andronicus. He died there in the year 1323.

AMADEUS VIII., Count and first Duke of Savoy, and latterly pope or anti-pope, under the name of Felix V., was born at Chambery in 1383, and succeeded his father, Amadeus VII., in 1391. Having, by purchase or otherwise, added large territories to his patrimonial possessions, he became so powerful that the Emperor Sigismund erected Savoy into a duchy in 1416; and after his elevation Amadeus added Piedmont and other provinces to his dominions. After this increase of rank and of territory he suddenly, in 1434, retired to a monastery at Ripaille. He does not appear, however, to have resigned his duchy, but continued to administer it through his son Louis. It is said, too, although some historians have cast doubts upon the story, that, instead of leading a life of asceticism, he spent much of the ducal revenues in furthering his own luxury and enjoyment. In 1439, when the pope, Eugenius IV., was deposed by the council at Basle, Amadeus, although not in orders, was elected, through bribery some say, his successor; and after resigning his duchy, was crowned in the following year as Felix V. In the stormy conflict that followed, the Emperor Frederick sided with Eugenius, and the nations of Europe, except Germany, which remained neutral, declared for the one pope or the other. In 1449 Amadeus thought it prudent to renounce his claim to the pontificate in favour of Nicholas V., who had been elected on the death of Eugenius. He, however, induced Nicholas to annul all the acts of Eugenius; to confirm the determination of the council of Basle to appoint him perpetual apostolical legate in Savoy, Piedmont, and the other places of his own dominions; and even to confer on him the bishoprics of Basle, Lausanne, Strasburg, and Constance. It was also conceded to Amadeus that he should continue to wear the pontifical dress, except in a very few particulars; that he should not be obliged to go to Rome to attend any general council; and that he, instead of kissing the pope's toe, should be permitted to kiss his cheek. Amadeus died at Geneva in 1451.

AMADIS OF GAUL. The best edition for English readers of this famous work is to be found in the abridged translation of Southey, and the best account of it is to be found in his preface, which, however, is not void of error. Here, for example, is its final sentence:—"*Amadis of Gaul* is among prose what *Orlando Furioso* is among metrical romances—not the oldest of its kind, but the best." We, of course, in England would place the *Morte d'Arthur* above all romances of the kind; and the praise that we allow to *Amadis of Gaul* is precisely that which Cervantes bestows upon it—of being the earliest and best of the Spanish romances. When the licentiate and the barber burnt the library of Don Quixote, they spared from the flames only three romances—*Amadis of Gaul*, *Palmerin of England*, and *Tirante the White*. "I have heard," said the licentiate, "that *Amadis of Gaul* was the first book of chivalry printed in Spain, and that all the rest sprung from it; I think, therefore, as head of so pernicious a sect, we ought to condemn him to the fire without mercy." "Not so, sir," said the barber, "for I have heard also that it is the best of all the books of this kind; and therefore—as being unequalled in its way—it ought to be spared." "You are right," said the priest, "and for that reason its life is granted." Although Cervantes speaks of the romance as a Spanish one, and although Southey translated it from the oldest extant edition, which is also Spanish, it is currently supposed to have been originally written in Portuguese by Vasco Lobeira, himself a good knight, who received his spurs on the field of battle from King Joam, and who died in 1403. The work, however, has been claimed as of French origin by the Comte de Tressan. Southey ridicules this theory, and insists upon the claims of the Portuguese author. It is quite certain that the Comte de Tressan attempted to prove too much; but, on the other hand, Southey has not allowed weight enough to the fact that the *Amadis of Gaul* is but the first work of romance which appeared in the Portuguese and Castilian languages; that it was preceded for more than a century by other romances of Anglo-Norman origin; and that, if not in its names and personages, yet in its idea—in the character of its incidents and in much of its geography—it belongs to the world of Anglo-Norman romance. What though we cannot lay our hands on the French original from which Lobeira translated, any more than we can lay our hands on Lobeira's own work from which the Castilian version has been made, we still know that all the ideas and materials, all the design, all the machinery of *Amadis of Gaul*, belong to the Anglo-Norman cycle of romance which was in vogue before Lobeira was born. And in this creed we cheat him of nothing when we say that we know not to what extent he is entitled to the praise of originality. Knowing what we do of these romances, it is not enough to say, for the establishment of Lobeira's claims, that we cannot trace the *Amadis of Gaul* to any one before him. Expressions of his own throughout his work show that if he was not a literal translator, he was at least a borrower. Thus, towards the end of his third chapter he writes—"The author ceaseth to speak of this, and returneth to the child whom Gandales brought up." The Spanish translator, Montalus, confesses to have taken liberties with the Portuguese version from which he worked, altering, adding, and abridging. The Comte de Tressan maintains that the original French work must have ended with the third book and the rescue of Oriana; and that from this point we can distinctly trace the work of Spanish hands. Southey, again, thinks that the work, as it left the hands of Lobeira, ended in the fourth book with the marriage of Amadis and Oriana, and that all which follows is due to the tasteless accretions of Montalus. Although this is mere conjecture, still it is natural that we should attach no little force to the correct feeling of Southey. For the story itself, it is impossible to give a summary of it—the plot being too disconnected; but he who has read one such tale, or even a few chapters of one, may have a general impression of all—hacking and hewing in every page, knights always at war and seeking adventures, giants in the path, lions in the forest, damsels in durance, castles to be attacked, wizards and witches with hate in their hearts, kings everywhere plentiful as blackberries, and lovely ladies abounding in tenderness. The sentiment of the work is very noble, and some of the descriptions are full of fire; but the reader owes more than he is aware to the curtailments of Southey.

AMADOU (*Polyporus fomentarius*), a fungus that grows upon old trees, especially the oak, ash, fir, and cherry. When beaten soft it is used as a styptic for slight hæmorrhage.

and as material for surgical pads. After being boiled in a solution of nitre it is employed as tinder.

AMAGER, or AMAK, a small island belonging to Denmark, lying in the Sound, close to the east coast of Seeland. The channel which separates its northern extremity from Seeland forms the harbour of Copenhagen; and nearly the third part of that city, the suburb of Christianshafen, is situated in Amager. The island is about 9 miles long and 4 broad, with a fertile soil, which produces large quantities of vegetables for the Copenhagen market. It is peopled chiefly by the descendants of a Dutch colony which Christian II. brought there in 1516, who still retain many of the old peculiarities of dress, language, and manners. Population about 9000, exclusive of the inhabitants of Christianshafen. The other towns are Dragoe and Castrup.

AMALASONTHA, or AMALASUENTHA, daughter of Theodoric, king of the Ostrogoths, was born about 498 A.D. In 515 she married Eutharic, the last representative of the Amali family, who died (524–5), leaving an only son, Athalaric. The latter was designated by his grandfather Theodoric as the heir to the throne, and Amalasontha was appointed his guardian. On the death of Theodoric in 526, Amalasontha became regent, and endeavoured by a wise and vigorous administration to carry on the work of civilisation and enlightenment which her father had commenced. She devoted herself with special solicitude to the education of Athalaric, but her efforts were frustrated by the opposition of the Gothic nobles. Encouraged by them, the young heir to the throne threw off the restraints imposed by his mother, plunged into debauchery, and died at the age of sixteen (534). In the same year Amalasontha married her cousin Theodahadus, and made him co-regent with herself. A few months later (April 535) she was assassinated by order of her husband in an island on Lake Bolsena.

AMALEKITES, an ancient people, widely spread throughout the country lying on the south and east of Palestine, often mentioned in the Jewish Scriptures, and celebrated also in Arabian tradition. In Scripture they occur first in Gen. xiv. 7, occupying the territory around Kadesh, and suffering from the invasion of Chedorlaomer and his confederates. They appear next assaulting the Israelites, shortly after the exodus from Egypt, at Rephidim, in the neighbourhood of Mount Sinai (Ex. xvii. 8; cf. Deut. xxv. 17). They again occur falling upon a party of the Israelites on the southern verge of the promised land (Num. xiv. 45; cf. xiii. 29). In the time of the judges they are found associated with the Moabites, the Ammonites, the Midianites, and "the children of the east," in repeated attacks upon the Israelites, invading their territory from the eastern side of Jordan (Judges iii. 13; vi. 3). Saul, by divine command, led an expedition into the country of Amalek, waging against them an exterminating war, "smiting them from Havilah until thou comest to Shur, that is over against Egypt" (1 Sam. xv. 1). David also "invaded the Geshurites, and the Gezrites, and the Amalekites; for these nations were of old the inhabitants of the land as thou goest to Shur, even unto the land of Egypt" (1 Sam. xxvii. 8). The last notice occurs in 1 Chron. iv. 43, from which we learn that in the days of Hezekiah a body of Simeonites "went to mount Seir" and "smote the rest of the Amalekites that were escaped;" a notice showing the accomplishment of the doom of extermination which had been denounced against them (Ex. xvii. 14–16; Num. xxv. 20), and finding an echo in the words of an Arabian poet, "The race of Amlak has disappeared, and there is left of it neither mean man nor mighty" (Maçoudi, *Les Prairies d'Or*, par Meynard et Courteille, vol. iii. 104). We twice hear of Agag as the name of the king of the nation (Num. xxiv. 7; 1 Sam. xv. 8); and it is reasonably supposed that this, like Pharaoh in Egypt, was a name common to all their kings. It has been generally supposed that the Haman of the book of Esther, called "the Agagite," belonged to the royal line of the Amalekites; but it is now found, from Assyrian records, that Agagi was the name of a country east of Assyria, from which it may be assumed that the title was derived. See Lenormant, *Lettres Ass.* i. 45.

Josephus agrees with Scripture in assigning to the Amalekites the territory immediately to the south of Palestine. Thus he speaks of them as inhabiting "Gobolitis and Petra" (Gobolitis = Gebal, in Ps. lxxxiii. 7; cf. Reland, *Palæstina*, p. 71); and as reaching "from Pelusium to the Red Sea" (*Ant. Jud.* iii. 2, 1; vi. 7, 3; cf. ii. 1, 2). The country which they are thus represented as occupying is suited only to a nomadic population; and accordingly the indications of the Scripture narrative point to this as the general character of the Amalekite people. They appear as the Bedouins of ancient times, rapid and devastating in their movements (1 Sam. xxx. 1); and in their expeditions "coming up with their cattle and their tents" (Jud. vi. 5). At the same time, in the more fertile portions of their territory they doubtless had settled abodes. We read in 1 Sam. xv. 5 of "a city of Amalek;" and Josephus speaks, apparently in an exaggerated way, of their cities being captured by means of elaborate siege operations (*Ant. Jud.* vi. 7, 2).

The ethnical character and relation of this people, and their complete national history, it is impossible satisfactorily to make out from the fragmentary materials in our hands. They are not mentioned in the table of nations in Gen. x., while in Gen. xxxvi. 12, 16, their ancestry seems to be referred to Esau. At the same time, the existence of the nation is noticed in Gen xiv., long before Esau; and it seems unnatural to understand this, with Hengstenberg and others, in a proleptic sense, especially as there are other independent grounds for referring the beginning of their history to an earlier date. It is certain that the genealogical tables of Scripture, like those of Arabia, include cases of adoption or affiliation as well as of direct descent, and probably it is in this sense that the notice referring Amalek to Esau should be understood. In Balaam's prophecy Amalek is called "the first of nations" (ראשית גוים, *præstantissima gentium*, Gesenius), Num. xxiv. 20, an expression scarcely reconcilable in the circumstances with descent from Jacob's brother. Again, though found in Jewish scripture located in the immediate south and east of the Israelitish territory, yet there are indications in Scripture itself that at one time they had had a wider extension. "The mount of the Amalekites" is mentioned as situated in "the land of Ephraim" (Jud. xii. 15), apparently warranting the inference that they once held possessions on the west of the Jordan (see Stanley, *Sin. and Pal.*, p. 237, n.) "Amalek" also is found in some copies of the LXX., as the translation of Maacah, in 2 Sam. x. 6, 8, giving some ground for the belief that a section of the same race had once been settled on the north-east of Palestine (see Ewald, *Gesch. Israel's*, Bd. I. 335). There is little in the Bible to illustrate their linguistic affinity; but so far as appears their language was Shemitic, identical with or very closely allied to the Hebrew. Samuel and the captive Agag (1 Sam. xv. 32), and David and the Amalekite youth (2 Sam. i. 13) converse together; and it has been attempted also to explain the names Amalek and Agag by Shemitic analogies (Meier, *Zeitschrift d. morg. Ges.*, Bd. xvii. p. 577). By Philo (*Vita Mosis*, § 39) the Amalekites of the Sinaitic peninsula are called Phœnicians.

The traditions of the Arabians regarding this race are confused and conflicting, yet certainly are not to be summarily rejected as destitute of any claim to historic credibility; and with all their entanglement they speak strongly for the ancient and far-extended power of the people in question, and also more doubtfully for their Shemitic affinities. In these traditions, Amlak or Amlik, the father of the Amalekites, is represented sometimes as the son of Laud (*i.e.*, Lud), the son of Shem; sometimes as the son of Aram, the son of Laud; while sometimes also he is spoken of as a son of Ham. They belong, with the Adites, Thamudites, and others, to the primitive races of Arabia. They are said to have been expelled from Babylonia by the Assyrian conquerors, and driven westward into Arabia and Syria, to have built and reigned in Aleppo, to have conquered and for some centuries retained possession of Egypt, and to be the ancestors of the Berbers in North Africa (see Abulfeda, *Hist. Ante-Isl.*, pp. 16, 178; Maçoudi, *op. cit.*, vol. iii., p. 106; C. de

Perceval, *Hist. des Arabes*, vol. i., p. 18); Knobel, *Volkertafel*, p. 198; Movers, *Phönizier*, 2ter Th., Bd. ii., p. 422). With these Arabian accounts it is natural to bring into connection the facts narrated by Manetho, and now in substance ascertained from old Egyptian records, regarding the conquest of the Nile valley by an Arabian race, called Hycsos by the former, and *Menti*, or shepherds, in the latter (see Bunsen, *Egypt's Place*, vol. iii., p. 266; Brugsch, *Hist. d'Egypte*, vol. i., p. 75; Chabas, *Les Pasteurs en Egypte*, p. 9) Now, from the time of the eighteenth dynasty, northern Arabia is found in Egyptian monuments to be in possession of a people called Shasu, a name which Egyptologers generally compare with the second syllable of Hycsos, and which also, perhaps, corresponds with Zuzim of Gen. xiv. 5. These Shasu may with confidence be identified with the Amalekites of Scripture; their *locale* and their habits are the same; and of them we learn that "they were spread over a vast territory, quite like the wandering Arabs of our day. They are found near Djor, on the north-east frontier of Egypt, as well as in the defiles of Lebanon, where their depredations made themselves felt fourteen centuries before our era" (Chabas, *Etudes sur l'Antiquité Historique*, p. 114; cf. his *Voyage d'un Egyptien*, p. 111). "They wear short tunics, a turban-like head-dress, and are armed with spears and axes. A characteristic feature is the long beard, as among the Canaanitish nations" (Brugsch, *Geog. Inschriften*, Bd. ii. 53).

The notices occurring in Arabian writers, which speak of Amalekites as spread over various more southern portions of Arabia, may probably be referred to the period subsequent to their expulsion from their northern seats by the Israelites and other enemies. The Benu-Kerker, who dwell around Mecca, are by some referred to this stock; the same is true of the Benu-Amila, who, before migrating northwards into Syria, dwelt in Yemen. We hear of Amalekites also in "Cheibar, Jatrib, and other parts of Hedjaz" (Abulfeda, *op. cit.*, p. 179); in regard to which notice a certain degree of confirmation is afforded by the mention by Pliny of an Arabian town, the name of which reads Marippa Palmalacum, but which probably should be read Jatrippa Alamalacum, that is, Jatrib the Amalekite (see Pliny, *Hist. Nat.* vi. 32; Blau, *Zeitschrift d. m. Ges.*, Bd. xxii. 668; cf. Noldeke, *Uber d. Amalekiter*, 37). According to some (Tuch, Blau, and others), the famous Sinaitic inscriptions, ascertained to be written in a Shemitic dialect, are to be ascribed to the Amalekite race. Doubtless their authors dwelt in the country once inhabited by this people, but that they belonged to them, and not to some succeeding race, has not yet been demonstrated.

From the cuneiform records we have gained as yet no illustration of this subject, unless the people Malikhu, or Malaku, mentioned in the inscriptions of Sennacherib among certain Aramæan tribes inhabiting the valley of the Euphrates, may be identified with Amalek (see *Records of the Past*, vol. i., pp. 26, 57).

AMALFI, a town of Italy, in the Principato Citeriore, situated at the entrance of a deep ravine on the north side of the Gulf of Salerno. It was founded, according to the common account, under Constantine the Great, and was one of the first cities to recover from the irruption of the barbarians into Italy. During the 10th and 11th centuries it was an independent republic of great commercial importance, with a trade which extended to Egypt and the east, and a population of 50,000. Its code of maritime laws (*Tabula Amalfitana*) is said to have regulated commerce at one time throughout the whole of Italy, but the truth of this statement appears to be extremely questionable. In 1135 Amalfi was plundered by the Pisans, who are said to have then discovered and carried off the far-famed manuscript of the Pandects of Justinian, which is now in the Laurentian library at Florence. Soon after this the town passed under the dominion of Naples, and from that time rapidly declined. In 1343 a terrible storm buried a large part of the town under the sea, and at the present day it is a mere wreck of its former greatness. It has only about 6500 inhabitants, whose chief employments are fishing and the manufacture of macaroni, silk, and paper. It is still the seat of an archbishop, and contains an ancient cathedral dedicated to St Andrew. Flavio Gioja, to whom the invention of the mariner's compass has been ascribed, and Masaniello were born at Amalfi.

AMALGAM, the name given to an alloy of mercury and another metal. The amalgams are a very numerous class of compounds, and many of them are used largely in the arts. Many amalgams are produced by direct contact of the metals, with evolution of heat. Others are obtained by the action of mercury on a salt of the metal, or the action of the metal on a salt of mercury, assisted by the passage of a weak electric current in some cases. Some amalgams are solid, others liquid. They are, generally speaking, weak compounds, many of them being decomposed by pressure, and all are decomposed at a white heat. Tin amalgam is used for "silvering" mirrors, gold and silver amalgam in gilding and silvering, cadmium and copper amalgam in dentistry, and an amalgam of zinc and tin for the rubbers of electrical machines. See MERCURY and CHEMISTRY.

AMALIA, ANNA, Duchess of Saxe-Weimar, was born at Wolfenbüttel on the 24th October 1739, and married Duke Ernest of Saxe-Weimar in 1756. Her husband died in 1758, leaving her regent for their infant son, Karl August. During the protracted minority she administered the affairs of the duchy with the greatest prudence, strengthening its resources and improving its position in spite of the troubles of the Seven Years' War. She was a warm patroness of art and literature, and attracted to Weimar many of the most eminent men in Germany. Wieland was appointed tutor to her son; and the names of Herder, Goethe, Knebel, Böttiger, Musæus, and Schiller shed an undying lustre on her court. In 1775 she retired into private life, her son having attained his majority. In 1788 she set out on a lengthened tour through Italy, being accompanied by Goethe. She died on the 10th April 1807. A memorial of the duchess is included in Goethe's works under the title *Zum Andenken der Fürstin Anna-Amalia.*

AMALRIC or AMAURI OF BENA, so called from his birthplace, a small village in the diocese of Chartres, was the founder of a school of pantheists known by his name. He lectured at Paris about the year 1200, and attracted a large circle of hearers. In 1204 his doctrines were condemned by the university; and on a personal appeal to Pope Innocent III. the sentence was ratified, Amalric being ordered to return to Paris and recant his errors. This he did in 1207. His death, two years later, was caused, it is said, by grief at the humiliation to which he had been subjected. In the same year (1209) ten of his followers were burnt before the gates of Paris, and Amalric's own body was exhumed and burnt, and the ashes given to the winds. The doctrines of the Amalricians were formally condemned by the fourth Lateran Council in 1215.

AMALTEO, the name of a family belonging to Oderzo, Treviso, several members of which were distinguished in literature. The best known are three brothers, Geronimo (1507–74), Giambattista (1525–73), and Cornelio (1530–1603), whose Latin poems were published in one collection under the title *Trium Fratrum Amaltheorum Carmina* (Venice, 1627; Amst. 1689). The eldest brother, Geronimo, was a celebrated physician; the second, Giambattista, accompanied a Venetian embassy to England in 1554, and was secretary to Pius IV. at the Council of Trent; the third, Cornelio, was a physician and secretary to the republic of Ragusa.

AMALTEO, POMPONIO, a painter of the Venetian school, was born at San Vito in Friuli in 1505, and died in 1584. He was a pupil of Pordenone, whose style he closely imitated. His works consist chiefly of frescoes and altar-pieces, and many of them have suffered greatly from the ravages of time.

AMARA SINHA, a Sanscrit grammarian and poet, of whose personal history hardly anything is known. He is said to have been "one of the nine gems that adorned the throne of Vikramaditya," and accordingly to have flourished about 56 B.C. This seems on the whole the most probable date, though the fifth century of the Christian era,

and even the eleventh, have also been assigned, on the supposition that the Vikramaditya spoken of was not the first but a later monarch of the name. Amara seems to have been a Buddhist; and an early tradition asserts that his works, with one exception, were destroyed during the persecution carried on by the orthodox Brahmins in the fifth century. The exception is the celebrated *Amara-Kosha* (Treasury of Amara), a vocabulary of Sanscrit roots, in three books, and hence sometimes called *Trikanda*, or the "Tripartite." It contains 10,000 words, and is arranged, like other works of its class, in metre, to aid the memory. The first chapter of the *Kosha* was printed at Rome in Tamil character, in 1798. An edition of the entire work, with English notes and an index by Colebrooke, appeared at Serampore in 1808. The Sanscrit text was printed at Calcutta in 1831. A French translation by Loiseleur-Deslongchamps was published at Paris in 1839.

AMARANTH, or AMARANT (from the Greek ἀμάραντος, unwithering), a name chiefly used in poetry, and applied to certain plants which, from not soon fading, typified immortality. Thus Milton (*Paradise Lost*, iii. 353) :—

> "Immortal amarant, a flower which once
> In paradise, fast by the tree of life,
> Began to bloom; but soon for man's offence
> To heaven removed, where first it grew, there grows,
> And flowers aloft, shading the fount of life,
> And where the river of bliss through midst of heaven
> Rolls o'er elysian flowers her amber stream:
> With these that never fade the spirits elect
> Bind their resplendent locks."

The famous flowers, however, still live upon earth, and are known in our gardens as love-lies-bleeding, prince's feather, cockscomb, and the globe amaranth. As we wreathe our churches in winter with holly and ivy, the churches in Portugal and other southern countries are adorned with the purple tints of the globe amaranth, which is said to retain its colour for years. It should be noted that the proper spelling of the word is amarant; the more common spelling seems to have come from a hazy notion that the final syllable is the Greek word for *flower*, which enters into a vast number of botanical names.

AMARAPURA, literally "the City of the Gods," a town of independent Burmah, situated on the east bank of the Irawadi river, in 21° 57′ N. lat., and 73° 4′ E. long. The town was founded in 1783, and made the capital of the Burmese kingdom. It increased rapidly in size and population, and in 1810 was estimated to contain 170,000 inhabitants; but in that year the town was destroyed by fire, and this disaster, together with the removal of the native court in 1819, caused a decline in the prosperity of the place. In 1827 its population was estimated at only 30,000. Since then it has suffered another severe calamity from an earthquake, which in 1839 destroyed the greater part of the city. It is regularly laid out, but, with the exception of some temples, is built only of bamboos, although several of the buildings, being richly gilt, have a showy appearance. The most remarkable edifice is a celebrated temple, adorned with 250 lofty pillars of gilt wood, and containing a colossal bronze statue of Buddha. The remains of the ancient palace of the Burmese monarchs still survive in the centre of the town. During the time of its prosperity Amarapura was defended by a rampart and a large square citadel, with a broad moat, the walls being 7000 feet long and 20 feet high, with a bastion at each corner.

AMASIA, or AMASIAYAH, a town in Anatolia, Turkey, situated on both sides of the Yeshil-Irmak, or Iris, in a narrow gorge about 80 miles from the mouth of the river. The houses being ill-built and the streets narrow, the town would have a mean appearance but for its situation and the splendid remains of antiquity in its neighbourhood. The most remarkable of these are the Acropolis, which is built on a lofty rock overhanging the town; the tombs of the kings of Pontus, described by Strabo the geographer, a native of Amasia; and a handsome mosque, erected in 1490 by the Sultan Bajazet II. The chief productions of Amasia and the surrounding districts are silk, salt, wheat, wine, and cotton. Population of the town, 25,000.

AMASIS, King of Egypt, ascended the throne 569 B.C. From the rank of a common soldier he gradually rose to be one of the principal officers in the court of Apries, the last king of the line of Psammetichus. Being commissioned by Apries to quell an insurrection, he went over to the rebels, who proclaimed him king. Apries, whose tyranny had caused nearly all his subjects to desert him, took the field with an army of mercenaries, and meeting Amasis near Memphis, was defeated and taken prisoner. The usurper treated the captive prince with great lenity; but so violent was the popular hatred, that he was compelled to deliver him into the hands of his enraged countrymen, who instantly put him to death by strangling. Under the prudent administration of Amasis, Egypt enjoyed the greatest prosperity. He adorned it with numerous and splendid buildings, among which were a portico to the temple of Minerva at Sais, and the great temple of Isis at Memphis. He also erected a colossus before the temple of Vulcan, 75 feet in length, resting on its back; and on the basis stood two statues, each 20 feet high, cut out of the same stone. To gain the alliance of the Greeks, he allotted settlements for them on the sea-coast, permitting them to build temples, and to observe all the rites of their religion unmolested; and when the temple of the Delphians was burnt he presented them with 1000 talents to assist them in rebuilding it. He also married a Grecian lady, named Ladice, the daughter of Battus of Cyrene, and had a bodyguard of Greeks in his pay. Solon, the celebrated lawgiver, is reported to have visited Amasis. The close of his reign was disturbed by the threatened invasion of Cambyses, king of Persia, and by the rupture of the alliance between Amasis and Polycrates of Samos. (See POLYCRATES.) Amasis, however, did not live to see the conquest of Egypt, for he died in 525, before the Persians had entered the country.

AMAT, FELIX, a Spanish ecclesiastical historian, was born at Sabadell, in the diocese of Barcelona, 10th August 1750. He entered the church in 1767, and after taking his doctor's degree at Grenada in 1770, was made professor of philosophy and librarian in the episcopal seminary at Barcelona. In these offices, and in that of director of the seminary, which he subsequently held, his talents and energy did much to advance the efficiency of the institution. In 1803 he was made archbishop of Palmyra by the pope, and in the same year the king, Charles IV., created him abbot of St Ildefonso. When the war with France broke out in 1794, Amat was at first looked upon as an undoubted patriot, but latterly he was suspected, and with some reason, of favouring the French cause. He was compelled to leave Madrid on the entry of the British in 1812; and was subsequently, in 1814, banished to Catalonia. He died in a Franciscan convent near Salent on 28th September 1824. Amat's chief work is his *Ecclesiastical History*, from the birth of Christ to the end of the 18th century, originally published in twelve volumes (1793–1803). It was condemned by the Inquisition, but rather on political than on religious grounds. His other works are numerous, the most important being his *Observations on Ecclesiastical Power* and his *Six Letters to Irenicus*, in which he attacked the theory that consent of the subjects is the necessary foundation of sovereignty. Amat was a man of gigantic stature, being, it is said, at the age of seventeen, 7 feet 2 inches in height.

AMATI, the name of a family of violin-makers who flourished at Cremona from about 1550 to 1692. According to Fétis, Andrea and Nicolo Amati, two brothers, were the first Italians who made violins. They were succeeded by Antonio and Geronimo, sons of Nicolo. Another Nicolo, son of Geronimo, was alive in 1692. The violins made by this family are distinguished by their small size, exquisite finish, and the mathematical proportion of the parts. Their tone is soft and sweet, but deficient in intensity, owing to the flatness of their model. Stradivari was a pupil of the Amatis.

AMATITLAN, the name of a lake and town in Guatemala, Central America. The lake is 18 miles from the city of Guatemala, and is about 9 miles long and 3 broad. The town, which is sometimes called St Juan d'Amatitlan, is situated on the shores of the lake. The houses are all of one storey, and are mostly built of mud. The Jesuits formerly had extensive sugar plantations at Amatitlan, but the chief industry now is the raising of the cochineal. The wells of the town are strongly impregnated with salt and alum, and in the vicinity there are several hot springs. Population about 10,000, chiefly mulattoes and samboes.

AMAUROSIS (ἀμαύρωσις), a deprivation of sight. The term is now limited chiefly to those forms of defect or loss of vision which are caused by diseases not directly involving the eye, although sooner or later the optic nerve undergoes changes recognisable by the ophthalmoscope. Sometimes the amaurosis is temporary, disappearing with the removal of the disease with which it is associated; but in many cases, more especially where the brain and spinal cord are affected, the amaurosis remains permanent.

AMAXICHI, a seaport town on the N. of the Ionian island of Santa Maura. It is the capital of the island, and the residence of a Greek archbishop. The frequent occurrence of earthquakes compels the inhabitants to construct their houses of wood; hence the town is of mean appearance. Its harbour admits small craft only. Population, 7000.

AMAZON, Marañon, Orellana, or Solimoens, a river of South America, the largest in the world. Its head stream is either the Ucayale or Apurimac, which rises in Peru about 16° S. lat., and 72° W. long.; or the more northerly Marañon, also called Tunguragua, which flows from Lake Lauricocha, 10° 30′ S. lat., and 76° 10′ W. long. The former is the longer river, but the latter has perhaps the weight of authority in its favour. The Marañon flows in a north-westerly direction, parallel to the Ucayale, as far as 6° S. lat., when it bends to the north-east, and, on reaching the frontiers of Equador, turns almost due east. It thence forms the boundary between Equador and Peru, with an easterly direction, until it joins the Ucayale. The united river continues to separate Equador and Peru as long as these countries are conterminous, and thereafter strikes through Brazil, the general direction being north-north-east. It finally discharges itself into the Atlantic under the equator. From the source of the Apurimac to the ocean this mighty river has a length, including windings, of nearly 4000 miles. It receives enormous tributaries—from the north, the Napo and the Putumayo, each about 700 miles long; the Yapura, 1000 miles; the Negro, 1400; as well as others of less importance: from the south, besides the Yavari, the Yutai, the Yurua, Tefe, the Puruo, and others, there are the Madeira, of nearly 2000 miles; the Topayos, of 1200; the Xingu, of 1300; and the Tocantins, of 1200. In addition to these, the Huallaga, of 500 miles, joins the Marañon, from the south, above its union with the Ucayale. The area drained by the Amazon and its tributaries is probably not less than 2,500,000 square miles, or more than a third part of South America. The breadth of the river, of course, varies at different points. At some distance below Jaen, on the Marañon, it was found to be 860 feet wide; at a pass called the Pongo de Manseriche its bed is suddenly contracted from 250 to 25 fathoms, being enclosed on either side by rocks, which rise like perpendicular walls to a great height; at the junction with the Napo its breadth has increased to 900 fathoms. Between the Negro and the Madeira it has the breadth of a league, which extends to two leagues at those parts where islands abound; but during the annual rise of the water it covers a great part of the adjacent country, and has then no determinate limits. The main mouth is about 50 miles wide above the island of Caviana, but the whole delta, including the Para mouth and the island of Joannes, is nearly 200 miles from shore to shore. The depth of the Amazon in some parts exceeds 50 fathoms, and the river is navigable for vessels of the largest size up to the confluence of the Marañon and the Ucayale. Beyond this point vessels of a smaller size can proceed as far as San Borja, on the Marañon, and a considerable distance up the Ucayale and the Huallaga. The velocity of the water above San Borja so greatly exceeds the average (which is about 2¼ miles an hour), that navigation becomes difficult, and among the rapids is impossible, even to canoes. Nearly all the branches of the Amazon are navigable to a great distance from their junction with the main stream; and collectively the whole presents an extent of water communication unparalleled in any other part of the globe. It may be mentioned, too, that as the wind and current are usually, at least from July to December, opposed to each other, a vessel can make her way either up or down with great facility by availing herself of her sails in the one case, and committing herself to the force of the current in the other. Since the introduction of steamers, however, this circumstance is of less importance. The influence of the tides is felt 400 miles above the mouth of the Amazon, while on the other hand the river current is distinctly perceptible in the ocean for more than 200 miles from the shore. The curious tidal phenomenon called the *bore*, or *proroca*, is thus described by La Condamine:—

> "During three days before the new and full moons, the period of the highest tides, the sea, instead of occupying six hours to reach its flood, swells to its highest limit in one or two minutes. The noise of this terrible flood is heard five or six miles off, and increases as it approaches. Presently you see a liquid promontory 12 or 15 feet high, followed by another, and another, and sometimes by a fourth. These watery mountains spread across the whole channel, and advance with a prodigious rapidity, rending and crushing everything in their way. Immense trees are sometimes uprooted by it, and sometimes whole tracts of land are swept away."

The Amazon traverses a region thickly covered with lofty forests, which are the haunts of the jaguar, bear, panther, and other wild animals, and are inhabited by numerous small tribes of savages, among whom the Spaniards and Portuguese have established missionaries. The river abounds with fish, many of which are delicious eating; and turtles of an excellent quality are numerous. Large alligators may be frequently seen stretched motionless in the mud like trunks of trees. The name Amazon (which is also written *Amazons* and *Amazonas*) is derived from the Indian word *Amassona*, or "boat-destroyer," the reference being to the destructive *proroca*. According to native usage, the name Amazon ought to be restricted to the lower part of the river, below the mouth of the Rio Negro, the portion above that point, as far at least as the junction of the Marañon and the Ucayale, being termed by the natives Solimoens. The other two designations by which the river is sometimes known owe their origin respectively to Francis Orellana, who in 1540 sailed from the mouth of the Rio Napo to the ocean, and Marañon,

who visited the upper waters in 1513. Yañez Pinzon, however, visited the river before either, having discovered the mouth in 1500. (See the works of Bates, Wallace, and W. H. Edwards, and the article BRAZIL.)

AMAZONS (Ἀμάζονες), a race of women represented in Greek legend as having lived in the north-east of Asia Minor, near the shore of the Black Sea, and as having there formed an independent state, with a queen at its head, and with the mythical town of Themiscyra, on the river Thermodon, as its capital. From this centre they made warlike excursions, sometimes northward, but chiefly against the people on the coast of Asia Minor. From the traditions that to repel and conquer them was assigned as a task to Bellerophon by the King of Lycia, and again to Hercules by Eurystheus, it may be inferred that they were regarded by the Greeks at least as a permanent source of danger. But equally, if the task of conquering them is to be strictly compared with the other tasks in which these heroes were generally opposed to monsters and beings impossible in themselves, but possible as illustrations of permanent danger and damage, it would follow that the Amazons were mythical illustrations of the dangers which beset the Greeks on the coast of Asia Minor. Their impossibility as actual beings is further recognised in works of art, in which combats between them and Greeks are placed on the same level as, and often associated with, combats of Greeks and centaurs. The belief in the existence of the Amazons, however, having been once accepted and introduced into the national poetry and art, it became necessary to surround them as far as possible with the appearance of not unnatural beings. Their occupation was hunting and war; their arms the bow, spear, axe, a half shield, nearly in the shape of a crescent, called *pelta*, and in early art a helmet, the model before the Greek mind having apparently been the goddess Athene (Minerva). In later art they approach the model of Artemis (Diana), wearing a thin dress, girt high for speed; while on the later painted vases their dress is often peculiarly Persian—that is, close-fitting trousers, and a high cap called the *kidaris*. They fought partly on foot, partly on horseback, and always without quarter; so that the epithet of ἀνδροκτόνοι, or *oiorpata*, which is the Scythian equivalent (Herod. iv. 110), was applied to them. To maintain their stock, annual visits were paid to the neighbouring peoples; and when, in consequence of this, children were born, the males were either sent over the borders or retained and brought up crippled, and in the condition of slaves, while the female children were assiduously trained to hunting and war. So as to have freedom in the use of the bow, the right breast was either removed by burning and other processes, or was checked in its growth; hence the ancient derivation of the name Amazon from ἀ-μάζος, "breastless." But instead of there being any indication of this in works of art, it is noticeable that in the case of wounded Amazons the wound is in the breast, as if the artist conceived them as truly womanly in that region. The other derivations are—(1) from ἀ-μάζος, in the sense of "strong-breasted," so as to compare with their deity Artemis *Polymazos*; (2) from ἀ-μάσσω, "not touching (men);" (3) from the Scythian *am azzen*, a "virago." The deities of the Amazons were Ares (Mars) and Artemis, the former being consistently assigned to them as a god of war, and as a god of Thracian and generally northern origin. In the case of Artemis, it was not here the usual Greek goddess of that name, but an Asiatic deity in some respects her equivalent, but different, among other points, in this, that troops of women (*hierodulæ*) were associated with her worship, especially as it existed at Ephesus in historical times. That it may have been so also in the early myth-making age, and that accordingly the idea of the Amazons as a race may have originated in the ecstatic lawless life of these women, has been conjectured. With regard to Ephesus, it was said that a body of Amazons, under a princess named Lampedo, had founded that town, and established the worship of Artemis; though in another account they appear as enemies of this religion, and as having burnt the temple of Artemis at Ephesus. Several other towns of Asia Minor claimed to have been founded by Amazons; but according to Diodorus (ii. 52, 55), the Amazons in this case were a race of women who inhabited the west of Libya, and who once, led by their queen Myrina, advanced through Asia Minor and on to Thrace, where they were defeated by Mopsus, and compelled to return. Other memorials of the expeditions and battle-fields of the Amazons were recognised in the tumuli in the Troad and elsewhere in Asia Minor. These ancient local traditions derived a strong colour of reality afterwards, when inroads of barbarians, under a female leader, occurred, as in the time of Cyrus, or when Thalestris appeared before Alexander the Great, announcing herself as the queen of the Amazons; but chiefly when it was observed that certain characteristics of the Amazons actually existed among the women of Sarmatia. The effect of this mixture of fact and legend may be seen in the account given by Herodotus (iv. 110) of the collapse of the Amazonian state, or in the origin of it as related by Justin (ii. 4). On the other hand, the Persian war seems to have freshened, as if to supply a mythical prototype, the national legends of combats between Greeks and Amazons. These legends recounted the defeat of the Amazons, first by Bellerophon, and secondly by Hercules, who had been ordered by Eurystheus to bring him the girdle of their queen Hippolyte, or, in other words, since the girdle of their queen would in Greek eyes be the most sacred object, to conquer the whole race of Amazons. It is supposed that he was accompanied by his friend Theseus, and that this was the occasion on which the latter became possessed of the Amazon princess Antiope. From his possession of her originated a third legend, which described an invasion of Attica by a body of Amazons, with the view of carrying off Antiope. Their utter defeat by Theseus must have seemed, in the light of Marathon and Salamis, as a forecast of the glory then won by Athens. The fourth legend, which deals with the appearance of an army of Amazons, led by their queen Penthesilea on the side of the Trojans in the Trojan war, was developed by Arctinus of Miletus in his poem the *Æthiopis*. Achilles and the queen meet in battle, and she falls by his hand; but the hero is smitten with grief, and lifts her gently before she dies. It is this feeling of regret on the part of a hero who is compelled to kill a woman in his own defence, that gives the principal tone to the existing works of Greek art, in which combats with Amazons are represented, and especially to works of sculpture. Of this class there exist (besides a number of reliefs, among which those from the temple of Apollo at Phigalia, now in the British Museum, are conspicuous for many touching motives of this kind), several statues of wounded Amazons, the sad expression of which, combined with the nobility of form and power of limb, shows what was the highest conception of them in the best days of Greek art. (A. S. M.)

AMBÁLÁ, a division, district, and city of British India, under the jurisdiction of the Lieutenant-Governor of the Panjáb. The Ambálá DIVISION comprises the districts of Ambálá and Ludhiáná in the plains, and the district of Simlá in the Himálayas. The last-named district consists of a few detached patches of territory, scattered among the territories of the petty chieftains by whom the neighbouring hills are held. Simlá district is, however, the

seat of the supreme government of India during the hot weather, and its chief town, of the same name, is the largest hill station in India. The other two districts of the division lie upon the plains at the foot of the Himálayas. They are bounded on the N.E. by those mountains, on the N.W. by the river Satlej, on the S.W. by the district of Firozpur, the independent native state of Patiálá, and the district of Karnál, and on the S.E. by the river Jamná.

Ambálá District stretches N.W. and S.E. along the lower face of the Himálayas, and lies between 29° 55′ and 31° 14′ N. lat., and between 76° 37′ and 77° 38′ E. long. It is bounded on the N.E. by the Himálayas, on the N.W. by the river Satlej, on the S.E. by the river Jamná, and on the S.W. by the district of Ludhiáná, the state of Patiálá, and the district of Karnál. The total area of the district is 2628 square miles, or 1,681,930 acres, of which 945,526 acres are cultivated, 283,989 acres are cultivable, but not actually under tillage, and 452,415 acres are uncultivable and waste. The total population of the district, according to the census of 1868, amounts to 1,035,488 souls, divided into the following classes:—Hindus, 689,333; Mahometans, 286,874; Sikhs, 56,440; others, 2841. The males numbered 567,930, and the females 467,558; the proportion of males to the total population being 54·84 per cent. The principal tribes and castes in point of numbers are—(1.) Játs, viz., Hindus and Sikhs, 161,967; Mahometans, 13,368: total, 175,335. (2.) Chámárs (Hindus), 125,638. (3.) Rájputs—viz., Hindus and Sikhs, 20,121; Mahometans, 62,866: total, 82,987. (4.) Bráhmans, 63,744. (5.) Gujjars—viz., Hindus and Sikhs, 24,500; Mahometans, 24,195: total, 48,695. (6.) Baniás (Hindus), 39,093. The total agricultural population was 501,056. Taking the population as compared with the area, the result gives 1·62 acres per head of the population, or 3·35 acres per head of the agricultural population. Putting aside the uncultivable and waste land, there are 1·18 acres of cultivated or cultivable land per head of the population, or 2·45 acres per head of the agricultural population. Taking only the area under actual cultivation, there are ·91 acres per head of population, or 1·88 acres per head of the agricultural population. With one small exception, the whole district consists of a level alluvial plain, sloping away gradually from the foot of the Himálayas, and lying between the rivers Jamná and Satlej. These rivers do not materially affect the district, which has a drainage system of its own, consisting of the numerous torrents and water-courses which pour down upon it from the hills. In the southern portion of the district these torrents run in broad sandy beds scarcely below the surface of the country, and vary from 200 yards to a mile in width, until, at a distance of 20 or 30 miles from the hills, they assume the form of comparatively docile streams, with well-defined clay banks. Towards the northern portion of the district the torrents run in deep beds from the point where they debouch from the hills; they also differ from the streams of the southern tract in being free from sand. The principal of these northern streams is the Ghaggar, into which all the other minor streams sooner or later empty themselves, some within and some beyond the limits of the district. Whatever surplus water of this river is not swallowed up by irrigation passes on through Patiálá state and Sirsá, and is finally lost in the sands of Rájputáná. The Ghaggar is the only perennial stream within the district, and even it dwindles down to a tiny rivulet in the dry weather, and disappears altogether beyond the border of the district.

The Sind, Panjáb, and Dehli railway passes through the centre of the district from south-east to north-west. The other principal land routes are two main lines of road, one passing through the district parallel to the line of railway, and the other coming from Dehli and Karnál, entering it on the south, and running northward till the two roads meet at Ambálá city. A less important road runs northward from this town to the foot of the Himálayas, and forms the route to the hill station of Simlá. The principal agricultural products of Ambálá district are wheat, grain, and barley for the spring harvest, and rice, joár (spiked millet), and Indian corn in the autumn. The total area under cultivation in 1871–72 was, for the spring harvest 437,377 acres, and for the autumn crop 496,542 acres. The land settlement of the southern portion of the district was completed in 1853, and that of the northern part in 1855. Both will expire in 1880. The following eight towns are returned as containing a population of upwards of 5000 souls, the first-named seven being also municipalities; Ambálá, population, 50,662 souls; Sháhábád, 11,678; Jagádhri, 11,678; Sadhaurá, 11,198; Rúpar, 8700; Búná, 8351; Tháneswar, 7929; Maní Májrá, 5989. A municipal income is also raised from the following seven towns:—Kharar, Síswán, Morindah, Pihewah, Rádaur, Ladwah, and Khizirábád. All the municipalities derive their revenue from a system of octroi duties. The total revenue of Ambálá district for 1871 was £101,362, of which 74 per cent., or £74,446, was derived from the land. The other principal items of revenue were as follows:—Distilleries, £3594, 14s.; drugs and opium, £3181, 4s.; income-tax, £2709, 14s.; stamps, £9308, 14s.; local rates levied under Act xx. of 1871, £7653, 18s. Ambálá is one of the territories previously held by a Sikh Sardár which lapsed to the East India Company in default of rightful heirs. The district was seized by Ranjit Singh during one of his marauding expeditions. This aggression caused the movement of British troops in 1809 which resulted in the treaty with Ranjit Singh by which he was required to withdraw his army from the left bank of the Satlej, and to relinquish his recent conquests in Sirhind.

Ambálá City, the capital of the district of the same name, is situated in 30° 24′ N. lat., and 76° 49′ E. long. It forms a large and important station on the Sind, Panjáb, and Dehli railway. The military station and cantonments lie a few miles south-east of the town. Ambálá is a large walled town, situated in a level and highly-cultivated country, well supplied with water, and capable of furnishing abundant supplies. The houses are built of burnt brick, and the streets are very narrow. The town population is returned at 50,662 souls, but this probably includes the English station. The population within municipal limits numbers 24,040, divided as follows:—Agriculturists, 3226; non-agriculturists, 20,814. The town has been constituted a second-class municipality, the affairs of which are conducted by a committee consisting of six official and five non-official members. The municipal income is derived from an octroi duty, and the revenue has increased from £836, 16s. in 1867–68, to £1520 in 1871–72. The average incidence of municipal taxation in the latter year was 1s. 3½d. per head of the population within municipal limits.

AMBARVALIA, or Ambarvale Sacrum (*ambio* and *arvum*, to go round the field), an annual festival celebrated in ancient Rome on three days during the month of May. The private *ambarvalia* is to be distinguished from the *sacrificium deæ diæ* celebrated by the twelve *fratres arvales*, though the two festivals were coincident in point of time and had a common object, namely, to obtain from the gods a favourable harvest. The *sacrificium* was offered up on behalf of the entire state; the *ambarvalia* was celebrated by each proprietor for himself. The victims were a sow, a sheep, and a bull, and were called by the combined name *suovetaurilia*. Previous to the sacrifice these were led round the fields, while the peasants sang hymns to Ceres. The form of prayer used (*carmen ambarvale*) is preserved in an inscription of the date of the Emperor Elagabalus (218 A.D.), which was discovered in 1777. The same inscription gives an interesting account of the entire ceremony. (See Marini's *Gli Atti e Monumenti de Fratelli Arvali*, Rome, 1792.) The Christian festival that seems to have taken the place of the *ambarvalia* is the Rogation or *Gang* Week of the Roman Catholic Church, for which the perambulation of the parish boundaries was substituted at the Reformation.

AMBASSADOR, a word introduced into the English language from the Fr. *ambassadeur*, the Ital. *ambasciatore*, or the Span. *embaxador*, which Wicquefort derives, perhaps without sufficient authority, from the Span. *embiar*, to send. The word denotes a public minister of the highest rank, accredited and sent by the head of a sovereign state to a foreign court or country, with power to represent the person of the sovereign by whom he is sent, to negotiate with a foreign government, and to watch over the interests of his own nation abroad. The power thus conferred is contained in the credentials or letters of credence of which the ambassador is the bearer, and in the instructions under the sign-manual delivered to himself. The credentials consist in a sealed letter addressed by the sovereign in person whose representative he is, to the sovereign to whom he is sent, and they contain a general assurance that the sovereign by whom he is despatched will approve and confirm whatever is done by the ambassador in his name. In England these letters of credence are under the sign-manual of the Queen, and are not countersigned by the Secretary of State. On special occasions, as for the negotiation of treaties, additional an express powers are given to an ambassador under the great seal, and sometimes (but very rarely) full general powers to treat on all subjects. Lord Clarendon held such powers at the Congress of Paris in 1856

Diplomatic envoys are of three ranks, as was finally determined by a common agreement of all the powers which was annexed to the final act of the treaty of Vienna in 1815:—1. Ambassadors; the ambassador of the pope being called a nuncio, and the ambassador of the Emperor of Austria to the Sublime Porte being called his inter-nuncio. These only have representative rank. 2. Envoys extraordinary or ministers plenipotentiary, accredited to sovereigns (*auprès des souverains*). 3. Chargés d'affaires, who are only entitled to transact business with the Minister of Foreign Affairs. We shall confine ourselves in this article to the diplomatic officers of the first rank. The relative number of ambassadors, as distinguished from ministers, has of late years been considerably increased. The Emperor Nicholas refused for many years to send an ambassador to the court of France, and he therefore suppressed the grade for a time altogether. His example was imitated by other powers. But the old practice has now been reverted to. The Queen of England has embassies at Paris, Constantinople, Vienna, St Petersburg, and Berlin. The number of British ministers plenipotentiary is twenty-three, and three chargés d'affaires; but these numbers vary.

From the 15th century, when the practice of sending resident embassies may be said to have commenced in Europe, down to the close of the 18th century, these missions were surrounded with a prodigious amount of splendour, ceremonial, and contentious dignity. British ambassadors were commonly sent out till within the last thirty years in ships of war. The ambassador represented a monarch, and was to play the part of one. The memoirs of those ages are full of the magnificence and profuse display which marked their progress—lacqueys, liveries, state coaches, led horses, and all the pageantry of state. Fierce disputes frequently arose between rival ambassadors for precedence; sometimes these disputes even extended to the courts and ministers to whom these envoys were despatched as messengers of peace, and a vast deal of time was lost (especially at the Congress of Münster) in adjusting them. On the part of the sovereign to whom they were to present their credentials the same display was made. The new ambassador was fetched by the master of the ceremonies in the king's coaches and feasted at the king's expense. The solemn entry and the public audience, as they were termed, were an essential part of the mission. The ambassador had the right to stand covered in the presence of royalty. At Venice the doge placed Sir Harry Vane, covered and seated, on his right hand in the Council of Ten. A speech was then delivered, in which the ambassador declared the friendly sentiments of his own sovereign, and his own humble desire to give effect to them. Modern simplicity and the facility of intercourse has swept away many of these formalities. Traces of them survive at the courts of Berlin and Vienna, but elsewhere an ambassador is presented with little more than the customary ceremony of a court. It has long been held that every state is at liberty to receive ambassadors with or without ceremony, just as it pleases, provided they are all treated alike. Formalities of this kind are, however, still of moment in dealing with Oriental states, where ceremony is the language of power. Perhaps it is nowhere carried to higher perfection than at the court of Japan. The knotty question of precedence was also settled at the Congress of Vienna by an agreement that precedency should be regulated by seniority, dating from the notification of the arrival of the envoy. In foreign countries the senior ambassador is known as the dean or doyen of the diplomatic body; but in England the diplomatic body has no general mouthpiece or representative.

Every state or sovereign has the right, if it thinks fit, to refuse to receive a particular person as an ambassador, or even to receive any ambassador at all. It is therefore customary to ascertain beforehand whether the person designated for an embassy is favourably regarded, and will be well received. There have been instances, not very remote, of unfavourable answers or refusals to receive given individuals.

The rank of an ambassador, as regards the society of the nation to which he is accredited, places him immediately after the princes of the blood royal, because he represents a sovereign power, and this rank is universally conceded to him. The rank of a minister plenipotentiary is rather more dubious, but by a rule laid down by Her Majesty for the court of St James they follow dukes and precede marquises. An ambassador or minister not actually accredited to this court has of course no official rank at all, and must take his personal rank. No distinction is made between the ambassadors of monarchies and of republics. The Venetian ambassadors held in their time a very prominent rank in Europe; so in our day do the ministers of the United States; but the United States have never sent any ambassador to Europe—their representatives therefore rank in the second class of public ministers.

We shall now proceed briefly to enumerate that which constitutes the essential dignity and utility of an ambassador —on the one hand his rights and privileges, on the other his duties.

A. The first right of an ambassador is that of personal audience of the sovereign. His credentials must invariably be presented to the sovereign in person, and he may ask for an audience on any fitting occasion. In England, however, the sovereign does not officially receive an ambassador except in the presence of one or more of the ministers of the crown. Mr Canning complained bitterly of the influence of Prince Lieven and Prince Esterhazy over George IV., who lived on intimate terms with these ambassadors, and used to say "his father would never have done so." In England the right of audience is now generally limited to the presentation of some congratulatory letter; but at Continental courts it is not without considerable utility and importance, as was shown by the memorable conversation of Sir Hamilton Seymour with the Emperor Nicholas, and the personal interviews of Lord Cowley and Lord Clarendon with the Emperor Napoleon III.

In all ages the perfect personal security of persons invested with high diplomatic functions, as the representa-

tives of a foreign power, has been an essential and fundamental principle of the law of nations. Indeed it *was* the law of nations when there was no other. Alexander the Great destroyed Tyre for an insult offered to his ambassador; and it stands recorded in the Roman law, "Si quis legatum hostium pulsasset, contra jus gentium id commissum esse existimatur, *quia sancti habentur legati*" (*Dig. L. Tit.* vii. § 17). In moments of excessive excitement or revolutionary frenzy even this principle has been violated, as in the murder of Dr Dorislaus at the Hague (1649), and of the French envoys at Rastadt (1799); but such acts leave an indelible disgrace on those who have committed them. For it is the interest of all mankind that ambassadors and envoys should have absolute security to perform their missions with freedom of speech and the liberty "eundi et redeundi" undisturbed, insomuch that to intercept or refuse passage to an ambassador, even through the territory of a third party, is justly regarded as a base action, though probably the leave of the third party to grant the passage ought to be asked. It was the barbarous custom of Turkey to send an ambassador to the Seven Towers on a declaration of war, and detain him there as long as the war lasted; but the Porte formally relinquished and abandoned this practice on the breaking out of war with Russia in 1827. To secure this immunity from all interference, an accredited ambassador or envoy is wholly free from the jurisdiction of the courts of law, or of any other authority in the country in which he is sent to reside. This constitutes the doctrine of *extra-territoriality*. His house is as sacred as his person. It is supposed, like a ship at sea, to form part of the territory represented by the flag which he may hoist over it. All the members of the embassy, and even the servants of the ambassador, share the same inviolability. They cannot even be arrested and prosecuted for offences without his consent. Hence, as the courts of justice have no jurisdiction over them, and indeed would have no means of enforcing an adverse decision either by distress or imprisonment, these diplomatic agents cannot be impleaded or sued. The only means of obtaining redress for an injury or breach of contract is an appeal to the head of the mission, or a further appeal to the government which he represents, which, it must be presumed, will not allow a wrong to be committed with impunity under the shelter of privilege. In England, by the statute 7 Anne, c. 12, it is expressly enacted that any process against foreign ambassadors or ministers, or their goods and chattels, shall be altogether void. This Act was passed in consequence of an attempt, made in 1708, to arrest an ambassador of Peter the Great in London for a debt of £50, and it is still law; but in fact it is only declaratory, and in confirmation of the common law and the law of nations.

An ambassador or envoy pays no taxes or contributions to the public revenue of the country in which he resides, and on this principle he is entitled to receive commodities from abroad free of customs duties. But he is not exempted from the payment of local rates,—though, indeed, if he were to decline to pay them, no process could issue against him for the purpose of levying them. He also pays the ordinary rates of postage, but he has the privilege of sending his own couriers carrying sealed despatches, which exempts him from the monopoly of the post office. These couriers, and their despatches or mails, are also regarded by common consent as inviolable messengers, unless they chance in time of war to fall into the hands of a hostile belligerent. In some countries ambassadors and their couriers have been allowed to have a prior claim for post horses over private travellers.

Another of the important privileges of an ambassador or envoy is the free exercise of the religion or form of worship to which he adheres; but it is laid down by the best writers on the subject that a foreign minister has not the right of maintaining a chapel or chaplain within his hotel, under the law of nations; hence the liberty of religious worship for the ambassador and his suite was made a matter of treaty engagement between Catholics and Protestants, and between Christians and Mussulmans. By courtesy, though not of strict right, the usage of ambassadors' chapels has, however, become general; and it had a real importance in countries where the free exercise of different forms of belief was not tolerated by law. Thus, at the time when the rites of the Church of Rome were forbidden in England, the Spanish and Bavarian chapels in London were free; and they have remained in existence till our own days, although the enlarged tolerance of the present age has removed in every civilised country those barriers. In China and Japan the free exercise of the Christian religion by the Christian embassies is formally secured by treaty.

B. We now pass to the duties of an ambassador, and we place at the head of them that of keeping his own sovereign well informed of all that may concern his interests in foreign countries. He is the eye of the government he serves, specially directed to a particular spot, and he ought to be thoroughly acquainted with the course of policy, the movements of parties, the character and disposition of individual statesmen, and the material and commercial resources of the country in which he resides. His public despatches, and his private correspondence with the Minister of Foreign Affairs under whom he serves, ought to be a record of all that can interest or concern the state which he represents. In this sense the diplomatic reports of the ambassadors of former times are invaluable materials for history. His next duty is to protect and defend, if necessary, the persons and interests of his fellow-countrymen abroad; and this is of especial moment in the case of a British ambassador, whose countrymen are to be met with as travellers, navigators, or merchants in all parts of the globe. To them the presence and influence of the diplomatic representatives of their country is of incalculable value, and nothing can be more ill-judged than the proposals that have been made to cut down and contract our foreign embassies and missions. A third, but not less important, duty of an ambassador is to maintain the most amicable relations with the sovereign to whom he is accredited, and with his ministers, and to observe towards them the strictest respect, veracity, and good-will. It has been said in joke that the first duty of an ambassador is to keep a good cook; but if this implies that he is to exercise a liberal hospitality and to make his house agreeable, those no doubt are means which may powerfully assist him in the objects of his mission. In former times it was considered to be essential to good diplomacy to act as a spy upon the motives and conduct of foreign statesmen, to cheat without being cheated, to use clandestine means to obtain information, to endeavour to form a party in foreign states favourable to the ambassador's own national interests, to observe and resist with the utmost jealousy the demeanour of other foreign envoys, and to carry on a species of warfare under the mask of courtesy and good-breeding. These practices have given diplomacy and the functions of ambassadors a bad name, but it must be said that they are repudiated by the principles and practice of the present time, and more especially by the foreign policy of this country. Down to a recent period, these struggles for ascendancy in foreign countries were carried on with great eagerness, and they led to unfortunate results. In Spain, for example, the untoward marriage of Queen Isabella was notoriously brought about by the violent and arbitrary interference of the French ambassador; and in 1848, when Lord Palmerston instructed

Sir Henry Bulwer to represent to the Spanish minister that they would do well to adopt a more liberal and constitutional system of government, General Narvaez immediately sent the British envoy out of the country. This was the exercise of an extreme right, for which the British government could claim no redress. So, again, when in the course of the Russian war (1855) it appeared to the American government that the British envoy in Washington had infringed the neutrality laws of the United States by endeavouring to enlist recruits for the service of Her Majesty, he was compelled to leave the country, and Great Britain had no just cause of complaint. These modern cases are important, because they prove that no state which respects itself will tolerate, on the part of a foreign envoy, a direct interference in the internal affairs of government or an infraction of its own laws. Hence arises the great principle on which our modern practice is founded, namely, that it is the duty of an ambassador to observe a strict neutrality between contending parties in the state to which he is accredited; to accept the government *de facto* with which he communicates as the government and sovereign of the nation; to pay implicit obedience to the laws of that state, whatever they be; and to abstain as much as possible from all intervention in its internal affairs. These doctrines are comparatively new, but they are sound, and they may be said to have received the assent and the approval of the most enlightened governments of Europe. Great changes have occurred within the last few years in France, Germany, Austria, Italy, and Spain; but they have all the distinguishing mark that they are wholly independent of foreign diplomatic influence. The first, perhaps we ought to say the sole duty, of an ambassador is to protect his own national interests and to promote the most friendly relations with the sovereign to whom he is accredited; and experience has proved that these objects are best secured by confining himself to the principal objects of his mission, and by relying on no arts but those of sincerity, forbearance, and truth. (H. R.)

AMBATO, or ASIENTO D'AMBATO, a town of Ecuador, on the northern slope of Chimborazo, about 65 miles south of Quinto, 8859 feet above the sea. It was destroyed by an eruption of Cotopaxi in 1698, but was soon rebuilt, and now carries on a flourishing trade in grain, sugar, and cochineal. Population, 12,000.

AMBER (Gr. Ἤλεκτρον; Lat. *Succinum, Electrum;* Fr. *Succin, Ambre;* Ger. *Bernstein*) is a hard, brittle substance with a resinous lustre, sometimes found perfectly transparent, but more usually of varying degrees of translucency, and possessing a prevailing yellow colour, passing from a pale straw tint to a deep orange. It occurs in irregular masses, and has neither taste nor, at ordinary temperatures, odour. It develops electrical phenomena by friction, a property which doubtless early drew attention to amber, and invested it with the romantic interest which attached to it in ancient times. The popular regard for the substance among the nations of antiquity was further maintained by the fabulous tales of the manner in which amber was formed and the mystery connected with its occurrence.

The earliest notice of amber we find occurs in the *Odyssey* of Homer, where in the list of jewels offered by Phœnician traders to the Queen of Syra occurs "the gold necklace hung with bits of amber" (*Od.* xv. 460). Thales of Miletus, 600 B.C., noticed that amber when rubbed attracted light bodies, and that remote and simple observation is the foundation of the modern science of *electricity,* so named from the Greek ἤλεκτρον. Among the Greek fables purporting to account for the origin of amber, it is narrated that the Heliadæ, on seeing their brother Phæthon hurled by the lightning of Jove into the Eridanus, were by the pitying gods transformed into poplar trees, and the tears they shed were dropped as amber on the shores of the river. Hence arose the Greek term for amber, Ἤλεκτωρ being one of the names of the sun god. A less poetical theory of its origin states that it was formed from the condensed urine of the lynx inhabiting northern Italy, the pale varieties being produced by the females, while the deeper tints were attributed to males. In such repute was amber in Rome in the time of Pliny that he sarcastically remarks, "the price of a small figure in it, however diminutive, exceeds that of a living healthy slave." Besides its application to jewellery and carved ornaments, and its use, partly decorative and partly prophylactic, as necklaces, peculiar virtues were attributed to it. Pliny observes—"True it is that a collar of amber beads worn about the necks of young infants is a singular preservative to them against secret poison, and a counter-charm for witchcraft and sorceries." As an article of personal ornamentation, the same authority states that amber was used to produce imitations of precious stones by artificial staining, a use to which it was peculiarly adapted owing to its brilliant lustre combined with the ease with which it could be worked and polished.

The great source of supply of amber in all ages appears to have been the Baltic coasts, from which the supplies of commerce still continue to be drawn. During the reign of Nero an expedition was sent from Rome to explore the amber-producing country, and so successful was the party that a present of 13,000 ℔ of amber was brought back to the emperor, including a piece weighing 13 ℔. It occurs in regular veins along the Baltic coast, but in greatest abundance between Pillau and Grosz Hubenicken, on the Prussian coast. Professor Phillips thus describes the mines:—

"Near the sea-coast in Prussia there are regular mines for the working of amber: under a stratum of sand and clay, about 20 feet thick, a stratum of bituminous wood occurs, from 40 to 50 feet thick, of a blackish brown colour, and impregnated with pyrites. Parts of these trees are impregnated with amber, which sometimes is found in stalactites depending from them. Under the stratum of trees were found pyrites, sulphate of iron, and coarse sand, in which were rounded masses of amber. The mine is worked to the depth of 100 feet; and from the circumstances under which the amber is found it seems plain that it originates from vegetable juices."

After heavy storms large quantities are usually found thrown up on the coast at the localities where it is regularly excavated, and the assumption is, that amberiferous deposits crop up in the shallow waters near the shores, from which pieces become detached during the violent commotion of the water. It is further sparingly cast on the Swedish and Danish coasts, and occasionally pieces are picked up along the shores of Norfolk, Essex, and Sussex in England. It occurs at numerous localities inland throughout Europe, among which may be noted the neighbourhood of Basle in Switzerland, the departments of Aisne, Loire, Gard, and Bas Rhin in France, and in the Paris clay it is associated with bituminous deposits. In England it has been found in the sandy deposits of the London clay at Kensington. The coasts of Sicily and the Adriatic likewise afford amber. The most beautiful specimens are perhaps those which are found at Catania. They often possess a beautiful play of colour, approaching to purple, not to be observed in the product of other places. Professor Dana gives the following note on its occurrence in America:—

"It has been found in various parts of the greensand formation of the United States, either loosely embedded in the soil or engaged in marl or lignite, as at Gay Head or Mather's Vineyard, near Trenton, and also at Camden, in New Jersey, and at Cape Sable, near Magothy river, in Maryland."

It is said to be taken in large quantities from the north of Burmah to the markets of China, where it is highly prized.

The appearance of enclosed foreign bodies, such as insects, leaves, twigs, &c., which amber very often presents, and the markings on its surface, very early led to correct inferences as to its origin. Pliny states that "amber is an exudation from trees of the pine family, like gum from the cherry and resin from the ordinary pine; and in accordance with this opinion is its Latin name *succinum*, the gum-stone. The opinion expressed by Pliny is that which at the present day may be fairly held as established; but of course amber differs from other resins owing to changes induced by its fossilised condition. Sir David Brewster has pointed out that in optical properties it agrees with other resinous exudations. The insects found enclosed in amber are for the most part of extinct species, and so also are the remains of plants. A species of conifer has been established provisionally as the amber-yielding tree, *Pinites succinifer*, but Göppert has shown that many trees may have yielded the exudation, and these not all necessarily belonging to the pine order.

The close relation of amber to ordinary resins is further brought out by its chemical properties and composition. According to Berzelius, it consists mainly of a resin, succinite, insoluble in alcohol, in combination with small proportions of two others, isomeric with the first, but soluble in alcohol and ether. By dry distillation it gives off at a low temperature water, succinic acid, and oil of amber, which last substance was formerly used in medicine in combination with alcohol and ammonia under the name of *eau de luce;* but now amber and all its products have disappeared from the standard pharmacopœias. Its composition is, according to Schrötter—

Carbon	78·94
Hydrogen	10·53
Oxygen	10·53

and mineralogically it belongs to Dana's class of oxygenated hydrocarbons. It burns with a pale yellow flame, with a good deal of black smoke, evolving an agreeable odour, and leaving a shining black carbonaceous residue.

It is said that by exposing amber covered with sand in an iron pot to the influence of heat for forty hours, or boiling it for twenty hours in rape oil, it will become transparent, and pieces will cement and mould together. The great size of vessels of amber which have come down from ancient times suggests the probability of some such art being practised in remote periods. It is now applied to few useful purposes among western nations beyond forming the mouthpieces for tobacco-pipes and cigar-holders. Fine pieces are in some demand for public collections and for the purposes of the carver. In the East, besides its being highly prized for ornamental purposes, a feeling of veneration for its mystic properties still enhances its value. The Turks esteem it highly as a mouthpiece for tobacco pipes, and believe that it resists the transmission of infection. The principal demand for the amber of commerce is among the Armenians, through whom it is conveyed to Egypt, Persia, China, and Japan; and a great quantity is purchased to be consumed at the shrine of Mahomet by the pilgrims bound to Mecca. The value of amber depends upon its colour, its lustre, and its size. In 1576 a mass weighing 11 ℔ was found in Prussia, and deemed worthy of being presented to the emperor; later, a mass of 13 ℔ was found, for which it is said 5000 dollars were refused. In the royal cabinet at Berlin a piece is shown weighing 18 ℔; but such masses are of very great rarity.

AMBERG, a walled town of Bavaria, formerly the capital of the Upper Palatinate, and at present the seat of the appeal court for the district, is situated on both sides of the Vils, 35 miles east of Nuremberg. It is a well-built town, and has a library, a gymnasium, a lyceum, elementary schools, an arsenal, and several churches, the finest of which is St Martin's, with many fine paintings, and a tower 300 feet high. The principal manufactures are fire-arms, ironmongery, earthenware, woollen cloth, beer, and salt; in the neighbourhood are iron and coal mines. The French under Jourdan were defeated by the Austrians near Amberg in 1796. Population in 1871, 11,688.

AMBERGRIS (*Ambra grisea*, *Ambre gris*, or Grey Amber) is a solid, fatty, inflammable substance of a dull grey or blackish colour, the shades being variegated like marble, possessing a peculiar sweet earthy odour. It is now known to be a morbid secretion formed in the intestines of the spermaceti whale (*Physeter macrocephalus*), and is found floating upon the sea, on the sea-coast, or in the sand near the sea-coast. It is met with in the Atlantic Ocean, on the coasts of Brazil and Madagascar; also on the coast of Africa, of the East Indies, China, Japan, and the Molucca Islands; but most of the ambergris which is brought to England comes from the Bahama Islands, Providence, &c. It is also sometimes found in the abdomen of whales, always in lumps in various shapes and sizes, weighing from ½ oz. to 100 or more ℔. A piece which the Dutch East India Company bought from the King of Tydore weighed 182 ℔. An American fisherman from Antigua found, inside a whale, about 52 leagues south-east from the Windward Islands, a piece of ambergris which weighed about 130 ℔, and sold for £500 sterling. Like many other substances regarding the origin of which there existed some obscurity or mystery, ambergris in former times possessed a value, and had properties attributed to it, more on account of the source from which it was drawn than from its inherent qualities. Many ridiculous hypotheses were started to account for its origin, and among others it was conjectured to be the solidified foam of the sea, a fungoid growth in the ocean similar to the fungi which form on trees, the excreta of sea-birds, &c. The true source and character of ambergris was first satisfactorily established by Dr Swediaur in a communication to the Royal Society (*Philosophical Transactions*, vol. lxxiii.) It was found by Dr Swediaur that ambergris very frequently contained the horny mandibles or beaks of the squid (*Sepia moschata*), on which sperm whales are known to feed. That observation, in connection with the fact of ambergris being frequently taken from the intestines of the sperm whale, sufficiently proved that it was formed within that creature, and not an extraneous substance swallowed by the whale. It was further observed that the whales in which ambergris was found were either dead or much wasted and evidently in a sickly condition. From this it was inferred that ambergris was in some way connected with a morbid condition of the sperm whale. Ambergris, when taken from the intestinal canal of the sperm whale, is of a deep grey colour, soft consistence, and a disagreeable smell. On exposure to the air it gradually hardens, becomes pale, and develops its peculiar sweet earthy odour. In that condition its specific gravity ranges from 0·780 to 0·926. It melts at a temperature of about 145° Fahr. into a fatty yellow resinous-like liquid; and at 212° it is volatilised into a white vapour. It is soluble in ether, volatile and fixed oils, but only feebly acted on by acids. By digesting in hot alcohol, a peculiar substance termed ambrein is obtained, which deposits in brilliant white crystals as the solution cools. In chemical constitution ambrein very closely resembles cholesterin, a principle found abundantly in biliary calculi. It is therefore more than probable that ambergris, from the position in which it is found and its chemical constitution, is a biliary concretion analogous to what is formed in other mammals. The

use of ambergris in Europe is now entirely confined to perfumery, though it formerly occupied no inconsiderable place in medicine. As a material of perfumery its price varies from 15s. to 25s. per ounce; and in minute quantities its alcoholic solution is much used for giving a "floral" fragrance to bouquets, washes, and other preparations of the perfumer. It occupies a very important place in the perfumery of the East, and there it is also used in pharmacy, and as a flavouring material in cookery. The high price it commands makes it peculiarly liable to adulteration, but its genuineness is easily tested by its solubility in hot alcohol, its fragrant odour, and its uniform fatty consistence on being penetrated by a hot wire.

AMBERT, chief town of an arrondissement of the same name in the department of Puy de Dôme, France, situated on the Dore, 35 miles from Clermont. Its chief manufactures are paper, linen, lace, ribands, and pins; it has also an extensive trade in cheese of a very fine quality. Population in 1872, 7625.

AMBLESIDE, a small market town in Westmoreland, situated about a mile from the head of Lake Windermere, and 14 miles from Kendal. During the summer it is much frequented by tourists on account of its beautiful situation. In its vicinity is Rydal Mount, for many years the residence of the poet Wordsworth. Some indistinct remains of Roman fortifications, in which coins, urns, and other relics have been frequently discovered, exist in the neighbourhood. Coarse woollen cloths are manufactured at Ambleside. Population in 1871, 1988.

AMBLETEUSE, a seaport town of France, in the department of the Pas de Calais, on the English Channel, 6 miles north of Boulogne. From the accumulation of sand in its harbour it has lost its importance as a seaport, and the town is now almost deserted. It possesses an historical interest as the landing-place of James II. after his abdication in 1688; and Napoleon I. in 1804 attempted to improve the harbour for the flat-bottomed boats by means of which he was to invade England. Near Ambleteuse is the column which he erected to the grand army in 1805. Population, about 700.

AMBO, or AMBON (Gr. ἄμβων, from ἀναβαίνω), a reading-desk or pulpit in early Christian churches which was placed in the middle of the nave. It was ascended by a flight of steps on both the east and west sides, and was in some cases so large as to accommodate fifty persons. From it the lessons were read, and hence it was sometimes called *suggestus lectorum* and βῆμα τῶν ἀναγνωστῶν. It was also occasionally used by the preacher. Two movable ambos may be seen in the church of St John Lateran at Rome. The purposes of the ambo were served in mediæval churches by the rood-loft, a gallery across the chancel-arch, and in modern churches it has given place to the lectern and the pulpit.

AMBOISE, a town situated in a rich wine-producing district in the department of Indre-et-Loire, France, on the left bank of the Loire, 14 miles east of Tours. Its chief manufactures are cloth and files. At Amboise the French Protestants were first called Huguenots, and 1200 of them were massacred there in 1560 on the discovery of their conspiracy against the Guises. The ancient castle, which is situated on a height above the town, was a seat of the French kings, and it was set apart as a residence for the Arab chief Abd-el-Kader during his captivity in France. Population, 4570.

AMBOYNA, one of the Moluccas or Spice Islands, belonging to the Dutch, lying south-west of Ceram, in 3° 41′ S. lat. and 128° 10′ E. long. It is 32 miles in length, with an area of about 280 square miles, and is of very irregular figure, being almost divided into two. The south-eastern and smaller portion (called Leitimor) is united to the northern (known as Hitoe) by a neck of land about a mile broad. The island is mountainous, but is for the most part fertile and well-watered. Large tracts are covered with rich tropical forests, which embrace a great variety of trees, although ordinary building timber is scarce. The climate is comparatively pleasant and healthy; the average temperature is 80° Fahr., rarely sinking below 72°. The rainfall, however, after the eastern monsoons, is very heavy, and the island is liable to violent hurricanes and earthquakes. Amboyna produces most of the common tropical fruits and vegetables, including the sago-palm, bread-fruit, cocoa-nut, sugar-cane, maize, coffee, pepper, and cotton. Cloves, however, form its chief product, and the only one that is of any real commercial importance. The Dutch have done much to foster the cultivation of this article in the island, and at one time prohibited the rearing of the clove-tree in all the other islands subject to their rule, in order to secure the monopoly to Amboyna. Each tree yields annually from 2 to 5 ℔ of cloves, and sometimes even more; while the total annual quantity produced probably averages about 500,000 ℔. The animal kingdom is poorly represented. Indigenous mammals are feeble in species as well as few in number; birds are more abundant, but of no greater variety. The entomology of the island is, however, very rich, particularly among the *Lepidoptera*. The aborigines of Amboyna are a race called Horaforas, but Malays constitute the main body of the population; there are also Chinese, Dutch, and a few Portuguese. The Malays in most points resemble those of Java. They are naturally lazy and effeminate, but when properly trained make good soldiers. The inhabitants are mostly Christians or Mahometans. Amboyna is the chief island of the Dutch residence of the Moluccas, which comprises, in addition, the islands of Boeroe, Amblauw, Ceram, Manipa, Kilang, Bonoe, Haroekoe, Honimoa or Saparoa, Noesa-laut, and Hila. The Portuguese were the first European nation to visit Amboyna (1512). They established a factory there in 1521, but did not obtain peaceable possession of it till 1580, and were dispossessed by the Dutch in 1605 About the year 1615 the British formed a settlement in the island, at Cambello, which they retained until 1623, when it was destroyed by the Dutch, and frightful tortures inflicted on the unfortunate persons connected with it. In 1654, after many fruitless negotiations, Cromwell compelled the United Provinces to give the sum of £300,000, together with a small island, as compensation to the descendants of those who suffered in the "Amboyna massacre." In 1796 the British, under Admiral Rainier, captured Amboyna, but restored it to the Dutch at the peace of Amiens in 1802. It was recaptured by the British in 1810, but once more restored to the Dutch in 1814. Population, about 50,000. See MOLUCCAS.

AMBOYNA, the chief town of the above island, and also of the Dutch Moluccas, is situated towards the north-west of the peninsula of Leitimor. The streets are broad and unpaved, running at right angles to one another, and intersected by numerous rivulets. The houses are of wood, roofed with palm leaves, and mostly of one storey, on account of the frequent earthquakes. An esplanade of 250 yards reaches from Fort Victoria to the town, and is terminated by a handsome range of houses. The town-house is a neat structure of two storeys; and among the other buildings are two Protestant churches and a hospital. The government offices are in Fort Victoria. The roadstead of Amboyna is safe and commodious. Population, about 13,000.

AMBRACIA, or AMPRACIA, an important city of ancient Epirus, situated on the eastern bank of the river Arachthus, about seven miles from the Ambracian Gulf.

According to tradition, it was originally a Thesprotian town, founded by Ambrax, son of Thesprotus, or by Ambracia, daughter of Augeas. About 635 B.C. it was colonised by Corinthians, and so became a Greek city. Its power increased rapidly until the time of the Peloponnesian war, when it commanded the whole of Amphilochia, including the town of Argos, from which the original inhabitants were expelled. In 432 B.C. the expelled citizens, with the assistance of the Athenians under Phormion, retook Argos. In 430 the Ambracians made an unsuccessful attempt to recover the town, and a second attack in 426 resulted in a still more disastrous failure. The power of Ambracia now declined as rapidly as it had grown. In 338–7 it was compelled to submit to Philip of Macedonia, and it remained subject to that kingdom until it was ceded by Alexander V. to Pyrrhus of Epirus about 295. The latter made it his capital, and enriched it with numerous works of art. It subsequently came under the power of the Ætolian League (239), and sustained a memorable siege in the war between the latter and Rome (189). In the end the city opened its gates to the enemy, who removed many of its most valuable works of art to Rome. In 31 B.C. the inhabitants of Ambracia were removed by Augustus to Nicopolis, the town he had founded in commemoration of the victory of Actium. The site of Ambracia is occupied by the modern Arta, near which remains of the ancient fortifications may be seen.

AMBROSE OF ALEXANDRIA lived in the beginning of the third century. Jerome and Eusebius differ in the account they give of him, the one calling him a Marcionite, the other a Valentinian; but they agree in alleging that he was converted to the orthodox faith by the preaching of Origen. Origen dedicated many of his works, among others his book *On Martyrdom*, to Ambrose, at whose desire and expense they were published, and the two lived on terms of the most intimate friendship. According to some, Ambrose died a martyr in the persecution under Maximin, about the year 236; but the dedication of Origen's *Eight Books against Celsus* proves that he lived to the year 250, or near that period. Origen speaks of him as a man of sincere piety, and much devoted to the study of the Scriptures.

AMBROSE, SAINT, Bishop of Milan, was one of the most eminent fathers of the church in the fourth century. He was a citizen of Rome, born in Gaul,—according to some historians, in the year 334, but according to others in 340. At the period of his birth his father was prætorian prefect of Gallia Narbonensis; and upon his death the widow repaired to Rome with her family. Ambrose received a religious education, and was reared in habits of virtue by his mother, an accomplished woman, and eminent for her piety. The names of his instructors in the rudiments of Greek and Roman literature have not been transmitted to posterity; but in these branches he made early proficiency, and having directed his attention to the law, he employed his eloquence with such reputation in the prætorian court of Anicius Probus, that he was soon deemed worthy of a place in the council. After he had continued in this station for some time, Probus appointed him consular prefect of Liguria and Æmilia, comprehending the territories of Milan, Liguria, Turin, Genoa, and Bologna. Milan was chosen as the place of his residence; and, by the prudent and gentle use of his power, he conducted the affairs of the province with general approbation and growing popularity.

The death of Auxentius, bishop of Milan, in the year 374, made a sudden change in the fortune and literary pursuits of Ambrose. At that period the tide of religious contention ran high between the orthodox and the Arians, and a violent contest arose concerning the choice of a successor to Auxentius. When the people were assembled in the church to elect the new bishop, Ambrose, in the character of governor of the place, presented himself to the assembly, and in a grave, eloquent, and pathetic address, admonished the multitude to lay aside their contentions, and proceed to the election in the spirit of religious meekness. It is reported that when Ambrose had finished his address, a child cried out, "Ambrose is bishop," and that the agitated multitude, regarding this as a miraculous intimation, unanimously elected Ambrose bishop of Milan. Some suppose that this was entirely a device of Ambrose or his friends; others ascribe it to mere accident. Ambrose professed strong reluctance, and even fled, or pretended to fly, from the city in order to avoid the intended honour. The place of his concealment, however, was soon discovered; the emperor's confirmation of his election was made known to him; and after being baptized, he was ordained bishop of Milan, about the end of the year 374. Whatever we may think of the singular conduct of Ambrose in accepting an office for which he was certainly unqualified in respect of previous studies, habits, and employments, it must be admitted that he immediately betook himself to the necessary studies, and acquitted himself in his new elevation with ability, boldness, and integrity. Having apportioned his money among the poor, and settled his lands upon the church, with the exception of making his sister tenant during life, and having committed the care of his family to his brother, he entered upon a regular course of theological study, under the care of Simplician, a presbyter of Rome, and devoted himself to the labours of the church.

The irruption of the Goths and the northern barbarians, who rushed down upon the Roman empire at this time, spreading terror and desolation all around, compelled Ambrose, along with several others, to retire to Illyricum, but his exile was of short duration, for the northern invaders were quickly defeated by the forces of the emperor, and driven back with considerable loss into their own territories.

The eloquence of Ambrose soon found ample scope in the dispute between the Arians and the orthodox. About this era the doctrine of Arius concerning the person of Christ had been extensively received, and had many powerful defenders both among the clergy and the common people. Ambrose espoused the cause of the Catholics. Gratian, the son of the elder Valentinian, took the same side; but the younger Valentinian, who had now become his colleague in the empire, adopted the opinions of the Arians; and all the arguments and eloquence of Ambrose were insufficient to reclaim the young prince to the orthodox faith. Theodosius, the emperor of the East, also professed the orthodox belief; but there were many adherents of Arius scattered throughout his dominions. In this distracted state of religious opinion, two leaders of the Arians, Palladius and Secundianus, confident of numbers, prevailed upon Gratian to call a general council from all parts of that empire. This request appeared so equitable that he complied without hesitation; but Ambrose, foreseeing the consequence, prevailed upon the emperor to have the matter determined by a council of the Western bishops. A synod, composed of thirty-two bishops, was accordingly held at Aquileia in the year 381. Ambrose was elected president; and Palladius being called upon to defend his opinions, declined, insisting that the meeting was a partial one, and that the whole bishops of the empire not being present, the sense of the Christian church concerning the question in dispute could not be obtained. A vote was then taken, when Palladius and his associate Secundianus were deposed from the episcopal office.

Ambrose was equally zealous in combating the heathen

superstitions. Upon the accession of Valentinian II., many of the senators who remained attached to the pagan idolatry made a vigorous effort to restore the worship of the heathen deities. Symmachus, a very opulent man and a great orator, who was at that time prefect of the city, was intrusted with the management of the pagan cause, and drew up a forcible petition, praying for the restoration of the altar of Victory to its ancient station in the hall of the senate, the proper support of seven vestal virgins, and the regular observance of the other pagan ceremonies. In the petition he argued that this form of religion had long been profitable to the Roman state, and reminded the emperor how much Rome had been indebted to Victory, and that it had been the uniform custom of the senators to swear fidelity to the government upon that altar. He likewise adduced many facts to prove the advantages accruing to the state from its ancient religious institutions, and pleaded that, as it was one divinity that all men worshipped under different forms, ancient practice should not be rashly laid aside. He even proceeded so far as to assert the justice of increasing the public revenue by robbing the church, and attributed the late famine which had overtaken the empire to the neglect of the ancient worship. To this petition Ambrose replied in a letter to Valentinian, arguing that the devoted worshippers of idols had often been forsaken by their deities; that the native valour of the Roman soldiers had gained their victories, and not the pretended influence of pagan priests; that these idolatrous worshippers requested for themselves what they refused to Christians; that voluntary was more honourable than constrained virginity; that as the Christian ministers declined to receive temporal emoluments, they should also be denied to pagan priests; that it was absurd to suppose that God would inflict a famine upon the empire for neglecting to support a religious system contrary to His will as revealed in the Scriptures; that the whole process of nature encouraged innovations, and that all nations had permitted them, even in religion; that heathen sacrifices were offensive to Christians; and that it was the duty of a Christian prince to suppress pagan ceremonies. In the epistles of Symmachus and of Ambrose both the petition and the reply are preserved, in which sophistry, superstition, sound sense, and solid argument are strangely blended. It is scarcely necessary to add that the petition was unsuccessful.

The increasing strength of the Arians proved too formidable for Ambrose. In 384 the young emperor and his mother Justina, along with a considerable number of clergy and laity professing the Arian faith, requested from the bishop the use of two churches, one in the city, the other in the suburbs of Milan. The prelate believing the bishops to be the guardians both of the temporal and spiritual interests of the church, and regarding the religious edifices as the unquestionable property of the church, positively refused to deliver up the temples of the Lord into the impious hands of heretics. Filled with indignation, Justina resolved to employ the imperial authority of her son in procuring by force what she could not obtain by persuasion. Ambrose was required to answer for his conduct before the council. He went, attended by a numerous crowd of people, whose impetuous zeal so overawed the ministers of Valentinian that he was permitted to retire without making the surrender of the churches. The day following, when he was performing divine service in the Basilica, the prefect of the city came to persuade him to give up at least the Portian church in the suburbs. As he still continued obstinate, the court proceeded to violent measures: the officers of the household were commanded to prepare the Basilica and the Portian churches to celebrate divine service upon the arrival of the emperor and his mother at the ensuing festival of Easter. Perceiving the growing strength of the prelate's interest, the court deemed it prudent to restrict its demand to the use of one of the churches. But all entreaties proved in vain, and drew forth the following characteristic declaration from the bishop:—"If you demand my person, I am ready to submit: carry me to prison or to death, I will not resist; but I will never betray the church of Christ. I will not call upon the people to succour me; I will die at the foot of the altar rather than desert it. The tumult of the people I will not encourage; but God alone can appease it."

Many circumstances in the history of Ambrose are strongly characteristic of the general spirit of the times. The chief causes of his victory over his opponents were his great popularity and the superstitious reverence paid to the episcopal character at that period. But it must also be noted that he used several indirect means to obtain and support his authority with the people. He was liberal to the poor; it was his custom to comment severely in his preaching on the public characters of his times; and he introduced popular reforms in the order and manner of public worship. It is alleged, too, that at a time when the influence of Ambrose required vigorous support, he was admonished in a dream to search for, and found under the pavement of the church, the remains of two martyrs, Gervasius and Protasius. The vulgar crowded to behold these venerable relics, and, according to report, a number of sick persons were healed by touching the bones. Ambrose exulted in these miracles, and appealed to them in his eloquent sermons; while the court derided and called in question their existence. It is remarkable that these and many other miracles obtained current credit among the Christian historians of the second, third, and fourth centuries; and Dr Cave, in speaking of them, says—"I make no doubt but God suffered them to be wrought at this time on purpose to confront the Arian impieties."

Although the court was displeased with the religious principles and conduct of Ambrose, it respected his great political talents; and when necessity required, his aid was solicited and generously granted. When Maximus usurped the supreme power in Gaul, and was meditating a descent upon Italy, Valentinian sent Ambrose to dissuade him from the undertaking; and the embassy was successful. On a second attempt of the same kind Ambrose was again employed; and although he was unsuccessful, it cannot be doubted that, if his advice had been followed, the schemes of the usurper would have proved abortive; but the enemy was permitted to enter Italy, and Milan was taken. Justina and her son fled; but Ambrose remained at his post, and did good service to many of the sufferers by causing the plate of the church to be melted for their relief. Theodosius, the emperor of the East, espoused the cause of Justina, and regained the kingdom.

In the year 390 a tumult happened at Thessalonica, in which Botheric, one of the imperial officers, was slain. Theodosius was so enraged at this that he issued a royal mandate for the promiscuous massacre of the inhabitants of the place, and about 7000 persons were butchered without distinction or mercy. The deed called forth a severe rebuke from Ambrose, who charged the emperor not to approach the holy communion with his hands stained with innocent blood. The emperor reminded him that David had been guilty of murder and of adultery. The bishop replied, "You have imitated David in his guilt; go and imitate him in his repentance." The prince obeyed, and after a course of eight months' penance he was absolved, on condition that in future an interval of thirty days should intervene before any sentence of death or confiscation was executed.

The generosity of Ambrose was favourably exhibited in

the year 392, after the assassination of Valentinian and the usurpation of Eugenius. Rather than join the standard of the usurper, he fled from Milan; but when Theodosius was eventually victorious, he supplicated the emperor for the pardon of those who had supported Eugenius. Soon after acquiring the undisputed possession of the Roman empire, Theodosius died at Milan (395). Bishop Ambrose did not long survive him, having died in the year 397.

On many accounts the character of the bishop of Milan stands high among the fathers of the ancient church. With unvarying steadiness he delivered his religious sentiments on all occasions; with unwearied assiduity he discharged the duties of his office; with unabated zeal and boldness he defended the orthodox cause in opposition to the Arians; with a liberal hand he fed the numerous poor who flocked to his dwelling; with uncommon generosity he manifested kindness to his adversaries; and with Christian affection he sought the happiness of all men. His general disposition and habits were amiable and virtuous, and his powers of mind vigorous and persevering. Ambition and bigotry were the chief blemishes in his character.

The writings of Ambrose are voluminous, but many of them are little more than reproductions of the works of Origen and other Greek fathers. The great design of them was to defend and propagate the Catholic faith. His expositions of Scripture contain many extreme examples of allegorical and mystical interpretation. Modern readers will regard much in the writings of Ambrose as trivial, and even as ludicrous; but his style is vigorous, and the sentiment is often weighty. Gibbon's judgment appears to be too severe: "Ambrose could act better than he could write; his compositions are destitute of taste or genius, without the spirit of Tertullian, the copious elegance of Lactantius, the lively wit of Jerome, or the grave energy of Augustin." His exegetical writings include an exposition of the Gospel of St Luke, and commentaries on certain Psalms. His *Hexaëmeron* is a homiletical treatise on the history of the creation. "*The Hymns* of St Ambrose have exercised a powerful influence on Christendom. They were designed by him to be a preventive against the errors of Arianism, and to confirm the professors of the true faith in the doctrines of the Trinity and the divinity of Christ. . . Very many of them have found a place in the liturgies of the western Church. On account of the celebrity of St Ambrose, many hymns have been attributed to him which are not his; and, on the other hand, some critics have gone into the opposite extreme, and have deprived him of his property. In the Benedictine edition of his works only twelve hymns are admitted; and Dom. Biraghi [of the Ambrosian Library, who has endeavoured, in his *Inni Sinceri di Sant' Ambrogio*, to restore the hymns to their primitive form] shows reason for believing that only seven of these are genuine" (*Journal of a Tour in Italy, by Chr. Wordsworth, D.D.*, 1863.) The most accurate and complete edition of his works is that published by the Benedictines, printed at Paris in 1686 and 1690, in two volumes folio.

A liturgical form, the Ambrosian Ritual, which is still in use in the arch-diocese of Milan, has been traditionally ascribed to Saint Ambrose. Several attempts were made, in particular by the Emperor Charlemagne and Pope Nicolas II., to secure uniformity by enforcing the adoption of the Roman breviary throughout the Western Church, but the clergy of Milan refused to yield. The ritual of Ambrose is included in the *Liturgia Latinorum* of Pamelius (Cologne, 1571–6). "Full information concerning its history will be found in the *Ceremoniale Ambrosiano*, by Dom. Giovanni Dozio, published at Milan, 1853" (Wordsworth's *Tour*, 1863).

For a description of the famous church of St Ambrose, founded by him at Milan 387 A.D., see MILAN. For the Ambrosian Library, see LIBRARIES. Notices of his LITURGY and HYMNS will be found under these headings.

AMBROSE, ISAAC, a Puritan divine. Formerly the practical and devotional writings of this eminent Nonconformist rivalled John Bunyan's in popularity, and his *Looking to Jesus* holds its own even now. Prominent name as his was in his generation, very scanty are the personal memorials of him. His own "Media," under the head of "Experiences," yields a few incidents of his life. According to Anthony à Wood, he was a minister's son, descending from those of the name living at Lowick, and they from the Ambroses of Ambrose Hall in Lancashire. It is probable that his father was Richard Ambrose, vicar of Ormskirk, who was succeeded by another son, Henry. It seems improbable that any of his line could descend of the Lowick Ambroses, inasmuch as they were the most "persistent Catholics of Lancashire;" and there is the additional consideration that, while in our worthy's writings there are many references to the Papists, he makes not the slightest allusion to his conversion from Popery, or to any Catholic relatives or associations. He entered Brazenose college, Oxford, in 1621, in the seventeenth year of his age, and must therefore have been born in 1603–4. Having proceeded M.A. and been ordained, he received at the outset a little cure in Derbyshire, which was at that time and onward to Puritanism what Goshen was to Egypt and Israel. By the influence of the Earl of Bedford, he was appointed one of the king's itinerant preachers in Lancashire. Having later served for a time a curacy in Garstang, he was selected by the Lady Margaret Hoghton as vicar of Preston. He was on the celebrated committee for the ejection of "scandalous and ignorant ministers and schoolmasters" during the Commonwealth. So long as Ambrose continued at Preston he was favoured with the warm friendship of the Hoghton family, as was John Howe,—their ancestral woods and the tower near to Blackburn affording him sequestered places for those devout meditations and "experiences" that give such a charm to his diary. The immense auditory of his sermon at the funeral of Lady Hoghton is a living tradition still all over the county. For some reason which is unknown, perhaps failing strength for so onerous a charge, Ambrose left his great church of Preston, and became minister of Garstang, where before he had been curate. He was vicar of Garstang when the Act of Uniformity was passed. He could have conscientiously complied with many of its requirements, for he was willing to use the Prayer-book, and did not stickle at things whereat other tender consciences did; but the enforcement was so absolute, not to say brutal, that he found himself constrained to form one of the Two Thousand. His after years were passed among old friends at Preston. He spent a great part of his time every summer in Widdicre wood, where, seldom seen by any except on the Sabbath, he communed with his own heart and his God. The last time he was seen alive was by some friends from Garstang, of whom he is said to have taken leave with unusual affection and gravity. Immediately after they left him he retired to his wonted place of meditation, where he was found by an attendant *in articulis mortis*. He died in 1664 at the age of sixty-one. Calamy says he was seventy-two, but his college entry shows he was mistaken. As a religious writer, Ambrose has a vividness and freshness of imagination possessed by scarcely any of the Puritan Nonconformists. He is plaintive as Flavel and as intense as Baxter. Many who have no love for Puritan doctrine, nor sympathy with Puritan experience, have appreciated the pathos and beauty of his writings, which have never been out of print from their original issue until now. (A. B. G.)

AMBROSIUS, Aurelianus, a leader of the Britons during the 5th century. He is said, on somewhat doubtful authority, to have been a son of Constantine, who was elected emperor by the Roman army in Britain in 407. The usually received account of his life, based chiefly upon the history of Geoffrey of Monmouth, contains much that is evidently fabulous. It seems probable that he was educated at the court of Aldroën, king of Armorica, who sent him over with a strong force to assist his countrymen against the Saxons, whom Vortigern had invited to Britain. There is also little doubt that, having defeated Vortigern, he was chosen to succeed him as king of Britain. Geoffrey also states that he built Stonehenge (see Stonehenge), that he defeated Hengist, and that he compelled the Saxons to surrender at York; but these stories are inherently improbable. The circumstances of his death are involved in equal obscurity. According to Geoffrey's account, he died of poison at Winchester; but others state that he was killed in a battle with Cerdic the Saxon in 508.

AMBULANCE, the French *ambulance*, *hôpital ambulant*, derived from the Latin *ambulare*, to move from place to place.

Ambulances, in military phraseology, are hospital establishments moving with armies in the field, and organised for providing early surgical assistance to the wounded after battles. They are only prepared for affording help of a more or less temporary kind, and they are thus distinguished from the *stationary* or *fixed hospitals*, in which sick and wounded soldiers receive care and treatment of a permanent character. The term is not unfrequently misapplied in common speech in England to the ambulance waggons, or other conveyances by which the wounded are carried from the field to the ambulances and fixed hospitals. Such vehicles form part of the ambulance equipment, and will be noticed presently.

The constitution of an ambulance includes (1) a certain staff of officers and subordinates, and (2) a certain equipment. The equipment naturally divides itself into (*a*) the medical and surgical equipment, and (*b*) the equipment forming the means of transport for the wounded. But the constitution would hardly be understood without a general comprehension of the system on which the functions of ambulances are discharged, or, in other words, the plan of administering surgical assistance in the field to the wounded of armies. *Ambulance administration* will therefore be first noticed, keeping in view the circumstances of armies operating in Europe, and the *ambulance staff* and *equipment* subsequently.

Ambulance Administration.—The origin of the ambulance system which now prevails in all civilised armies, though variously modified among them in particular details, only dates from the last decade of the last century. Before that time no ambulance establishments had been organised for effecting the removal of the wounded, or for giving the requisite surgical attention to them, while battles were in progress. Soldiers wounded in the ranks were either carried to the rear by comrades, or were left to lie exposed to all risks, and unheeded, until after the fighting had ceased. The means of surgical assistance did not reach the battle-field till the day after the engagement, or often later, and to a large proportion of the wounded it was then of no avail. In 1792 Larrey introduced his system of *ambulances volantes*, or flying field hospitals, establishments capable of moving from place to place with speed, like the flying artillery of the time. They were adapted both for giving the necessary primary surgical help, and also for removing the wounded quickly out of the sphere of fighting. The first Napoleon warmly supported Larrey in his endeavours to introduce and perfect the new system of surgical aid to the wounded in battle; and, being received with much favour by the troops, the plan obtained a firm footing, and was subsequently brought to a high state of perfection. About the same time another distinguished surgeon of high position in the French army, Baron Percy, introduced and developed a corps of *brancardiers*, or stretcher-bearers. These consisted of soldiers trained and regularly equipped for the duty of collecting the wounded while a battle was in progress, and carrying them on stretchers to places where means of surgical aid were provided.

From the period when these improvements were introduced most civilised armies have had ambulance establishments formed for giving surgical help near to the combatants. It is only, however, during the last twenty years that ambulances have acquired the completeness of organisation which they have now attained in some armies, especially in those of Germany. In the armies of the United States of America, during the late great civil war, the ambulance system attained a very complete organisation, particularly from March 1864, when an Act was passed by Congress, entitled "An Act to establish a uniform system of Ambulances in the United States." This law fixed a definite and single system of ambulance arrangements for all the armies of the United States at that time in the field.

The ambulance arrangements of the British army have never reached the degree of completeness which they have reached in Continental armies. During the Peninsular war the want of a trained ambulance corps, and of properly-constructed sick-transport carriages, formed a theme of constant complaint. For the former, soldiers from the ranks were substituted—a double evil, as they were unsuited for the work, while their employment lessened the fighting strength; for the latter, commissariat waggons, or the agricultural carts of the country in which the troops were operating. It was not from want of attention being called to the subject, as the writings of Sir J. M'Grigor, Hennen, Millingen, and other Peninsular surgeons sufficiently testify. The last-named military surgeon published a very complete scheme of an ambulance establishment shortly after the war was concluded, approaching closely in its principles to those put into practice of late years in the armies of Germany. There is reason for believing that had the operations of the British troops on the Continent not been discontinued, some plan of the kind would have been introduced. As it was, subsequently to 1815, so far as army hospitals were concerned, administrative attention was chiefly given to improving those for the accommodation of the sick in peace time. The wars that British troops were engaged in in India, China, the south of Africa, and elsewhere, did not lead to improvements like those which have been made in Continental armies; for either the habits of the natives of the respective countries, or the nature of the climate, or the state of the country, necessitated special arrangements for the care of the sick and wounded unsuited for meeting the circumstances of European warfare. Thus, when the Crimean war broke out the English army was still without an ambulance corps, or an ambulance establishment of *matériel*. An ambulance corps of military pensioners was hastily raised, but failed from the habits and enfeebled constitutions of the men. They were succeeded by a corps formed of civilians, unused to the discipline and habits of military life, which likewise failed. Several forms of sick-transport vehicles were tried, but only indifferently answered their intended purposes. Fortunately, as the troops were for the most part stationary during the war, the want of thoroughly organised ambulances was not felt to the same extent as it would have been had the operations been extended far into the interior of the country. The experience of the Crimean war led to efforts to repair the

defects which were then made manifest. Since that time a trained army hospital corps has been constituted, and much of the ambulance equipment has been revised.

One serious impediment to perfecting an ambulance system is the costliness of maintaining, in time of peace, establishments which will only be required for use in time of war. All that can be done is to form a nucleus which can be expanded according to need when war breaks out. But even in Continental armies, with frequent wars pressing upon them, the urgency of giving close attention to the subject, and in countries where the existence of conscription furnishes a greater supply of men at less cost than in England, the deficiencies of the ambulance establishments have hitherto been so great in respect to the numbers and necessities of the wounded on occasions of great battles, that an extensive volunteer organisation, with national societies in every country of Europe, has sprung up for giving additional assistance. This is not the place to discuss the advantages of such volunteer aid; but, if accepted, all who have considered the subject well have admitted the necessity for its being placed under military authority, and under distinct regulations, in order to secure maintenance of order and discipline. It is also generally admitted that volunteer aid to wounded soldiers is out of place in the ambulances, and can best be employed in the fixed hospitals, by which means some of the regular military *personnel* may be set free for work in the field.

One important step, taken a few years since, towards the amelioration of the condition of the wounded of armies in the field must be just mentioned. This was the European Convention signed at Geneva in 1864, by the terms of which, subject to certain regulations, not only the wounded themselves, but the official staff of ambulances and their equipment have been rendered neutral; the former, therefore, not being liable to be retained as prisoners of war, nor the latter to be taken as prize of war. This convention has greatly favoured the development of ambulance establishments.

The conditions of modern warfare have led to the need of army ambulances being arranged on principles different from what were applicable only a few years ago. The immensely increased range of rifles and artillery in the present day, the consequent extension of the area over which fire is maintained, the suddenness with which armies can be brought into the field from increased facilities of locomotion, the rapidity of their movements, the shortened duration of campaigns, the large numbers of wounded which have to be dealt with, not merely from the destructive qualities of the fire-arms, but from the vast forces collected on occasions of important battles, the increased proportion of severe wounds,—are all circumstances which have entailed need for revision of ambulances and their administration. The ambulances must be so organised as to be able to keep up with the troops, and so disposed as in no way to interfere with their movements. They must be capable of meeting the wants of a partial or general engagement at any moment, and if the troops advance, must be prepared to accompany them, so as to be ready to meet future wants.

Whatever the details of organisation may be when an important battle is fought, the ambulance system must admit of three help stations at least being established in rear of the combatants. There must be a station of limited character immediately in rear of the troops for attention to such wounds as entail speedy loss of life if no assistance be rendered; a second station, more remote, where temporary assistance of a more general nature can be afforded; a third, where more thorough attention can be given, and where the wounded can receive food and protection until there are means of sending them away. Recently, in some armies, the ambulance arrangements have been calculated for furnishing aid at four stations; and, indeed, owing to the increased range of fire, and the consequent distance between the help stations when only three are formed, the fatigue thrown on the bearers is so great, and the time the wounded are left without help so long, that the division of the ambulances into four stations has become almost essential. If this arrangement be followed, there will be —1st, the *field station*, for help of prime urgency; 2d, the *transfer station*, where the wounded will be transferred from the hand conveyances to wheeled vehicles; 3d, the *dressing station*, where the provisional dressings will be applied; and 4th, the *field hospital station*, where definitive treatment will be adopted.

The disposition and distances of these four ambulance sections must vary according to the nature of the battle, the configuration of the terrain, and other circumstances, but in a general way will be as follows:—1st, the field station, in the immediate rear of the troops, moving with them, and therefore under fire; 2d, the transfer station, clear of the enemy's rifle fire, but not too far for the bearers, and at a place practicable for waggons, from 800 to 900 yards behind the troops engaged; 3d, the dressing station, beyond range of artillery fire, at a spot easily reached by the ambulance waggons, and on the way to the fourth station, with a running stream or well at hand if possible, from 800 to 1000 yards in rear of No. 2; and 4th, the field hospital station, at a place free from risk of being brought within the sphere of fighting, from 2 to 4 miles in rear of the combatants. This last station may be at a farm or country house, or in a village, but should not be in a place of strategical importance, or in one likely to be blocked by the general transport of the army. When the four stations are in working order, as men fall badly wounded, those within reach will be placed on stretchers by the men told off for duty as bearers, and, after hasty inspection by the field surgeon, and, as far as practicable, receiving such help as is of vital importance, they will be borne to the second or transfer station, and placed in ambulance waggons, or on wheeled stretchers if they are in use. The bearers, then taking vacant stretchers, will return to the field station for more wounded. The wounded who have been transferred to the wheeled conveyances will be driven by the men of the ambulance train to the third or dressing station, and there receive whatever provisional dressing may be necessary before being sent on to the fourth or field hospital station, where definitive treatment will be adopted, and any surgical operations performed that may be required.

It is obvious that such a system of help can only be carried out, with any approach to regularity and requisite speed, with ambulance establishments proportionate to the number of troops in the field, each ambulance being well organised, provided with a sufficient staff and complete equipment, and acting under the general supervision of an experienced director, whose duty it is to watch the varying events of the contest while it is in progress, and to order changes in the ambulance arrangements according as the troops advance, retire, or otherwise change position. Even with these advantages, the difficulties of adequately meeting the wants of the wounded must always be very great, owing to the rapid manœuvres of the troops, the varying features of the ground over which battles are extended, and the rapidity with which the wounded fall; but without a proper organisation arranged beforehand, the difficulties are insuperable, and no help of much value can be afforded until all fighting has ceased.

Ambulance arrangements have to be modified to suit particular military operations, such as when troops disembark on a hostile shore, on occasion of sieges, &c.

AMBULANCE STAFF.—The scheme of ambulance administration and action just described involves the necessity of a staff comprising the following *personnel*, viz.:—1. Bearers of wounded; 2. Surgeons and attendants; 3. Ambulance train *personnel*; 4. Ambulance police; 5. Servants to officers.

Bearers of Wounded.—These are soldiers specially trained and told off for the duty of picking up and carrying the badly wounded on stretchers. In Continental armies special provision is made to meet this particular want, but under different systems in different armies. In the Prussian army companies of bearers, distinguished by a particular uniform, and denominated "sanitäts-detachements," have the duty assigned to them of gathering the wounded during battles, and carrying them to the dressing and field hospital stations. Each of these bearer columns consists of a military staff of officers for discipline and direction, non-commissioned officers, buglers, and a large number of bearers; a special medical staff, with assistants and dressers; a transport staff of non-commissioned officers and drivers, with a certain number of stretchers, wheeled stretcher supports, sick transport waggons, and store waggons for the carriage of instruments, dressings, and other necessary materials. Separate establishments exist for the field hospitals. In addition to these sanitary detachments, auxiliary sick-bearers (*Hilfs-krankenträger*) are provided for service on occasions of great battles. To form these auxiliaries, four men in each company of every battalion of the army are practised at regular periods with the sanitary detachments in time of peace in the modes of picking up, temporarily attending to, and carrying wounded. These auxiliary bearers wear the uniform of their regiments, of which they perform the ordinary duties, but have a distinguishing badge on the left arm when serving as bearers. When a battle is imminent, the auxiliary bearers fall out, are provided with stretchers and other needful appliances from the ambulance waggons, and act under the orders of the officers of the divisional sanitary detachments. The system in the Austrian army is very like that in the Prussian. In the British army no corresponding establishment exists. The hospital attendants belonging to the Army Hospital Corps are trained in all that refers to the care of wounded men, but in time of war they will be too urgently needed for their duties in the field and fixed hospitals to be spared for duty as bearers of the wounded from the field to the dressing stations. The regimental bandsmen are generally regarded as available for these duties in the British service; but though the army regulations order that bandsmen are liable to serve in the ranks on an emergency, they nowhere constitute them bearers of wounded, nor do bandsmen receive the necessary training to fit them for the duties. As it is understood that the ambulance arrangements of the British army are at present under consideration, this, with other details, will probably be shortly placed on a settled basis.

Surgical Staff.—This section embraces the medical officers (administrative and executive), the dispensers of medicine, and the officers, non-commissioned officers, and men of the Army Hospital Corps. The last-named corps includes the dressers, nurses, cooks, and all the hospital subordinates who are required for the care, dieting, watching, and protection of the patients, for the hospital correspondence, &c. The men act professionally under the directions of the surgeons; in respect of other matters, under their own officers. The constitution and duties of the several divisions and grades of the army medical department are shown in a special code of instructions known as the "Army Medical Regulations."

Ambulance Train.—On the officers and men of the ambulance train devolve the duties of conducting the wheeled transport, and the mule litters and cacolets when such conveyances are used. In the British service these duties are entrusted to the ordinary transport branch of the Control department. It has been recommended that the officers and men to whom these duties are entrusted should be specially selected and trained, as well as familiarised, to co-operate with the bearers and ambulance corps. They would thus form an ambulance train somewhat like that which exists in the sanitary detachments of the Prussian army.

Military Servants.—Orderlies are required as servants to the ambulance surgeons and other officers, in order that they may give their time fully to the concerns of the sick and wounded. When special orderlies are not provided, men of the Army Hospital Corps usually act as servants to officers,—a bad system, for the whole time and services of these trained men should be devoted to their legitimate functions.

Ambulance Police.—Many irregularities are liable to occur in the rear of troops engaged in a general action; not so much from acts of the troops themselves as from camp followers, hired drivers, and others. The officers charged with the military discipline of the bearer, train, and hospital corps have other pressing duties to engage them on such occasions. In the British army it devolves on the provost-marshal to arrange for this service.

AMBULANCE EQUIPMENT.—As before mentioned, ambulance equipment divides itself into two categories:—1. The medical and surgical equipment; 2. The equipment for the transport of wounded. These divisions will therefore be noticed separately, and the description will be confined to the equipment supplied in the British army for service in Europe. In India and in tropical countries special ambulance equipments are rendered necessary.

Medical and Surgical Equipment.—This portion of ambulance equipment consists of the articles necessary for the service of the wounded in the field itself, at the dressing stations, and in the field hospitals. It has to be distributed in forms such that it may be readily conveyed to the places where it is required, and such also as will admit of its being hastily packed up and removed should the circumstances of the field operations require it. At the same time, these forms must be adapted for use at all seasons of the year, for passage over all descriptions of ground that troops can march over, and must be protected against the effects of exposure to all varieties of weather.

It would occupy too much space to name the articles comprising this equipment. The special forms under which it is issued will be mentioned, and a brief explanation of them and the nature of their contents be added.

The equipment is distributed as follows:—Supplies of instruments, dressings, medicines, and restoratives, of first necessity, in small cases named "medical field companions," and in large cases named "field panniers;" of cooking utensils and other articles for field hospital service in "canteens;" of articles of light nourishment, stimulants, &c., in "medical comfort boxes;" of hospital tents, bedding, and the bulkier articles of surgical equipment, in ambulance equipment carts or store waggons. In addition, every soldier on taking the field is supplied with a "field dressing;" each surgeon carries a pouch-belt, arranged both for distinguishing his functions and at the same time carrying his "pocket case" of instruments; and each Army Hospital Corps man has his "orderly's dressing-case." Every wounded man has therefore on his person the means of a first dressing for his wound, every surgeon has at hand instruments for affording surgical aid, and every ambulance and field hospital attendant the

means of assisting the surgeon in his duties. Moreover, wherever the soldier can go, there the first two forms of the surgical equipment—the medical field companion and the field panniers—can also be taken. The articles for use in the field hospitals, being carried in wheeled vehicles, can only move where the other transport of the army can be taken.

Medical Field Companions.—These are small cases carried by men of the Army Hospital Corps selected to accompany surgeons. They consist of two pouches and a wallet, worn nearly in the same way as the pouches and belt-bag in which ammunition is carried by combatant troops. The two pouches, carried on the waist-belt, contain small supplies of essential medicines and styptics; the surgical wallet, also carried on the waist-belt, and supported by valise straps, contains materials for surgical dressings and other articles. As these attendants are not armed with rifles, they can carry their valises and the medical field companions at the same time without inconvenience. With each medical field companion is carried, by a shoulder-strap, a water-bottle and a drinking-cup.

Field Panniers.—These are tough wicker baskets covered with hide, each being 2 feet 2 inches in length, by 1 foot 2½ inches in breadth, and 1 foot 4½ inches in depth. They are supplied in pairs, and are arranged for being attached to a pack-saddle and carried on a bât-pony or mule. They are capable of being opened while on the animal in such a way that all the contents can be readily got at. The field panniers contain instruments for important surgical operations, chloroform, surgical materials (such as splints, bandages, plaisters, &c.), a lamp, supplies of wax candles, restoratives, and medical comforts in concentrated forms, and other articles necessary for urgent cases at the dressing stations and field hospitals. Each pannier has a double lid, and the four lids of the two panniers, when they are laid on the ground, can be connected so as to form a substitute for an operating table.

Field Hospital Canteens.—These are also supplied in pairs, and are distinguished as A and B canteens. They are wooden boxes nearly similar in size to the field panniers, so that, although usually carried in the equipment vehicles, they can, in case of need, be carried on the backs of bât-animals. Their contents consist of camp-kettles and other utensils for cooking purposes; tin plates, drinking-cups, and other such requisites; sets of measures and weights; a lantern of coloured glass for indicating the field hospital at night; together with various articles required for the service of patients in a tent or other field hospital.

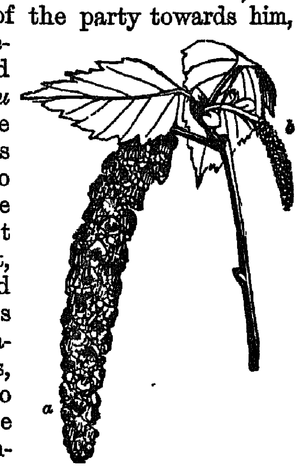
Medical Comfort Boxes.—These also are supplied in pairs, and resemble the canteens in shape and dimensions. The contents of the two are different, and they are therefore marked No. 1 and No. 2 respectively. Each box is partitioned and fitted with cases or bottles with labels indicating their contents. These principally consist of essence of beef, groceries, arrowroot, preserved vegetables, brandy, wine, and sundry accessory articles. The wounded are supplied with the same rations as the healthy troops, and they are turned to the best account available for their nutriment, supplemented by such medical comforts as are named above.

Ambulance Equipment Waggons.—In these vehicles are carried the tents for forming the field hospital in case of no building being available, with a supply of blankets, waterproof covers, and other articles of bedding for the patients. The canteens and medical comfort boxes are also carried in these vehicles. Certain implements, as reaping-hooks, spades, pickaxes, saws, which are constantly required when men are thrown so much on their own resources as they must be in campaigning, are also carried in the equipment waggons.

Ambulance Equipment for the Transport of Wounded Troops.—The ambulance conveyances authorised for use in the British army are of four kinds. They are the following:—1. Conveyances carried by the hands of bearers, called *stretchers;* 2. Conveyances wheeled by men, *wheeled stretchers;* 3. Conveyances borne by mules, *mule litters* and *mule cacolets;* and 4. Wheeled conveyances drawn by horses, *ambulance waggons.* The forms of all these conveyances have been lately revised by a committee which was appointed in 1868 by Sir J. Pakington, then Secretary of State for War, to inquire into the general question of ambulance and hospital conveyances for the army, and the new pattern vehicles have now been authorised for use. (T. L.)

AMELOT DE LA HOUSSAYE, ABRAHAM NICOLAS, historian and publicist, was born at Orleans in February 1634, and died at Paris 8th December 1706. Little is known of his personal history beyond the fact that he was secretary to an embassy from the French court to the republic of Venice. At a later period he was imprisoned in the Bastile by order of Louis XIV. In 1676 he published at Amsterdam his *Histoire du Gouvernement de Venise,* in three volumes. Under the assumed name of De la Mothe Josseval, he published in 1683 a translation of Fra Paolo Sarpi's History of the Council of Trent. This work, and especially certain notes added by the translator, gave great offence to the advocates of the unlimited authority of the pope, and three separate memorials were presented to have it repressed. Amelot also published translations of Machiavel's *Prince,* and of the *Annals* of Tacitus, besides several other works.

AMELOTTE, DENIS, a French ecclesiastic and author, was born at Saintes in Saintonge in 1606, and died October 7, 1678. Soon after receiving priest's orders he became a member of the congregation of the oratory of St Philip Neri. In 1643 he published a Life of Charles de Goudren, second superior of the congregation, which by some of its remarks on the famous abbot of St Cyran, gave great offence to the Port Royalists. Another work, containing a vehement attack on the doctrines of the Jansenists, still further embittered the feelings of the party towards him, and elicited from Nicole a severely satirical reply entitled *Idée Générale de l'Esprit et du Livre du P. Amelotte.* Amelotte in revenge availed himself of his influence with the chancellor to prevent the publication of the newly-completed Port Royalist translation of the New Testament, which had therefore to be issued at Mons in Flanders. He thus secured a free field for a translation of his own with annotations, which appeared in 4 vols. octavo in 1666-8. The dedication to the archbishop of Paris contained another abusive denunciation of the Jansenists.



Betula alba (the common birch), an amentiferous tree, the male flowers, *a*, are produced in scaly catkins, and so are the female flowers, *b*.

AMENTIFERÆ, or AMENTACEÆ. Under this name are included apetalous unisexual plants bearing their flowers in catkins (*amenta*). This group of plants includes trees and shrubs chiefly of temperate climates. It is divided into the following orders:—*Salicaceæ,* willows and poplars; *Corylaceæ* or *Cupuliferæ,* hazel, oak, beech, chestnut, hornbeam, &c.; *Betulaceæ,* birch, alder; *Casuarinaceæ,* Casuarina (beefwood); *Altingiaceæ* or *Balsamifluæ,* liquidambar; *Platanaceæ,* the plane; *Juglandaceæ,* walnut; *Garryaceæ* Garrya; *Myricaceæ,* bog myrtle.

NORTH AMERICA

AMERICA

OUR object in this article is to take a comprehensive survey of the American continent in its physical, moral, and political relations. In attempting this, we shall dwell at some length upon those great features and peculiarities which belong to it as a whole, or facts which can be most advantageously considered in connection with one another. The new continent may be styled emphatically "a land of promise." The present there derives its greatest importance from the germs it contains of a mighty future. It is this prospective greatness which lends an interest to the Western continent similar to that which the Eastern derives from its historical associations. But the Western continent also has its past, which abounds in points of interest relating to both the historic and prehistoric periods. Facts show that although America may be called the New World in consequence of its having been the last to come under the general knowledge of geographers, it is from most other points of view an old world. It abounds in the oldest known strata; it has yielded some of the oldest known remains of man, indicating that he has long been a denizen there; and it has afforded evidences of a civilised era, which may even have preceded that of Western Europe.

The new continent, when compared with the old, enjoys three important advantages. First, it is free from such vast deserts as cover a large part of the surface of Asia and Africa, and which not only withdraw a great proportion of the soil from the use of man, but are obstacles to communication between the settled districts, and generate that excessive heat which is often injurious to health, and always destructive to industry. Secondly, no part of its soil is so far from the ocean as the central regions of Asia and Africa. Thirdly, the interior of America is penetrated by majestic rivers, the Mississippi, Amazon, and Plata, greatly surpassing those of the old continent in magnitude, and still more in the facilities they present for enabling the remotest inland districts to communicate with the sea.

In the physical formation of North and South America there is a remarkable resemblance. Both are very broad in the north, and gradually contract towards the south till they end, the one in a narrow isthmus, and the other in a narrow promontory. Each has a lofty chain of mountains near its western coast, abounding in volcanoes, with a lower ridge on the opposite side, destitute of any recent trace of internal fire; and each has one great central plain declining to the south and the north, and watered by two gigantic streams, the Mississippi, corresponding to the Plata, and the St Lawrence to the Amazon. In their climate, vegetable productions, and animal tribes, the two regions are very dissimilar.

Extent. The extent of the American continent and the islands connected with it is as follows:—

	Square Eng. miles.
North America	7,400,000
South America	6,500,000
Islands	150,000
Greenland, and the islands connected with it lying north of Hudson's Straits, may be estimated at	900,000
	14,950,000

The American continent, therefore, with its dependent islands, is four times as large as Europe, and about one-third larger than Africa, but somewhat less than Asia, while it is nearly five times the size of the Australian continent. It constitutes about three-tenths of the dry land on the surface of the globe. It is characterised by having a greater length from N. to S. than any other continent; and by the northern and southern portions being connected by a comparatively narrow strip of land. South America has a more regular form, and as a mass is situated much farther east than North America. In South America the most central point lies in about 58° W.; but in North America the most central point would be in about 100° W.

Sketch Map of America.

As regards continuity of land, America comprises some islands at the southern end; a main continental portion, including South America, Central America, and North America; some islands off the north shore, and many other islands along the east and west coasts, those on the east being the most important. The most northern point of the mainland is that of Boothia Felix, in Bellot Strait, 71° 55′ N., 92° 25′ W. The islands to the north extend beyond 82° 16′ N., 65° W., which point was reached by the "Polaris" in August 1871. The southernmost point of the mainland is Cape Froward, which lies close to 54° S., 71° W.; while Cape Horn, the most southern point of the islands, is in 56° S., 67° 20′ W. The extreme points traced are consequently 138° apart; and the continental part stretches over about 126 degrees of latitude. This corresponds to lengths of 8280 and 7560 geographical miles respectively. The extreme east points of the continent are Cape St Roque, in 5° 28′ S., 35° 40′ W., in South America, and Cape St Charles, in 52° 17′ N., 55° 35′ W., in North America. The most western point of South America is Point Parina, in 4° 40′ S., 81° 10′ W.; and of North America, Prince of Wales Cape, in 65° 30′ N., 167° W. The greatest breadth of North America is

between Cape Lisburne and Melville Peninsula; and of South America, between Pernambuco and Point Aguja. The narrowest part is 28 miles, at the isthmus of Panama. The nearest approach to the Old World is at Behring Strait, which is 48 miles across, and shallow. On the east side the nearest point to the Old World is Cape St Roque, which is opposite the projecting part of the African coast at Sierra Leone. Greenland is separated from the archipelago of Arctic America by a deep and for the most part broad sea, and seems naturally to belong to the European rather than the American area.

Physical regions. North America, with the general form of a triangle, naturally divides itself into five physical regions: 1. The table-land of Mexico, with the strip of low country on its eastern and western shores; 2. The plateau lying between the Rocky Mountains and the Pacific Ocean, a country with a mild and humid atmosphere as far north as the 55th parallel, but inhospitable and barren beyond this boundary; 3. The great central valley of the Mississippi, rich and well wooded on the east side; bare but not unfertile in the middle; dry, sandy, and almost a desert on the west; 4. The eastern declivities of the Alleghany Mountains, a region of natural forests, and of mixed but rather poor soil; 5. The great northern plain beyond the 50th parallel, four-fifths of which is a bleak and bare waste, overspread with innumerable lakes, and resembling Siberia both in the physical character of its surface and the rigour of its climate.

South America is a peninsula likewise of triangular form. Its greatest length from north to south is 4550 miles; its greatest breadth 3200; and it covers an area, as already mentioned, of 6,500,000 square English miles, about three-fourths of which lie between the tropics, and the other fourth in the temperate zone. From the configuration of its surface, this peninsula also may be divided into five physical regions—1. The low country skirting the shores of the Pacific Ocean, from 50 to 150 miles in breadth, and 4000 in length. The two extremities of this territory are fertile, the middle a sandy desert. 2. The basin of the Orinoco, a country consisting of extensive plains or *steppes*, called Llanos, either destitute of wood or merely dotted with trees, but covered with a very tall herbage during a part of the year. During the dry season the heat is intense here, and the parched soil opens into long fissures, in which lizards and serpents lie in a state of torpor. 3. The basin of the Amazon, a vast plain, embracing a surface of more than two millions of square miles, possessing a rich soil and a humid climate. It is covered almost everywhere with dense forests, which harbour innumerable tribes of wild animals, and are thinly inhabited by savages, who live by hunting and fishing. 4. The great southern plain, watered by the Plata and the numerous streams descending from the eastern summits of the Cordilleras. Open *steppes*, which are here called Pampas, occupy the greater proportion of this region, which is dry, and in some parts barren, but in general is covered with a strong growth of weeds and tall grass, which feeds prodigious herds of horses and cattle, and affords shelter to a few wild animals. 5. The country of Brazil, eastward of the Parana and Uruguay, presenting alternate ridges and valleys, thickly covered with wood on the side next the Atlantic, and opening into steppes or pastures in the interior.

In our more particular description of the physical conformation, the geological structure, the mountains, rivers, and forests, and the climates of America, we shall first deal with the southern peninsula, as having the more strongly marked conditions.

S. America: Mountains. The mountain areas of South America are, as a general rule, those which have received the thickest accumulations of sedimentary matter, and this thickness is nearly proportional to their height. During the periods of the formation of such deposits, these areas were to a great extent areas of subsidence, and since those beds which once formed the sea bottoms now constitute the highest peaks, these areas must have been subjected to subsequent upheaval. Vertical movements of this kind have occurred again and again, indicating that these areas are specially liable to disturbance, either from comparative weakness or from the greater comparative power of the moving forces. The history of the mountain chains is almost co-extensive with that of the continent itself. In the sea the beds were deposited horizontally, or nearly so; and at certain intervals the deposition was arrested, in consequence of the beds being uplifted above the sea. Each successive submergence and emergence occupied a long period of time, during which the rocks were at one time faulted, folded, and metamorphosed, and at other times denuded both by the sea and by meteoric agents. As a general rule, the strike or line of direction of the strata ran approximately parallel to the trend of the shore line on the large scale, and the dip was at right angles to their direction. During each elevation the land was uplifted in a broad band, the axis of which ran parallel to the shore of the sea in which the beds were formed. The axes of the principal folds and faults usually run parallel to the stratigraphical axis or strike. The principal ridges formed during the same period usually coincide in direction with the stratigraphical strike of the bed forming them. In the mountains of South America, and especially in the Andes, several of these groups of ridges, formed at different periods, combine to make up a single system of mountains. The high range of mountains which extends from the most southern parts of South America, and runs approximately on the same meridian of 72° to the isthmus of Panama, forms the Andes. These consist of a vast rampart, having an average height of some 11,000 or 12,000 feet, and a width varying from 20 to 300 or 400 miles. In most places the chain rises to heights of several thousand feet, and upon this chain rest two or three principal ridges of mountains, enclosing lofty plains or valleys, separated one from another by mountain knots, which mark the spots where ridges belonging to different systems intersect. In one sense, the lofty plains of the Desaguadero, Quito, and others, are valleys, since they are encompassed by mountains; but in a certain sense they are plateaus, since they form the broad summit of the range or platform on which the bounding ridges themselves stand. Further details respecting the Andes are given under ANDES, and in the geological remarks of this article.

Transverse chains. Three branches or transverse chains proceed from the Andes, nearly at right angles to the direction of the principal chain, and pass eastward across the continent, about the parallels of 18° of S. and 4° and 9° of N. latitude; thus forming the three natural areas of the Orinoco, Amazon, and La Plata river basins. The most northern of these is "the Cordillera of the coast," which parts from the main trunk near the south extremity of the lake Maracaybo, reaches the sea at Puerto Cabello, and then passes eastward through Caraccas to the Gulf of Paria. Its length is about 700 miles, and its medium height from 4000 to 5000 feet; but the Silla de Caraccas, one of its summits, has an elevation of about 8632 feet; and its western part, which is at some distance from the sea, contains the Sierra of Merida, 15,000 feet in height. The second transverse chain is connected with the Andes at the parallels of 3° and 4° north, and passing eastward, terminates in French Guiana, at no great distance from the mouth of the Amazon. It consists properly of a succession of chains nearly parallel to the coast, and is sometimes called the Cordillera of Parimé, but is named by Humboldt the "Cordillera of the Cataracts of the Orinoco," because this river, which flows amidst its ridges in the

upper parts of its course, forms the cataracts of Maypure at the point where it descends into the plains. Its mean height is estimated at 4000 feet above the level of the sea; but at about 70° and 75° W. longitude, it sinks to less than 1000 feet, and at other points rises to 10,000. This chain divides the waters of the Orinoco and the rivers of Guiana from the basin of the Amazon, and is covered with magnificent forests. Its breadth is supposed to be from 200 to 400 miles, and it encloses amidst its ridges the great lake Parimé, in longitude 60°, and several of smaller size. At the Caratal gold-field, which lies south of Angostura, the range is about 60 miles across, and the watershed about 1100 feet above the sea. On a table-land forming part of it, about the 67th degree of longitude, the Cassiquiari forms an intermediate channel which connects the rivers Orinoco and Negro, so that, during the annual floods, a part of the waters of the former flows into the latter. This singular phenomenon was made known long ago by the Spanish missionaries, but was thought to be a fable till the truth was ascertained by Humboldt. The length of this chain is about 1500 miles. The third transverse chain leaves the main trunk near 17° 25′ S., and extends almost as far as Santa Cruz, near the river Mamore. Some of the mountains in the western part are of considerable height. South of this range are a number of ridges having an east and west direction, an average height of about 10,000 feet, and terminating in the plains near the Paraguay. This country, which divides the waters of the Amazon from those of the Plata, is a broad plateau of elevated land, rather than a distinct mountainous ridge, and consists of low hills or uneven plains, with very little wood, presenting in some places extensive pastures, and in others tracts of a poor sandy soil. Its average height probably does not exceed 2000 or 3000 feet above the level of the sea.

The mountains of Brazil, which are of moderate height, and occupy a great breadth of country, form an irregular plateau, bristled with sharp ridges running in a direction approximately parallel to the eastern coast, connected by offsets running in a more or less east and west direction. They extend from 5° to 25° of south latitude, and their extreme breadth may be about 1000 miles. Between Victoria on the north and Morro de St Martha on the south, a range with numerous curves lies a little way back from the coast, and is, for the greater part of its length, known as the Sierra do Mar; somewhat farther inland is a higher range, the different parts of which have different names, but it is best known as the Sierra de Mantiqueira. It contains the highest peaks in Brazil, amongst which may be mentioned Mount Itacolumi, famous for the gold and diamond yielding strata in its vicinity; the Pico dos Orgaos, which is 7700 feet high; and Itambe, 8426 feet. Some of the peaks are believed to be even higher. West of this the uplands of Brazil stretch far into the interior, and at length sink into the great central plain through which flows the Paraguay and its tributaries.

Geology. Although large areas of South America remain as yet unexplored by geologists, the researches of D'Orbigny, Humboldt, Boussingault, Darwin, Forbes, Agassiz, and many other travellers, suffice to give an approximately correct general view. This is mainly owing to the simplicity of the stratigraphy of the country. The same groups of rocks spread over such extensive areas, that, from what is seen in the areas which have been examined, we can safely infer the general condition of those which have not been explored. The general disposition of the rocks is as follows:—The oldest rocks, which are Pre-Silurian, possibly Laurentian, form the outermost rim of the continent, of which the N.E. and S.E. corners have probably been swept away. These corners now correspond with the mouths of the Orinoco, the Amazon, and the La Plata rivers. Within this basin, and following close upon these old rocks, are schists and quartzites, which are in all probability of Silurian age. These enter largely into the transverse ranges by which the central hollow is subdivided into three basins. Within this again are sandstones and limestones, usually referred to the Carboniferous period, which also form part of the transverse ridges. A band of rocks of secondary age follow, some of which are believed to be Triassic, while others are identified as Cretaceous. Tertiary beds, some of Miocene date, together with Post-Tertiary beds, cover the largest part of the areas of the great river basins and the hollows in the mountain range, and also occur on the seaward flanks of the principal chains.

By following the development of these beds, we shall be able to give a brief account of the growth of the present continent. In the Argentine Confederation a few bosses of gneiss protrude through the more recent beds constituting the Pampas. Granite, supporting gneiss and quartzite, occurs along the coast of Chili. In Bolivia we find a range of granitic mountains which have a general direction somewhat to the E. of N., and which are flanked on either side by zones of gneiss and quartzite. The gneiss also prevails along the shores of Peru, Ecuador, and New Granada, or, to call it by the name which it received in 1861, Columbia. The gneiss is again seen at the eastern base of the Andes, in the last-mentioned State, associated with quartzites, and both these can be traced along the Venezuelan coast. Gneiss is largely developed near Angostura, and has a strike approaching E. and W. At Limones, which is near the Caratal gold-field, the country consists largely of granite and gneiss, which latter lies here a little to the E. or to the W. of N. In Brazil the gneiss forms a long band from Bahia to the southern portion of the province of Santa Catharina. Near the coast it rests upon and apparently passes into granite; but towards the west, as far as the Mantiqueira chain, it gradually becomes more and more schistoid. Gneiss, again, is met with in the mountains which stretch through the Bolivian provinces of Moxos and Chiquitos. It has not been ascertained if these older rocks appeared above the waters before the deposition of those which follow, and which will next be noticed.

In Chili the succeeding rocks are slaty schists. In Bolivia the mountainous district crossing the country is largely composed of talcose schists, which, where exposed to the weather, have formed by their decomposition a layer of clay; in advancing from the east towards the west the schists become more and more crystalline, and are at last replaced by gneiss. This, as has already been stated, rests against granite, on the west side of which gneiss is again brought in by an anticlinal arrangement of the beds, and dips beneath a thick mass of schists, which constitute the great bulk of the Andes in this district. In this mountain range the lower portion of the formation is mainly siliceous schist, alternating with beds of compact quartz; above this come talc-bearing quartzites, alternating with slaty schists, which latter become more and more prevalent as we ascend in the strata, and at last constitute the predominating rock. They form, indeed, the crest of the range; the thickness of the formation may be roughly estimated at 10,000 feet. These rocks are much disturbed and faulted against other and probably newer rocks, which with them constitute the great bulk of the lofty eminences in the range of which Mount Illimani forms so conspicuous a feature. The lower argillaceous schist, which is associated with gneiss all along the Pacific coast from lower Peru to Panama, possibly belongs to this group of rocks. In the high valleys of Ecuador the oldest rocks visible are granite, gneiss, and schists, which are frequently in a vertical position. The schistose group appears

to be absent on the east side of the Andes in Columbia, as also along the coast of Venezuela. In the mountain range south of the Orinoco, hornblende, talcose, and mica schists again appear on a large scale, more especially in the Caratal district, where auriferous veins occur. In Brazil the micaceous and talcose schists enter into the composition of the Mantiqueira chain and of the uplands to the west; they probably pass beneath the valley of the Panama, since they occur to the west of it, and extend through the provinces of Goyaz and Matto Grosso, so as to approach within a moderate distance of the similar strata in Bolivia. They are associated with talc-bearing quartzites, which are famous for the diamonds and auriferous particles they have yielded in the district around Mount Itacolumi. The soil is usually a clay, such as would result from the decomposition of talcose schist; but we shall have occasion to refer to the soil of South America subsequently. Some of these rocks in various parts of the continent have yielded Silurian fossils. Facts are not sufficient yet to warrant the correlation of these strata with those of other countries, or to settle how far they belong to distinct geological periods. The prevalent strike of the rocks is about east and west, but sometimes the strike approaches to a north and south direction. At any rate, the rocks which overlie them do so unconformably, indicating that, prior to the deposition of these newer rocks, land had appeared at least once on areas now constituting part of South America. At this early date the continent was represented by a few islands only; one corresponded with part of Brazil, another with parts of Venezuela and Columbia; perhaps a third more or less with Peru, Bolivia, Ecuador, and Chili; while a few small islands appeared where now we have the Pampas. These were the nuclei around which the present land has accumulated, and already we see faint indications of the existing outline and broad geographic features of the future continent.

The next group of rocks are always in stratigraphical discordance with those beneath them; and, in consequence of the highly metamorphosed condition of those on the west side of the continent, it is difficult to correlate them with the rocks of Brazil. In the Andes of Chili they are represented by enormous stratified masses of quartzose porphyries, which there is good reason to believe are metamorphosed argillaceous schists and felspathic sandstones, into which rocks they have been seen gradually to pass. These porphyries not only form the great bulk of the principal chain of the Andes, but also the smaller chain on the west, the interval between them being formed by the longitudinal valley of Chili. Further west they rest on syenitic rocks, beyond which come the older rocks already noticed. On passing into Bolivia, we find that to the west of the great fault developed there, the beds consist of micaceous sandstones and dark bituminous schists, which are believed to be the equivalents of the porphyries of Chili. Such formations constitute the west slope of the Andes from Sorata to Illimani, and also form two bands, one stretching from Illimani to Cochabamba, the other between Calamarca and Chayanta. Towards the west they dip beneath black bituminous and siliceous limestones, which are well developed near Tiahuanaco. Carboniferous strata with seams of coal occur near Pisco and Arequipa in Peru. In Brazil the beds which succeed those previously mentioned are quartzites, rich in mica and magnetic oxide of iron; talcose schists; and crystalline limestones, containing a great deal of talc. These rocks form the highest regions and loftiest peaks in Brazil. Unconformably upon these rest micaceous sandstones and argillaceous schists, which occupy the western part of St Paul province between Ytu and the banks of the Parana. In Mount Arasoyaba and some other places, a carboniferous limestone succeeds and is overlain by a thick white or yellowish sandstone, siliceous limestones, and bituminous schists. The limestones occupy most of the area between the Uruguay and the Parana. In the Diamantina district the carboniferous limestone is overlain by red sandstone, which belongs to the succeeding group of beds. The beds in Brazil appear to be fuller than those on the west side of the continent, and represent probably both the Devonian and Carboniferous periods. Rocks of this age are also exposed in a narrow band round portions of the basin of the river Amazon. The strata next in succession are of secondary age. The lowest formation is a red sandstone, which is spread over a very extensive area. It is remarkably well developed in Chili, where, together with more recent beds, it is a marked feature in the crest of the Andes. In the small chain to the west it is associated with conglomerates. In the small chain of Colorado, near Tiahuanaco, a thick conglomerate rests on the older limestones, and supports red sandstones and conglomerates dipping west beneath marls. The red sandstone extends across the province of Carangas, and uninterruptedly over both slopes of the western Cordillera. In the desert of Atacama the red sandstone, with the overlying marls, forms a number of parallel chains directed north and south. Red sandstones and conglomerates form the base of the Cordilleras of Quito; they stretch north into the basins of the Magdalena and Cauca rivers, and east over the basin of the Orinoco. In the province of Bahia, and far away to the north, there is a great development of red sandstone. The age of these sandstones has been variously stated; their stratigraphical position would indicate a secondary age, and possibly they may be Triassic. After their deposition, and prior to that of the marls, syenitic rocks were introduced amongst the strata in the Andes, causing the red sandstones, as also the older sandstones and schists, to be converted into porphyries. This eruption was also accompanied by, and probably connected with, the formation of auriferous veins, the elevation of the strata, and the faulting of the rocks. The strike of the strata, as also of the faults, was about 8° to the E. of N., but subsequent movements have modified the direction in places. The red sandstone has a similar strike from Venezuela in the north to Magalhaens Strait on the south, and this favours the idea that all are of the same age. Several of the ranges in the Andes have a corresponding direction. As the sandstone is believed to underlie the basins of the great rivers, it appears that during its deposition South America was still represented by a few large islands only. Its elevation gave rise to north and south trending mountains, whereby these scattered portions were connected, and the Andes received their first development. The great features of the continent were then first distinctly marked out, and only a few gaps remained to be filled up. The next succeeding period, represented by strata, is characterised by saliferous and gypseous marls, which rest unconformably on the rocks beneath. In Chili they occur in the lower plains, or abut against the western spurs of the Andes; but they have been largely denuded, so that they now occur in isolated plateaux or basins, and there is a patch capping the lofty Aconcagua. It is stated that in Chili the marls, or at least some of them, are Liassic. In Bolivia, also, they form plateaux between San Andres and the mountains of Tarija. Here they consist of alternations of greenish marls and wine-coloured beds supporting limestones, with interstratified beds of gypsum and saliferous clay. There are beds of gypsum and limestone in the Orinoco plains. Marls are associated with marly sandstones in the Gulf of Bahia and in the plains of Reconcavo. These beds are arranged along strikes which are approximately east and west, and their elevation is apparently connected with the formation of chains running

in the same direction, as, for instance, most of the lateral spurs from the Andes. Some geologists think it is also connected with the east and west faults, through which, in the Andes, labradorite and hypersthenite rocks have been erupted. This eruption, it is said, has caused the metamorphism of the calcareous rocks into crystalline limestones, marls into jaspers, and red sandstones into porphyries; and has also given rise to the copper-bearing veins. Calcareous beds occupy large areas in Venezuela, Columbia, and other parts of the continent. Miocene strata occur in Venezuela, and probably in other districts. Finally, there are deposits of Post-Miocene date, which chiefly belong to the Post-Pliocene and recent periods, and which cover most of the lower lands along the coasts and in the interior of the continent. In Chili they occur in the valleys, and fill up the gulfs in the old granite range near the coast. Here the succession is a calcareous sandstone abounding in marine shells and beds of lignite; above this is a pumiceous conglomerate, which passes in places into a pebbly conglomerate, and then follow the marine sands which stretch from Coquimbo across the desert of Atacama. The most recent formation is drift, which occurs in patches and sheets. In the valley plains of the Desaguadero there are clays and sandy marls overlain by pumiceous conglomerates, which near La Paz are surmounted by drift. Near this place the drift is many hundred feet thick, and formed of large blocks; but, on receding from the mountains, it passes into a sand which encircles the plains of the Desaguadero, which are chiefly formed by limestone deposits, such as concretionary limestone, which abounds in the fossil remains of plants and fresh water shells. The lacustrine beds approximate in age to the marine tertiary beds near the coast. In Peru the pumiceous conglomerate is overlain by drift. Tertiary beds occur at Guayaquil in Ecuador, while in the valley of Quito there are enormous layers of pumice, scoriæ, and drift, which last has yielded the remains of various Post-Pliocene mammals and terrestrial shells. Drift with similar remains occurs in the lower grounds of Columbia. In the Gulf of Bahia there are recent beds; and near St Paul, as also in many other parts of Brazil, there are patches of lacustrine deposits. On the west side of the continent the pumiceous conglomerate is intimately connected with trachytes, and indeed is formed from them. It is intermediate in age between the lacustrine beds, the marine deposits near the shore, and the drift, which is in its turn covered by the more recent lava overflows; and it is in this intermediate age that the upheaval of the principal chain of the Andes occurred. The ranges and faults which are assigned to this period, probably Pliocene or Post-Pliocene, run very nearly north and south. This elevation did not materially alter the extent of land west of the Andes, its general effect being to add a strip about thirty miles in width. On the east the change was great, since the larger proportion of the great central plain then emerged, and thus connected the high lands on the east, west, and north into one great continent. The eruption of the trachytes, which form so marked a feature in the Andes, was accompanied by a metamorphism distinct in character from those of earlier ages. The rocks were then subjected not only to heat and water, but also to acid vapours, which changed the felspar into sulphates of alumina and iron, salt into anhydrous sulphate of soda; and, probably, by freeing the chlorine and iodine, originated the chlorides and iodides which are so abundant in the argentiferous veins. Since the drift there has been a slight elevation along a meridional axis.

Such is a brief account of the growth of South America. We must, however, mention that Professor Agassiz and his coadjutors believe that the red soil and immediately underlying beds, seen near Rio Janeiro and in the valley of the Amazon, are true glacial formations, and infer that the similar beds which are spread over such an enormous area in South America have been formed under similar conditions. Professor Agassiz has found moraines and ice-transported boulders in various places in the mountains of Brazil, as also indications of valley glaciers. Professor Orton has found marine shells in these beds at Pebas in Ecuador.

Volcanoes. The foregoing sketch indicates that there have been several periods of volcanic activity; and that, so far as our present knowledge goes, such activity has only been manifested along the line of the Andes. Volcanic rocks have rarely been observed on the east side of the continent, but some of the Tertiary and Post-Tertiary beds of the plains contain matter which has been showered upon them during eruptions, and which now forms a portion of the Pampean deposits. At one period or other the whole system of the Andes has been subjected to volcanic disturbance, but at the present time the active volcanoes occur in groups more or less widely separated. The most southern active volcano is Corcovado, in 43° 10′ S. There are, besides, some twenty or more volcanic cones, of which about a dozen are known to be active. Bolivia has one or two active vents, and Peru several; but it is in Ecuador, with its dozen ignivomous vents, that have occurred the grandest and most frequent displays. Columbia has four or five volcanoes. Earthquakes. With the exception of the Moluccas, no country in the world has had so many and so destructive earthquake shocks as South America. But these are concentrated, both as regards frequency and strength, along the Andes, and more particularly their western slope. Comparatively few are felt in the plains to the east of them; but occasionally it happens that shocks are felt at points on the opposite slopes of this great range without being perceived in the intermediate higher regions. Peru seems to be the principal focus of action; and next to it in importance as a seismic area comes Chili; but although some earthquake shocks spread over both these areas, there does not seem to be the community of action which we should expect between the two areas. In Peru the maxima of seismic intensity were in the decades ending 1590, 1610, 1660, 1690, 1710, 1720, 1730, 1750, 1770, 1790, 1840, 1870. In Chili they occurred in the decades ending 1580, 1640, 1650, 1660, 1690, 1730, 1780, 1800, 1820, 1840, 1850. Nearly every other portion of the continent is subject to earthquakes. Bolivia, which lies between Peru and Chili, is comparatively free from them, as also are Brazil, Patagonia, and the Argentine Confederation, but they are more frequent in Ecuador, Columbia, Venezuela, and the three Guianas.

N. America: Mountains. The mountains of North and Central America will not detain us long. The ranges of Central America have no relation to the Andes, differing from them both as regards age and direction, which is generally N. 55° W., and being separated from them by gaps only a few hundred feet above the sea, and upwards of 100 miles wide. During the Tertiary period the mountains of N. and S. America had still less connection than at present, for where the isthmus now forms a bridge of land there was a broad strait, which lasted up to the end of the Pliocene, or beginning of the Post-Pliocene period. Volcanoes are frequent in Central America; and basalt and other volcanic products cover a large portion of the country. The large development of trachytes indicates an earlier period of volcanic activity, during which most of the Tertiary strata were metamorphosed into porphyries. At any rate these rest upon cretaceous limestones. In many places the clays and sandstones of the Cretaceous age have been metamorphosed into granite rocks. From Puebla to Durango the Mexican mountains no longer present the appearance of a chain, but spread out to a table-land or elevated plain, from 5000

to 9000 feet in height, and from 100 to 300 miles in breadth. Across this plain, close to the 19th parallel, six volcanoes are distributed in a line running east and west, as if a vast rent, extending from the Atlantic to the Pacific, had opened a passage for the internal fires of the globe at this spot. Two of those on the east side of the continent, with a group of four or five other cones lying between Jalapa and Cordoba, have an elevation exceeding 17,000 feet, and are the only mountains in New Spain that rise to the region of perpetual snow, which commences here at 15,000 feet above the level of the sea. Jorullo, the lowest of the six volcanoes, rose suddenly in the middle of a plain, in September 1759, after fearful concussions of the ground, which continued for fifty or sixty days. Near the tropic the Mexican Cordillera divides into three parts. One runs parallel to the eastern coast at the distance of thirty or forty leagues, and terminates in New Leon. Another proceeds in a north-western direction, and sinks gradually as it approaches the Californian Gulf in Sonora. The third or central Cordillera traverses Durango and New Mexico, divides the sources of the Rio Gila from the Rio Bravo del Norte, and dies out before reaching the Rocky Mountains.

Volcanoes.

In a recent scientific survey of the Rocky Mountains, conducted by Professor Hayden of Yale College, a higher peak has been discovered than was formerly known. Holy Cross mountain was computed to reach 17,000 feet above the sea, or 2000 feet higher than Big Horn (15,000), which has hitherto been supposed to be the highest of the chain. The greatest altitudes on the North American continent are now said to be the following—St Elias (17,850) in Alaska, Popocatepetl (17,884) in Mexico, Orizaba (17,337) in Mexico, Holy Cross (17,000), Rocky Mountains, Big Horn (15,000), and Mount Lincoln (14,300), both in the same chain. The Great Salt Lake of Utah is in 41° N. and 112° W., and has intensely salt waters. It is nearly 300 miles in circumference, and its shores, for a breadth of several miles, are covered with an incrustation of very pure salt. It lies in a basin, which measures about 500 miles each way, and contains much fertile soil.

If we run a line westward across the continent of North America at the latitude of Delaware Bay (38°), the geological formations present themselves in the following order:—1. Tertiary and Cretaceous strata on the shores of the Atlantic; 2. Gneiss underlying these strata, and presenting itself on the eastern slope of the Alleghany or Appalachian mountains, but covered in parts by New Red Sandstone; 3. Palæozoic rocks, consisting of Silurian, Devonian, and Carboniferous strata, curiously bent into parallel foldings, with synclinal and anticlinal axes, the crests of the latter forming the ridges of the Alleghany Mountains, which in this region rise to the height of 2500 feet. Upon these Palæozoic rocks rest three great coal-fields—the Appalachian, that of Illinois, and that of Michigan, covering a large portion of the space between the Alleghanies and the Mississippi, and embracing collectively an area equal to the surface of Great Britain. From the Mississippi westward to Utah the Palæozoic rocks occur in great folds, between which are extensive areas of Triassic, Oolitic, Cretaceous, and Tertiary beds. In California the rocks are chiefly metamorphosed secondary strata on which lie patches of Tertiary sediments. In British America there is an enormous development of the Laurentian and Huronian rocks, which are the oldest yet discovered, and occupy most of the country immediately north of the large lakes. Newfoundland and the neighbouring British territories consist of Pre-Silurian, Silurian, Devonian, Carboniferous (which includes coal-fields of considerable extent), and Triassic rocks. The area north of about 40° N. is also covered and strewed with glacial drift and boulders.

The Ozark Mountains resemble the Alleghanies in their mineral structure, containing the same rocks from the granite to the carboniferous, and probably upwards to the chalk.

In no single circumstance is the superiority of America over the old world so conspicuous, as in the number and magnitude of its navigable rivers. The Amazon alone discharges a greater quantity of water than the eight principal rivers of Asia, the Yenesei, Indus, Ganges, Oby, Lena, Amoor, and the Hoang-ho and Yang-tse of China. The Mississippi, with its branches, affords a greater amount of inland navigation than all the streams, great and small, which irrigate Europe; and the Plata, in this respect, may probably claim a superiority over the collective water of Africa. But the American rivers not only surpass those of the Old World in length and volume of water,—they are so placed as to penetrate everywhere to the heart of the continent. By the Amazon, a person living at the eastern foot of the Andes, 2000 miles of direct distance from the Atlantic, may convey himself or his property to the shores of that sea in forty-five days, almost without effort, by confiding his bark to the gliding current. If he wish to return, he has but to spread his sails to the eastern breeze, which blows perennially against the stream. The navigation is not interrupted by a single cataract or rapid, from the Atlantic to Jaen, in west longitude 78° where the surface of the stream is only 1240 feet above the level of its estuary at Para. The part of North America most remote from the sea is the great interior plain extending from the Rocky Mountains to the Alleghanies and the lakes, between the parallels of 40° and 50°; but the Mississippi, Missouri, and St Lawrence, with their branches, are wonderfully ramified over this region, and the Missouri is in some degree navigable to the centre of the continent. It is only necessary to cast the eye over a map of South America, to see that all the most sequestered parts of the interior are visited by branches of the Plata and the Amazon. These streams, having their courses in general remarkably level, and seldom interrupted by cataracts, may be considered without a figure of speech, as a vast system of natural canals, terminating in two main trunks, which communicate with the ocean at the equator and the 35th degree of south latitude. Since the invention of steam navigation, rivers are, in the truest sense of the term, Nature's highways, especially for infant communities, where the people are too poor, and live too widely dispersed, to bear the expense of constructing roads. There is little risk in predicting, that in two or three centuries the Mississippi, the Amazon, and the Plata, will be the scenes of an active inland commerce, far surpassing in magnitude anything at present known on the surface of the globe. The Mississippi is navigable for boats from the sea to the falls of its principal branch the Missouri, 1700 miles from the Mexican Gulf in a direct line, or 3900 by the stream; and the whole amount of boat navigation afforded by the system of rivers, of which the Mississippi is the main trunk, has been estimated as equal to 40,000 miles in length, spread over a surface of 1,350,000 square miles. This, however, is perhaps an exaggeration; a navigable length of 35,000 miles may be nearer the truth.

N. and S. America: Rivers.

The Amazon contains many islands, is broad, and in the upper part so deep, that on one occasion Condamine found no bottom with a line 620 feet long. At its mouth, two days before and after the full moon, the phenomenon called a *Bore* occurs in a very formidable shape. It is a high upright wave of water rushing from the sea, which no small vessel can encounter without certain destruction.

The estuaries of all these great American rivers open to the eastward; and thus Providence seems to have plainly

indicated that the most intimate commercial relations of the inhabitants of America should be with the western shores of the Old World. It should at the same time be observed, that this position of the great rivers of America is but one example of a physical arrangement which is common to the whole globe; for it is remarkable that, in the Old World as well as in the New, no river of the first class flows to the westward. Some, as the Nile, the Lena, and the Oby, flow to the north; others, as the Indus and the rivers of Ava, to the south; but the largest, as the Volga, the Ganges, the Yang-tse, the Hoang-ho, the Euphrates, and the Amoor, have their courses to the east or south-east. This arrangement is not accidental, but depends most probably on the inclination of the primary rocks, which, in all cases where their *direction* approaches to the south and north, seem to have their steepest sides to the west and the longest declivities to the east. We have examples in the Scandinavian Alps, the mountains of Britain, the Ghauts of India, the Andes, and the Rocky Mountains.

The following table exhibits the lengths, size of the basins, and probable extent of the navigable waters of the greater rivers of America.

Table of Principal American Rivers.

	Length, miles.	Area of basin, sq. miles.	Navigable waters, miles.
Mississippi to source of Missouri	4300	1,350,000	35,000
St Lawrence through the lakes	2200	600,000	4,000
Orinoco.........................	1800	400,000	8,000
Amazon, not including Araguay.........................	4000	2,100,000	50,000
Plata, including Uruguay...	2400	1,200,000	20,000

Climate. The latitude and elevation of the land in each country, its position in reference to the sea, and the direction of the prevailing winds, are the chief circumstances which determine the nature of the climate. We have already mentioned that three-fourths of South America lie within the tropics, and the remaining fourth in the temperate zone; but, in both divisions, it might be naturally inferred that a huge wall like the Andes, rising into the atmosphere to the height of two or three miles, and running across the course of the tropical and extra-tropical winds, would exert a powerful influence on the temperature, the humidity, and the distribution of the seasons. This is actually the case; and it is this vast chain of mountains, with its prolongation in North America, which affords a key to the most remarkable peculiarities in the climate of the whole continent. The subject, which has been frequently misunderstood, admits of being explained in a very simple manner.

The trade-winds blowing from the east occupy a zone 60 degrees in breadth, extending from 30° of N. to 30° of S. latitude. Beyond these limits are variable winds; but the prevailing direction in the open sea, where no accidental causes operate, is well known by navigators to be from the west. Now these winds are the agents which transport the equable temperature of the ocean, and the moisture exhaled from its surface, to the interior of the great continents, where it is precipitated in the shape of rain, dew, or snow. Mountains receive the moisture which floats in the atmosphere; they obstruct and lift the aerial currents, and by causing a reduction of temperature, favour precipitation. Rain, accordingly, in all countries falls most abundantly on the elevated land. Let us consider, then, what will be the effect of a mural ridge like the Andes in the situation which it occupies. In the region within the 30th parallel, the moisture swept up by the trade-wind from the Atlantic will be precipitated in part upon the mountains of Brazil, which are but low, and so distributed as to extend far into the interior. The portion which remains will be borne westward, and, losing a little as it proceeds, will be arrested by the Andes, and fall down in showers on their slopes. The aerial current will now be deprived of all the humidity which it can part with, and arrive in a state of complete exsiccation at Peru, where no rain will consequently fall. That even a much lower ridge than the Andes may intercept the whole moisture of the atmosphere, is proved by a well-known phenomenon in India, where the Ghauts, a chain only 3000 or 4000 feet high, divide summer from winter, as it is called; that is, they have copious rains on their windward side, while on the other the weather remains clear and dry; and the rains regularly change from the west side to the east, and *vice versa*, with the monsoons. In the region beyond the 30th parallel this effect will be reversed. The Andes will in this case serve as a screen to intercept the moisture brought by the prevailing west winds from the Pacific Ocean; rains will be copious on their slopes, and in Chili on their western declivities, but none will fall on the plains to the eastward, except occasionally, when the winds blow from the Atlantic. The phenomena of the weather correspond in a remarkable manner with this hypothesis. On the shore of the Pacific, from Coquimbo, at the 30th parallel, to Amatapu, at the 5th of south latitude, no rain falls; and the whole of this tract is a sandy desert, except the narrow strips of land skirting the streams that descend from the Andes, where the soil is rendered productive by irrigation. From the 30th parallel southward the scene changes. Rains are frequent; vegetation appears on the surface, and grows more vigorous as we advance southward. "At Conception," says Captain Hall, "the eye was delighted with the richest and most luxuriant foliage; at Valparaiso the hills were poorly clad with a stunted brushwood and a poor attempt at grass, the ground looking starved and naked; at Coquimbo the brushwood was gone, with nothing in its place but a vile sort of prickly pear bush, and a thin sprinkling of gray wiry grass; at Huasco (latitude 28½°) there was not a trace of vegetation, and the hills were covered with bare sand."[1] It follows from the principle we have laid down, that in this southern part of the continent the dry tract should be found on the east side of the mountains, and such is the fact. At Mendoza, in latitude 32°, rain scarcely ever falls, and the district along the east foot of the Andes is known to consist chiefly of parched sands, on which a few stunted shrubs grow, and in which many of the streams that descend from the mountains are absorbed before they reach the sea. The whole country, indeed, south of the Plata, suffers from drought; but on the eastern side this is remedied to some extent by winds from the east or south-east, which bring occasional rains to refresh the soil. From Amatapu northward, on the other hand, the west coast is well watered and fruitful; and this is easily accounted for. The line of the coast here changes its direction, and trends to the north-east as far as the isthmus of Panama, where the mountains sink to a few hundred feet in height, and leave a free passage to the trade-wind, which here often assumes a direction from the north-east, or even the north. The exhalations of the Atlantic are thus brought in abundance to the coast of Quito, which is in consequence well watered; while the neighbouring district of Peru suffers from perpetual aridity.

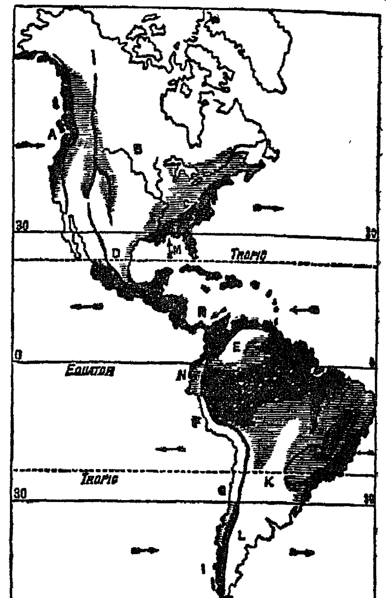
Our principle applies equally to the explanation of some peculiar facts connected with the climate of North America. The western coast of Mexico, as far as St Blas or

[1] Hall's *Extracts from a Journal*, vol ii. p. 12.

Mazatlan, in latitude 23° N., is well watered, because, *first*, the continent here is narrow; *secondly*, the table-land of Mexico, which is much lower than the Andes of Chili, is not so effectual a screen to intercept the moisture; and, *thirdly*, there is reason to believe that a branch of the trade-wind, which crosses the low part of the continent at Panama and Nicaragua, sweeps along the west coast during part of the year, and transports humidity with it. But beyond the point we have mentioned drought prevails. Sonora, though visited occasionally by rains, consists of sandy plains without herbage, where the streams lose themselves in the parched soil without reaching the sea; and even Old California, which has the ocean on one side, and a broad gulf on the other, and ought apparently to be excessively humid, is covered with sterile rocks and sandy hills, where the vegetation is scanty, and no timber is seen except brushwood. This dry region extends as far as 33° or 34° N.; but immediately beyond this we have another change of scene. New California is in all respects a contrast to the Old. It is rich, fertile, and humid, abounding in luxuriant forests and fine pastures; and the other American possessions to the northward preserve the same character. How can we account for this singular diversity of climate, except upon the principle which has been explained, namely, that in all regions where ranges of mountains intersect the course of the constant or predominant winds, the country on the windward side of the mountains will be moist, and that on the leeward dry; and hence parched deserts will generally be found on the west side of countries within the tropics, and on the east side of those beyond them? Our hypothesis applies equally to the country east of the Rocky Mountains. For the space of about 3000 miles along the foot of this chain the surface consists of dry sands or gravel, sometimes covered with saline incrustations, almost destitute of trees and herbage, and watered by streams flowing from the mountains, which are sometimes entirely absorbed by the arid soil. The central and eastern part of the basin of the Mississippi would in all probability have been equally barren had the configuration of the land been a little different in the south. A tract of country extremely low and level extends along both sides of this river; and a portion of the trade-wind blowing from the Mexican Gulf, finding its motion westward obstructed by the high table-land of the Cordillera, is deflected to the right, and ascends the valley of the Mississippi and Ohio. This wind, whose course was first traced by Volney, bears with it the humidity of the torrid zone, and scatters fertility over a wide region that would otherwise be a barren waste.

Forests.

The views on the subject of climate we have been unfolding will enable us to throw some light on an interesting point—the distribution of forests. We are induced to think, that in all countries having a summer heat exceeding 70°, the presence or absence of natural woods, and their greater or less luxuriance, may be taken as a measure of the amount of humidity, and of the fertility of the soil. Short and heavy rains in a warm country will produce grass, which, having its roots near the surface, springs up in a few days, and withers when the moisture is exhausted; but transitory rains, however heavy, will not nourish trees, because after the surface is saturated with water, the rest runs off, and the moisture lodged in the soil neither sinks deep enough, nor is in sufficient quantity to furnish the giants of the forest with the necessary sustenance. It may be assumed that 20 inches of rain falling moderately, or at intervals, will leave a greater permanent supply in the soil than 40 inches falling, as it sometimes does in the torrid zone, in as many hours. It is only necessary to qualify this conclusion by stating, that something depends on the subsoil. If that is gravel, or a rock full of fissures, the water imbedded will soon drain off; if it is clay or a compact rock, the water will remain in the soil. It must be remembered, also, that both heat and moisture diminish as we ascend in the atmosphere, while evaporation increases; and hence that trees will not grow on very high ground, though its position in reference to the sea and the prevailing winds should be favourable in other respects. In speaking of the *region of forests*, we neither restrict the term to those districts where the natural woods present an unbroken continuity, nor extend it to every place where a few trees grow in open plains. It is not easy to give a definition that will be always appropriate; but in using the expression, we wish to be understood as applying it to ground where the natural woods cover more than one-fourth of the surface.



Sketch Map showing the Forest Regions of America.

The small map of America prefixed will enable the reader to follow our statements with ease. The long black lines show the positions of the chains of mountains; the shading represents the regions of forests; the dense forests being marked by the double shading, and the thinner ones by the open lines. The white spaces represent the lands on which little or no wood grows. The equator and the parallel of 30° on each side are indicated by the horizontal lines marked 0 and 30. The arrows show the direction of the prevailing winds; but it must be remembered that, though the intertropical wind is assumed to have its course right from the east, this is only true at the equator, its direction inclining to north-east as we approach the northern tropic, and to the south-east as we approach the southern. In North America A is the woody region on the west coast, extending from latitude 35° to about 58°, and of unknown breadth. B, the region on the east side of the Rocky Mountains, partly a bare desert, partly covered with grass and dotted with trees. C, the forests of the Alleghany chain, thick on the east and south, and thin on the west; bounded by a curved line passing from St Luis, in Mexico, through Lake Huron, to the mouth of the St Lawrence, in latitude 50° N. The arrow at M points out the direction of the wind, which ascends the valley of the Mississippi, and nourishes the western part of these forests; and the arrow at R that which blows across the isthmus of Panama. D is the table-land of Mexico, graduating on the north-west into the dry plains of Sonora and California, all bare, or nearly bare, of wood. E is the Llanos or bare plains of Caraccas, nearly fenced round with mountains. F G is the long strip of bare dry sands on the west side of the Andes which constitutes Lower Peru and the north part of Chili; and N is Amatapu, its northern boundary. H is the great region of forests which constitutes the basin of the Amazon, and occupies all the rest of Brazil. Near the equator the moisture is so excessive, that after 150 or 200 inches of rain have fallen on the east coast, there is still sufficient humidity in the atmosphere to afford copious showers to all the country up to the Andes. Here, there-

fore, the woods reach from side to side of the continent. But as we recede from the equator the humidity diminishes rapidly; and though the continent becomes narrower towards the south, the supply of rain falls off in a still greater proportion, and the forests extend over a much smaller space. At the foot of the Andes the forests extend to 16° or 18° of S. latitude; on the east coast to 25° or probably 30°. K L are the *Pampas* or open lands of Buenos Ayres, extending on the east side of the Andes from Cape Horn to the latitudes just mentioned. If we divide this region into three parts, the most easterly, refreshed by occasional rains from the Atlantic, is covered with a strong nutritive herbage; the second, which is drier, displays a thin coarse wiry grass; and the third portion, which extends to the Andes, receiving little or no rain, is nearly a desert: all the three are destitute of timber, but the surface of the third is dotted with dwarfish shrubs. I is the southern part of Chili. Here the prevailing winds, which are from the west, coming loaded with the moisture of the Pacific Ocean, produce copious rains to nourish the herbage and the forests. This applies, however, chiefly to the country south of the 35th parallel. From that to Coquimbo, in latitude 30°, the wood is scanty. Beyond 50° on the east coast of North America, and 55° or 58° on the west, very little wood grows, in consequence of the rigour of the climate.

Moderating influences.

Great misapprehensions have arisen with regard to the climate of America, from comparisons being drawn between the east side of the new continent and the west side of the old. We have already pointed out the influence of winds blowing from the sea in modifying the state of the atmosphere over the land, both as to heat and humidity. When this circumstance is attended to, and when the east and west sides of the old and the new continents are respectively compared with one another, the difference is found to be small, and easily accounted for. In the torrid zone, and on the sea-shore, the temperature of both continents is found to be the same, viz., 82°; but in the interior the difference is rather in favour of America. There is no counterpart in the New World to the burning heats felt in the plains of Arabia and N. Africa. Even in the western and warmest part of the parched steppes of Caraccas, the hottest known region in America, the temperature of the air during the day is only 98° in the shade, which rises to 112° in the sandy deserts which surround the Red Sea. At Calabozo, farther east in the Llanos, the common temperature of the day is only from 88° to 90°; and at sunrise the thermometer sinks to 80°. The basin of the Amazon is shaded with lofty woods; and a cool breeze from the east, a minor branch of the trade wind, ascends the channel of the stream, following all its windings, almost to the foot of the Andes. Hence this region, though under the equator, and visited with almost constant rains, is neither excessively hot nor unhealthy. Brazil, and the vast country extending westward from it between the Plata and the Amazon, is an uneven table-land, blest with an equable climate. At Rio Janeiro, which stands low, and is exposed to a heat comparatively great, the temperature in summer varies from 68° to 82° Fahr., and the mean is only about 74°. Farther north, and in the interior, the Indians find it necessary to keep fires in their huts; and in the country near the sources of the Paraguay, hoar-frost is seen on the hills during the colder months, and the mean temperature of the year falls below 65° or 67°. On the declivities of the Andes, and on the high plains of Upper Peru, the heats are so moderate that the plants of Italy, France, and Germany come to maturity. Lower Peru, though a sandy desert, enjoys a wonderful degree of coolness, owing to the fogs which intercept the solar rays. At Lima, which is 540 feet above the sea, the temperature varies from 53° to 82°, but the mean for the whole year is only 72°. In the plains of La Plata the mean temperature of the year is very nearly the same as at the corresponding north latitudes on the east side of the Atlantic. At Buenos Ayres, for instance, the mean annual heat is 19°·7 of the centigrade thermometer (68° Fahr.), while that of places on the same parallel in the Old World is 19°·8. The range of temperature is probably greater in the basin of the Plata; but as we advance southwards, the diminishing breadth of the continent makes the climate approximate to that of an island, and the extremes of course approach each other. In the Strait of Magalhaens the temperature of the warmest month does not exceed 43° or 46°; and snow falls almost daily in the middle of winter, though the latitude corresponds with that of England. But the inference drawn from this, that the climate is unmatched for severity, is by no means just, for the winter at Staten Island is milder than in London. In point of fact, the climate of Patagonia is absolutely colder than that of places in the same latitude in Europe; but the difference lies chiefly in the very low temperature of the summer. This peculiarity no doubt results chiefly from the greater coolness of the sea in the southern hemisphere; for beyond the parallel of 48°, the difference of temperature in the North and South Atlantic amounts, according to Humboldt, to 10° or 12° of Fahrenheit's scale. If we push our researches a step farther, and inquire what is the cause of the great warmth of the Northern Sea, we shall be forced to admit that a very satisfactory answer cannot be given. Something may be due to the influence of the Gulf Stream, a minute branch of which is supposed to carry the waters of the torrid zone to the shores of Shetland and Norway; but such an agent seems too trifling to account for the phenomenon. The sum, then, of the peculiar qualities which distinguish the climate of South America may be briefly stated. Near the equator the new continent is perhaps more humid than the old; and within the tropics generally, owing to its vast forests, the absence of sandy deserts, and the elevation of the soil, it is cooler. Beyond the tropics the heat is nearly the same in the south temperate zone of America and the northern one of the old continent, till we ascend to the latitude of Cape Horn, where we have cold summers and a very limited range of the thermometer.

Highlands of N. America.

The mountain ranges of North America form two widely distant highland regions, separated from each other by the vast interior plain, which contains, in its southern slope, the Mississippi with all its tributaries, and the other rivers flowing into the Gulf of Mexico, while its northern part contains the great fresh-water lakes, and many rivers taking a northward course to Hudson's Bay or to the Arctic seas. The watershed of this plain, dividing the streams that run into the Missouri and Mississippi from those communicating with the Saskatchewan, with Lake Winnipeg, and with Lake Superior, is along a line from west to east nearly coinciding with the 48th parallel of latitude, and has a mean elevation of 1500 feet.

Along the whole of the western side, from near the mouth of the Mackenzie in the Arctic Ocean, and from Alaska on the Pacific shore, to the Isthmus of Nicaragua and Panama, that is, across 60° of latitude from north to south, extends with a grand double curve the continuous length of the Rocky Mountains, and others which prolong the line, having a position in North America similar to that of the Andes in South America, and shutting off, in some parts, a comparatively narrow portion of the continent, with the Pacific shore, from the great central plain. But several minor ranges, branching off or confronting the principal mountain-ridge or backbone of North America, enclose large spaces of a table-land, traversed by the Columbia, the Fraser, and the Colorado rivers, with those which join them, and holding the Great Salt Lake of

Utah in its central basin. The Cascade Mountains of Washington and Oregon, the Sierra Nevada of California, and the Coast Range prolonged through the Californian peninsula, have a general direction from north to south; while the Wahsatch, the Humboldt, the Blue Mountains, the Salmon River, and other ranges, stand rather across the table-land, or obliquely, from west to east. It may be convenient to speak of the former series, regarded altogether, as the general Pacific Coast Range, which we also observe to be continued northward, with some intervals, beyond latitude 60° N. to the peninsula of Alaska, presenting summits of increased height, that of Mount St Elias being above 17,000 feet, and Mount Fairweather nearly 15,000 feet. In the Cascade Range are Mount St Helens, north of the Columbia River, attaining an elevation of 15,750 feet; Mount Hood and Mount Jefferson, about 15,500 feet. The Sierra Nevada, at its northern extremity, where it forms an acute angle with the coast range, displays the lofty terminal peak of Mount Shasta, having an altitude of 14,400 feet. The minor Californian Coast Range nowhere rises to 4000 feet. The main Cordillera or spine of Western North America, which in the British Dominion and in the United States' territory is called the Rocky Mountains, but which takes the name of the Sierra Madre in Mexico, and in the isthmus, farther south, is split into two lower groups of a volcanic character, attains the height of 16,000 feet in Mount Brown, and 15,700 feet in Mount Hooker, both near the 54th degree of latitude, above the source of the Saskatchewan river; but Fremont, in the Wind River group, between Oregon and Nebraska, is 13,560 feet high, and there are peaks of 10,000 feet or 12,000 feet in Utah and New Mexico. The highest mountains, however, in North America, excelling even Mount St Elias, belong to a volcanic series which crosses the table-land of southern Mexico from west to east, and of which the culminating points are Popocatepetl, 17,884 feet, and Orizaba, 17,373 feet; while Agua, in Guatemala, rises to 13,000 feet. Thus we may remark, at each extremity of the Cordillera, at its north end, towards Alaska, and at its south end, in Central America, it is encountered by a cluster of volcanoes, Mount St Elias being one of this description, which exceed the height of the Rocky Mountains. The spaces enclosed between the main trunk and branches of this immense system of mountains are several hundred miles wide, and their surface is elevated 5000 feet or 6000 feet above the sea-level, as in the Utah lake-basin, the Nevada territory, and the plateau of Anahuac, or southern Mexico, which last has an elevation of 6000 feet to 8000 feet, and has therefore a temperate climate within the tropics.

An outline merely has been given of the western highland region of North America. The eastern highlands of this continent are mainly constituted by the Alleghanies or Appalachian system of mountains, with their dependencies, which are of no great height, the Black Mountain, or Mount Guyot, in North Carolina, being the highest, at 6476 feet; but they extend nearly 2000 miles, from the Gulf of St Lawrence to the Gulf of Mexico, having a general direction from north-east to south-west. The strip of land, one or two hundred miles wide, between these mountains and the Atlantic coast, is of the greatest historical interest, as it includes the seats of all the older English settlements on this continent, which seems destined for the grandest dwelling-place of our nation. North of the Gulf of St Lawrence, through the peninsula that terminates with Labrador between the Atlantic and Hudson's Bay, the Appalachian system of mountains is continued, or resumed, in a range called the Watchish, only 1500 feet high, but in the severe climate of that region covered with perpetual snow. The Alleghanies, south of the St Lawrence, including the Green Mountains of Vermont and the White Mountains of New Hampshire, are not so much a chain of mountains as a long plateau, crested by several different ridges, and intersected by wide valleys of considerable elevation, but altogether on a much smaller scale than the highlands of Western America. East of the river Hudson the mountains are chiefly granitic, with rounded summits, often covered with turf or moss to the top; they assume a more regular formation in Pennsylvania, Virginia, and North Carolina, but again decline and break into detached groups in approaching their southern extremity in Alabama. Next to the summit in North Carolina, which is named above, Mount Washington in New Hampshire stands pre-eminent, with an altitude of 6428 feet. The scenery of these "White Mountains" is very striking, especially where the Saco river cleaves its way through the barrier of granite by a cutting two miles long, in one place only 22 feet wide, between lofty precipitous walls. It is in the "Green Mountains," succeeding these to the west, and giving their name in French to the neighbouring State, that the prevalent form becomes that of round humps on a broad base, with firs or shrubs growing on the slopes, and with scanty grass or lichens on the summits. Both these two contrasted groups of New England mountains enter the State of Massachusetts from the north; the Hoosac and Taconic extensions of the Green Mountains rise on the west side, while the White Mountains are continued by those of which Mount Holyoke and Wachusett are the most conspicuous; and between their parallel ranges is the Connecticut river, with the Housatonic, Mount Tom, and Blue Hills to overlook its lower course. These features of the country, though of far less physical importance than the towering peaks of Colorado and California, will always be associated with the genuine traditions of English rural, domestic, and social life, transplanted to the New World in the 17th century, and defended by a long struggle against stern nature and savage men in the early age of the American colonies. The natural boundary separating New England from the great and more modern State of New York is that noble river the Hudson, rising in the Adirondack Mountains, near Lake Champlain and the waters of the St Lawrence, but pouring its beautiful and useful stream directly south, to the greatest of American commercial ports and cities. This river passes close by the Catskill and Shawangunk Mountains, from which is continued the general distribution of the eastern American highlands along the Atlantic states, but with a more westerly declination from the coast, running through Pennsylvania, West Virginia, the borders of Tennessee, and North Carolina, the upper parts of Georgia and Alabama. It is in Virginia that the Alleghanies have their greatest breadth, which is about 150 miles. They rise highest in North Carolina and Tennessee, and subsequently keep up a distinct line of position, across the cotton-growing States, between those of the Atlantic seaboard and those of the Lower Mississippi. This circumstance, it may be remarked, has had most important effects on the political and military events of late years, in the results of the attempted secession of the slaveholding States from the Union. Another feature of physical geography, which probably conditioned the earlier stages of that momentous civil struggle, in the disputes relating to the Missouri compromise and to the admission of Kansas as a free-soil State, is the existence of the Ozark range of mountains. These stand in the middle of the great Mississippi valley, stretching across from northern Texas to Arkansas and the confluence of the Missouri with the Mississippi. By the elevation they give to the soil, in latitudes between 30° and 40°, as well as by the raised table-land of New Mexico and Arizona farther west, the

area of United States' territory suitable for cotton plantations and for slave labour was so far limited, and confined to the shores of the Gulf of Mexico and the Atlantic seaboard. At the same time, in the latitudes north of these, between 40° and 50°, the whole vast prairie region from the Ohio to the Rocky Mountains was adapted to the growth of corn, while it had such continuity and uniformity of surface, and was so pervaded by the grand river-system of this middle plain of North America, that it could not well undergo political division. The entire West being thus secured to the Union, and the better part of the South being thus rescued from the curse of Negro slavery, by the moulding hand of nature in planning the distribution of mountain ranges and the level ground all over this continent, we may consider that the political and social destinies of the great English Republic, vindicated in the civil war from 1861 to 1865, were predetermined in the formation of the land.

Geology. The North American continent affords an interesting study of the geological changes and adjustments, by which the mighty work of preparation for what promises to be a noble development of humanity was slowly effected in the remote epochs of the past. The oldest sedimentary rocks anywhere found on the globe are those which underlie the whole of Canada, New Brunswick, and Newfoundland, the Labrador peninsula, and the country north of Lake Superior, perhaps also the less explored regions of the far north-west towards the Arctic Sea. This series, named the Laurentian, from the St Lawrence river, is perceived to exist in Europe only in a few scattered instances, in the Hebrides, and in Norway or Sweden. In North America it occupies the most extensive areas; the thickness of its beds is estimated by Sir William Logan at 30,000 feet; it rises to hills or mountains 4000 feet high, and in the deep gorge of the Saguenay river, forms perpendicular cliffs of 1500 feet. Only one fossil animal, which has been called the Eozoon Canadense, has been discovered to have left its trace in this most ancient bottom of the primeval ocean; it was one of the Foraminifera, which covered its gelatinous body with a thin crust of carbonate of lime, having numerous holes or pores for the emission of its filament-members, with which to feel and to feed outside. Next to the Laurentian, but with a vast unknown interval of time, comes the Huronian or Lower Cambrian series. It is suggested by geologists that, as the vast level bed of the Laurentian sea was cracked by internal changes of the earth's density, these cracks threw up certain ridges along the surface of the present continent, which laid a foundation for the principal mountain ranges we have described. At the borders and extremities of these mountain ranges, it is evident that there were intense volcanic eruptions, producing great quantities of lava and conglomerate, basalt, greenstone, and other formations resulting from igneous action. The northern shores of Lakes Huron and Superior exhibit results of this kind; but it is in the table-lands between the Rocky Mountains and the west coast ranges, as in the singular lava beds near the Klamath, on the frontier of Oregon and North California, that volcanic forces have made their strongest marks on the earth. On the eastern side also of the grand Cordillera, between the sources of the Missouri and of the Yellowstone rivers, is a wonderful region of boiling springs or geysers, of sulphur beds and other natural curiosities, which have recently been described by Dr Hayden, of the United States' Government Survey. To speak more generally of the local arrangement of different geological formations, it may be remarked that crystalline rocks are spread over the western parts of North America, from Alaska to Nicaragua, and over the most northern parts, also including Greenland; but some of later date are found in the eastern or Appalachian range, consisting of felspathic gneiss and quartz rocks, mingled with talcose and chloritic schists. The Palæozoic formations occupy that middle part of the continent which lies between the Rocky Mountains and the great lakes, as well as the shores of Hudson's Bay, and some portions of the Atlantic coasts. With reference to the Lower Silurian or Siluro-Cambrian period, it is abundantly illustrated by the Trenton and associated limestones, which can be traced over 40° of longitude, their beds consisting entirely of *débris* of coral, shells, and crinoids, from the shallow inland sea, teeming with animal life, that once filled the whole level space between the Alleghanies and the Rocky Mountains, separated by these ridges from the Atlantic and Pacific Oceans, and sheltered from the cold Arctic currents by the northern Laurentian highlands. This space, which is now the central plain of North America, comprising the prairies and the Mississippi valley, was then a coral sea with archipelagos of volcanic isles, resembling that of Australasia in the South Pacific. The next formation succeeding the Silurian presents immense deposits of sandstone and shale from the muddy waters troubled by subterranean motions; this is the Devonian formation, which in America has been called the Erian, on account of the great development of such beds south of Lake Erie. The deposits of this period in the western continent are stated to be 15,000 feet in thickness. They include the cliff limestones, studded with calcareous corals of great size and beauty of shape, noticed by Sir Charles Lyell at the falls of the Ohio, near Louisville; these limestones are estimated to extend, as an ancient coral reef, over 500,000 square miles of the American middle plain. In the State of New York and in Western Canada there is the corniferous limestone, in which the imbedded corals have been replaced, in the cavities they once filled, by flinty hornstones which present the perfect coral forms, as though cast in a mould. In the Carboniferous age the great internal sea of the continent was slowly changed into swampy flats and shallow lakes or creeks, and gradually filled with a rank vegetable growth, afterwards buried under later marine deposits and pressed into the existing coal-beds. Of this period there are very extensive developments throughout the eastern half of the great middle plain to the Alleghanies. This portion of America seems to have been land, covered with the forests of that period, while the western half of the middle plain, a northward extension of the Gulf of Mexico, was still under water. As the eastern half of North America, between the Mississippi and the Atlantic, was thus in the Carboniferous era well raised out of the sea, it exhibits no traces of the succeeding Permian age, such as we find in Europe. The earliest periods also of Mesozoic time have failed to leave any record here, but their formations appear towards the western range of mountains in what was the bed of a Mediterranean Sea. It is, however, the Cretaceous system, with its characteristic greensand, its sands, clays, marls, and soft grey limestones, that occupies most space in Western America, between the meridians of 97° and 112°. These strata, overlaid sometimes by those of the Tertiary periods, extend through the country up the Missouri, the Platte, the Arkansas, and the Red River, to the Rocky Mountains; they also form parts of the plains enclosed by different mountain ranges beyond the Cordillera. Along the eastern side of the Appalachians there is a broad belt of the Cretaceous formation, stretching from the Delaware across the upper parts of Virginia, Carolina, Georgia, and Alabama. Among the fossil animal remains discovered in this formation in North America, which are enumerated in a separate list, one of the most remarkable is that of the Mosasaurus, a combination of the serpent with the lizard

form, sometimes 80 feet in length, and of aquatic habits. The Tertiary deposits, including the boulder clay, prevail chiefly along the seaward districts, from Long Island, above New York, to the peninsula of Florida, and around the shores of the Mexican Gulf, and likewise on the Pacific shore from Lower California to Vancouver Island, also in some detached instances, as in Nebraska, in the midst of the interior plain. The newer Pliocene is met with in the southern part of Maine, and on the shores of Lake Champlain. The drift formation lies mostly north of 40° latitude. Alluvial deposits are of great amount from the large rivers and lakes, especially in the delta of the Mississippi, which has an area of 13,600 square miles, and must, by Sir Charles Lyell's reckoning, have taken 67,000 years for its composition, at the rate of the bringing down of solid matter by that mighty river.

Minerals. The mineral products of North America are of unequalled richness and variety. Gold is abundant, to a proverb, in California, and likewise in Nevada and Montana. It is also found in British Columbia, Mexico, Central America, and Canada, and sparingly in Virginia and South Carolina. Silver is obtained from Mexico in larger quantities than from any other country; it is supplied also by California and by Honduras, and a vein of this metal is worked in Newfoundland. Great masses of almost pure copper are found in the Huronian rock strata, the north and east shores of Lake Superior being the richest of copper-mining regions; while New York State and Indiana possess a share of the same metal, and it is found among the western mountains in different countries from British Columbia to the isthmus. The iron ores of Pennsylvania, and those of Canada, including New Brunswick, are of the greatest importance; the former are rendered more available by their occurring close to the beds of bituminous coal, giving materials for the manufacturing industry of Pittsburg; while anthracite coal is obtained from the eastern districts of Pennsylvania. It is estimated that one-third of the total area of this State is occupied by coal-fields, which can scarcely be exhausted. Lead is found in Wisconsin, Illinois, and Missouri, in New York State, in Canada, in California, and in Central America, as well as quicksilver; white zinc is got from Arkansas and New Jersey; both Canada and Mexico produce tin. Reverting to the subject of coal, as having an intimate economic connection with all metallic wealth, it should be observed that the united area of all the coal-fields in the United States is estimated at 190,000 square miles, exceeding twentyfold those of Europe. The chief of these coal-fields are, first, the Appalachian, extending from the Susquehanna, in Pennsylvania, to the Tuscaloosa, in Alabama, along the west side of the Alleghany Mountains; the area of this coal-field is 70,000 square miles, and its greatest thickness 2500 feet; secondly, the coal-field of Michigan, about the centre of that State; thirdly, the extensive coal-field between the Ohio and the Mississippi, across the States of Indiana and Illinois; lastly, the Iowa and Missouri coal-field, which occupies a large space in the very centre of the continent. Coal is found also in Nova Scotia, in British Columbia, and Vancouver Island, and wherever the Upper Palæozoic strata prevail in the geological structure. But in the vast extent of British American territory north-west of Lake Superior, around Lake Winnipeg and up the Saskatchewan river, even as far as the Peace river, in latitude 56° N., it may be expected that manufacturing as well as agricultural prosperity will result from the use of immense stores of natural wealth existing in the soil of that long-neglected land, which is now proved to have a climate not more severe than the inhabited provinces of Canada. The iron and copper, more especially of the Canadian Dominion, will employ and enrich, in all probability, at some future period, a nation that may become greater in material resources than the most powerful kingdoms of Europe. In view of these prospects from the working of the useful metals, by the aid of that most useful product of the earth which supplies heat and mechanical force to the service of human industry, we may regard the Californian gold-fields as a matter of secondary importance. They have indeed been surpassed by the productiveness of those in Australia and New Zealand.

Nine-tenths of North America lying under the temperate zone, the climate follows a different law from what is observed in the southern peninsula, and presents more striking contrasts with that of the best known parts of the Old World. The long narrow region now denominated Central America, which connects the two great divisions of the continent, stretching from Panama to Tehuantepec, has in general a very humid atmosphere; but, for a tropical country, it must be only moderately hot, as every part of it is within a small distance of the sea. At Vera Paz the rains fall during nine months of the year. Mexico is hot, moist, and unhealthy on the low coasts; but two-thirds of its area, comprising all the populous districts, consist of table-land, from 5000 to 9000 feet in height. In consequence of this singular configuration of its surface, Mexico, though chiefly within the torrid zone, enjoys a temperate and equable climate. The mean heat at the capital, which is 7400 feet above the sea, is 62½°, and the difference between the warmest and coldest months, which exceeds 30° at London, is here only about 12°; but the atmosphere is deficient in moisture, and the country suffers from drought. Beyond the parallel of 24° N. the western shores are hot and arid. Central and North America: Climate.

In the extensive region lying between the parallels of 30° and 50° N., which comprehends three-fourths of the useful soil of North America, we have three well-marked varieties of climate, that of the east coast, the west coast, and the basin of the Mississippi. On the east coast, from Georgia to Lower Canada, the mean temperature of the year is lower than in Europe by 9° at the latitude of 40°, and by 12½° at the latitude of 50°, according to Humboldt's calculation. In the next place, the range of the thermometer is much greater than in Europe, the summer being much hotter and the winter much colder. At Quebec the temperature of the warmest month exceeds that of the coldest by no less than 60½° of Fahr.; while at Paris, which is nearly under the same latitude, the difference is only 31°. In the third place, the climate undergoes a more rapid change in America as we proceed from south to north, a degree of latitude in the middle of the temperate zone producing a decrease of annual temperature of 1°·13 Fahr. in Europe, and of 1°·57 Fahr. in America. The comparison is greatly to the disadvantage of America when made in this form; but when the east coasts of the two continents are compared, the case is altered; the Old World is found to have no superiority over the New, for Pekin has still colder winters and warmer summers than Philadelphia, which is under the same latitude. It is the west coast of the new continent which ought to exhibit the climate of Europe; and from the observations made, we have reason to believe that it is quite as mild and equable. At the mouth of Columbia river, in latitude 46½° N., it appears that the mean heat of the warmest month was about 62° Fahr., of the coldest about 36°, and of the whole year 51°. Now the place is under the same latitude with Quebec, where the snow lies five months, and the mean temperature during the three winter months is 18° below the freezing point. This single circumstance marks emphatically the contrast in the climate of the east and west coasts of North America. But the mouth of Columbia river is also under the same parallel with Nantes at the mouth of the Loire; and we have, therefore, good grounds to conclude that the west

coast of America, in the middle latitudes, has nearly as mild and equable a climate as the west coast of Europe. The climate of the great central valley, or basin of the Mississippi, has a considerable affinity to that of the east coast. It was long a matter of dispute in what the difference between the two consists, but this seems at last to have been clearly settled by the meteorological registers kept at the military posts of the United States. From a comparison of four of these registers, from posts near the centre of this great valley, with others kept on the Atlantic coast in the same latitudes, it appears that the extremes of heat and cold in the basin of the Mississippi are from 5° to 6° higher and lower than on the coasts of New England. The proportion of fair weather to cloudy is as 5 to 1 in favour of the east coast. The climate of the interior, therefore, exhibits in still greater excess those extremes of temperature which distinguish the eastern coast of this continent from the western, and from the shores of Europe. The fourth region of extra-tropical America includes the parts beyond Mount St Elias on the west coast, and, in the interior, the plains extending from the 50th parallel to the Polar Seas. The intensity of the cold in this tract of country is scarcely equalled by anything that is known under the same parallels in Northern Asia. The northernmost spot in America where grain is raised is at Lord Selkirk's colony, on Red River, in latitude 50°. Wheat, and also maize, which requires a high summer heat, are cultivated here. Barley would certainly grow as far north as Fort Chippewyan, in latitude 58¾°, where the heat of the four summer months was found by Captain Franklin to be 4° higher than at Edinburgh. There is even reason to believe, that both this species of grain and potatoes might thrive as far north as Slave Lake, since the spruce fir attains the height of 50 feet three degrees farther north, at Fort Franklin, in latitude 65°. These, however, are low and sheltered spots; but in this dreary waste generally, it will not be found practicable, we suspect, to carry the arts of civilised life beyond the 60th parallel; and the desirable country, capable of supporting a large population, and meriting the name of temperate, can scarcely be said to extend beyond the 52d parallel. At 65° the snow covers the ground in winter to the depth of only two feet, but small lakes continue frozen for eight months. The sea is open only for a few weeks, fogs darken the surface, and the thermometer in February descended in one instance to *minus* 58°, or 90° below the freezing point. At Melville Island, under the 75th parallel, such is the frightful rigour of the climate, that the temperature of the year falls 1° or 2° below the zero of Fahrenheit's scale. It is a peculiarity in the climate of America, that beyond the parallel of 50° or 52°, it seems to become suddenly severe at both extremities. At the one, summer disappears from the circle of the seasons; at the other, winter is armed with double terrors.

Zoology: Mammalia.

The zoology of America is especially interesting, on account of the contrast which exists between the faunas of the north and south portions of the continent—a contrast which is especially exhibited in the case of the Mammalia. The zoological province which naturalists mark off as constituted by South America and part of Central America has been termed the neotropical region, and the area which has the nearest relationship to this is the Indian region. As regards South America, the Andes have the highest value as zoological boundaries; next to them in importance are the rivers, and then the confines of the forest region.

Quadrumana.

The Quadrumana are well represented, and are especially characteristic of the forest region which principally prevails in the western half of the continent. None are known to occur on the west side of the Andes south of Guayaquil. The sub-order Platyrhina is peculiar to South America, and so far as research has yet extended, it is not known even to have existed on any other area. On the other hand, no catarhine or lemurine Quadrumana have yet been found in South America. Some of the lower forms of monkey appear to have some affinity with the Lemuridæ, which occur in India, Africa, and Madagascar. There are two families, viz., the Cebidæ and Hapalidæ, all the members of which are strictly arboreal in habits. Some of these monkeys are the most highly developed tree-climbers known, and in many cases they rarely if ever descend to the ground; and since the monkeys of South America have never been seen to swim, it might be expected that the broad streams of the continent effectually limit the distribution of certain monkeys. The largest species is *Lagothrix Humboldtii*, so that as a whole the American monkeys are smaller than those of Asia and Africa. As they are the most powerful of arboreal Mammalia, they rule the forests, and this may in part account for the scarcity of squirrels in this region. The Cebidæ have a wide range, extending from the south of Mexico to the Uruguay. They include the highest forms of American monkey, and its most specialised representatives are those which have the best adaptation for life in trees, as may be exemplified by Ateles, with its long limbs and prehensile tail. This latter organ serves all the purposes of a fifth hand; the under surface is bare and provided with tactile papillæ, so that a monkey not only holds by, but also feels with it. It is as mobile and flexible, and in its way as useful to this genus of monkey as is the trunk to the elephant. The genus includes numerous species, the estimate of different naturalists varying from 8 to 40, but about 10 species have been well established. Most of them occur in Brazil and the Guianas; but each species generally has circumscribed limits. Thus *A. paniscus* occurs in the north-east corner of the continent, between the Rio Negro and the Amazon. On the south side of the Amazon its place is taken by another species, *A. marginatus*. *A. Bartlettii* occurs on the Upper Amazon. Brachyteles is represented by a single species in South-East Brazil. Several species of Lagothrix have been described, although perhaps all are but varieties of but one species. *L. Humboldtii* is confined to the Upper Amazon, west of the Rio Negro, and in some of the contiguous valleys of the Orinoco basin. Mycetes has six species, ranging from Guatemala to South Brazil. *M. seniculus* occurs on the north side of the Lower Amazon; *M. caraya* on the Upper Amazon; and *M. belzebuth* is the species which occurs near Para, and south of the Lower Amazon. All the above genera have prehensile tails, with bare under surfaces. Nyctipithecus, with three or four species, occurs in the upper portions of the Rio Negro, Amazon, and Orinoco basins. Callithrix ranges over the same ground, but also extends into South-East Brazil. Chrysothrix occurs throughout the northern part of the region. The genus Pithecia (including Brachyurus) is represented by about 12 species in the Amazon basin. *P. irrorata* is confined to the south bank of the Upper Amazon; another species only occurs on the north side to the west of the Rio Negro. *P. satanas* is the species east of the Rio Negro, and there is a species limited to the south side of the Upper Amazon. The family Hapalidæ, or marmosets, has about 30 species, belonging to the genera Hapale and Midas, which range throughout the forests of South America. One species, *H. œdipus*, occurs in Costa Rica, but this is the northernmost limit of the family. It seems that the distribution of the monkeys is restricted to the areas clad with continuous forests, so that the absence of monkeys in the Pampean, Andisian, and Peruvian sub-regions is mainly due to the absence of continuous forests. It is also noticeable that the sub-orders, families, and genera extend over the greater portion of the Brazilian sub-region; whereas in

many instances this sub-region is parcelled out into districts by the larger streams, which are characterised by distinct species. Hence it is probable that the continuousness of the forest area has lasted throughout the duration of those species, but not so long as the genera have existed; and that those species which occur on both sides of the Amazon, Rio Negro, and other large rivers, originated at an earlier period than those restricted to one side. The want of means of communication with North America would account for the absence of monkeys in that region. Our space will not allow of our dwelling so fully on the other orders, but we may notice that the arboreal habit is strongly marked in many, and that the strictly arboreal groups are frequently represented in river-bounded areas by distinct species. It often happens that genera, both of vertebrates and invertebrates, which are elsewhere terrestrial, are represented in the Amazonian forests by arboreal species.

Carnivora. The Carnivora do not present so marked a feature as regards distribution as the monkeys. The families Felidæ, Canidæ, Mustelidæ, and Ursidæ are represented; but the Hyænidæ and Viverridæ are absent, unless Bassaris of Mexico be referred to the latter family. The Felidæ comprise two groups, one formed of species which are uniformly coloured, the other of those which are striped or spotted. *Felis onca*, the jaguar, is the largest feline animal of this region, and ranges from La Plata to Louisiana, and on both sides of the Peruvian Andes. The puma or *F. concolor* is known everywhere from Patagonia to as far as 50° or 60° N., a range from north to south of about 110°, which is probably greater than that of any other mammal. *F. payeros* occurs on all the pampas of the southern portion of South America. *F. mitis* and *F. macrura* belong to South-East Brazil; *F. tigrina* and *celidogaster* to the Amazon basin; while *F. pardalis*, *F. eyra*, and *F. yagouaroundi* range from Brazil to Texas. The Canidæ family is represented by the genera Icticyon and Canis. The former comprises but one species, which is confined to Brazil, viz., *I. venaticus*, which is an aberrant form between dogs and badgers. The dogs comprise *C. jubatus*, *C. cancrivorus*, *C. vetulus*, *C. fulvicaudus*, *C. azaræ*, *C. magellanicus*, and one or two other species. The Mustelidæ are not abundant, there being only a few species of each of the sub-families *Mustelinæ*, *Lutrinæ*, and *Melinæ*; and among others *Mustela frenata*; two species of *Galictis*, a genus only found in this region; *Lutra chilensis* and *braziliensis*; and several species of Mephitis belonging to the sub-genus Thiosmus. Of Ursidæ there occur *Ursus ornatus* in Peru, and perhaps *Ursus frugilegus*; *Procyon cancrivorus*, *Nasua*, and *Cercoleptes*. The last two genera are characteristic of South America. In this order the species, with the exception of a few which range into North America, are restricted to this area; but only four of the eleven genera are peculiar, the others ranging not only into North America, but also into the Old World. The latter genera do not form a prominent feature in the fauna, and the species have probably migrated from North America in comparatively recent times from a geological point of view.

In the order Artiodactyla the sub-order Ruminantia is represented by a few species only of Cervus, belonging to the neotropical sub-genera Furcifer, Coassus, and Blastocerus, and even these only occur sparingly in the open tracts. There is nothing to represent the enormous herds of Antelopes and Bovidæ, which are so characteristic of North America and portions of the Old World. Auchenia, however, is a characteristic genus frequenting the Andes, and is interesting on account of its being the only genus of Ruminants which is confined to South America. It is isolated and far distant from the other members of the family Camelidæ, which are now special to Asia; but, as we shall presently find, the gap in distribution and structure is supplied by the extinct species of North America. The characteristic genus Dicotyles is the sole representative in South America of the sub-order Omnivora and of the family Suidæ, a family which is restricted (naturally) to the Neotropical, Æthiopian, and Indian regions. Another remarkable genus is Tapirus, which represents in this region the elephants and rhinoceroses of the Old World. Until recently, the tapirs of Sumatra and the Malay Archipelago were considered to belong to the same genus, but Dr Gray has proposed that the latter be ranked in a distinct genus, Rhinochœrus. There are several species of South American tapirs, viz., *T. americanus*, *T. villosus*, *T. Laurillardii*, *T. Roulinii*, and perhaps one or two others not determined. An allied form exists in the isthmus of Panama, namely *Elasmognathus Bairdii*, which is considered as the type of a distinct sub-family. There are no true Proboscideans in this region. The order Sirenia is represented by the genus Manatus, of which three or four species occur in the Amazon and other large rivers. This genus is remarkable for its distribution, since species belonging to it frequent the fresh-water streams of the opposite coast of Africa. Several species of dolphins and porpoises occur in the larger rivers; some of them range up almost to their sources, and are strictly river species, being unknown in the adjoining seas. The presence of these cetaceans, together with the distance of the shores (several miles) and the high waves, impart to some portions of these rivers a more or less oceanic aspect. The order Bruta is abundantly represented in this region, of the fauna of which it constitutes the most marked peculiarity. Marsupialism is not a prominent feature in this region, but its presence is important, because it now occurs nowhere else out of the Australian region. It should be observed that the connection is stronger with the extinct marsupial fauna of Palæarctic regions than with the living one of Australia.

The fossil and living mammalia of this region seem to indicate that at present our knowledge of the extinct faunas is very fragmentary. This is shown in various ways. None of the remains can be definitely assigned to an older period than the Post-Pliocene. The region was essentially the same as at present, zoologically, the same characteristic groups of platyrhine apes, rodents, cats, dogs, edentates, and opossums being represented; while the catarhine apes, insectivora, oxen, rhinoceroses, and other groups were excluded, or at any rate are not known to have existed in it, so that its isolation from the other zoological regions must have commenced before the Post-Pliocene period. The extraordinary development of large forms allied to the sloths and ant-eaters; the restriction of the Toxodontia amongst the Post-Pliocene mammals, and of the subungulated Rodents among the living mammals to this region,—these and other facts would lead the palæontologist to believe that the area must have been inhabited by mammals during the periods which preceded the Post-Pliocene, as far back, perhaps, as the Miocene or Eocene. The Toxodontia include the forms of Pachyderms most nearly allied to the Rodents, while the subungulated Rodents are those of the order which approach nearest to the Pachyderms. As both these groups occur here, and here only, we may reasonably expect to find genera partaking of the general features of both orders in beds of an earlier geological age in South America. The principal genera and species found fossil in this region are the following. In the Argentine Confederation we have—

Macrauchenia patachonica.	Felis longifrons.
Glyptodon spinicaudus.	Canis protalopex.
clavipes.	avus.
tuberculatus.	Mephitis primæva.
pumilio.	Ursus bonærensis.
clavicaudatus.	Myopotamus bonærensis.
clavatus.	antiquus.
asper.	Ctenomys bonærensis.
elongatus.	Lagostomus augustidens.
Machairodus neogæus.	Cavia breviplicata.

Megatherium americanum.
Mylodon giganteus.
gracilis.
robustus.
darwinii.
Scelidotherium leptocephalum.
cuvieri.

Megalonyx meridionalis.
jeffersoni.
Equus curvidens.
devillei.
Toxodon burmeisteri.
owenii.
Mastodon humboldtii.

Some of these also occur in Brazil, where species have also been found belonging to the genera Callithrix, Cebus, Protopithecus, Chlamydotherium, Cœlogenys, Colodon, Dasypus, *Equus neogœus*, *Equus principalis*, Euryidon, Heterodon, Hoplophorus, Myrmecophaga, Nesodon, Pachytherium, and Xenurus. Remains of many of these genera have also been found on the banks of the Rio Negro in Uruguay, and those of some, such as Mastodon, Equus, Auchenia, &c., in Ecuador. As space forbids our dwelling upon the points of interest which these fossil forms present, we pass on to the lists of the extinct faunas of North America.

The oldest species yet found in North America belongs to Dromatherium, and was found in the Triassic beds of Virginia. Then nothing is known until we come to the Tertiary deposits which were formed in lakes along the base and in the midst of the Rocky Mountains and neighbouring ranges, and in the marine beds which lie nearer the present sea margin. The following lists are given by Dr Leidy,[1] who considers the oldest beds in Nebraska, which rest on the Cretaceous series, as of Miocene age. They contain *Titanotherium prouti*, Lophiodons, and several other forms which would induce us to regard them as Eocene. However, we follow his lists. The Miocene species are—

Carnivora.
Canidæ.
Amphicyon vetus.
gracilis.
Hyænodontidæ.
Hyænodon horridus.
cruentus.
crucians.
Felidæ.
Drepanodon (Machairodus) primævus.
(Machairodus) occidentalis.
Dinictis felina.
Ruminantia.
Oreodontidæ.
Oreodon culbertsoni.
gracilis.
major.
affinis.
hybridus.
bullatus.
Merycochœrus proprius
Leptauchenia major.
decora.
nitida.
Agriochœridæ.
Agriochœrus antiquus.
major.
latifrons.
Camelidæ.
Poebrotherium wilsoni.
Protomeryx halli.
Moschidæ.
Leptomeryx evansi.
Artiodactyla.
Suidæ.
Elotherium mortoni.

Artiodactyla.
Suidæ.
Elotherium ingens.
superbum.
leidyanum.
Perchœrus probus.
Leptochœrus spectabilis.
Nanohyus percinus.
Anthracotheridæ.
Hyopotamus americanus.
Anoplotheridæ.
Titanotherium prouti.
Perissodactyla.
Rhinocerotidæ.
Rhinoceros.
Hyrocodon.
Tapiridæ.
Lophiodon.
Solidungula.
Anchitheriidæ.
Anchitherium.
Anchippus.
Hypohippus.
Parahippus.
Anchippodus.
Rodentia.
Leporidæ.
Palæolagus haydeni.
Castoridæ.
Palæocastor nebrascensis.
Muridæ.
Eumys elegans.
Insectivora.
Erinacidæ.
Leptictis haydeni.
Ictops dakotensis.
Omomys carteri.

Since this list was published numerous genera and species have been discovered in Wyoming and other districts in the far west from what appear to be the older or Eocene group of beds. Amongst these the most remarkable is the large *Dinoceras mirabilis*, an animal which had three pairs of horns, and which was intermediate in character between the Proboscideans and the Perissodactyles. There are also several generalised forms in the foregoing lists, which present a fauna with numerous remarkable features, which we can only briefly allude to. It is quite distinct in character from the present South American fauna, and yet, like it, it has a strong Asiatic facies; at the same time it resembles in many points the older Tertiary fauna of Europe. The occurrence of rhinoceroses, camels, and musk-deer, is noticeable; but its great feature is the abundance of oreodonts (which family is not known elsewhere) and of equine forms. The Pliocene fauna consists of the following genera and species:—

Carnivora.
Canidæ.
Canis sævus.
temerarius.
vafer.
haydeni.
Felidæ.
Pseudælurus intrepidus.
Ælurodon ferox.
Ursidæ.
Leptarctus primus.
Ruminantia.
Oreodontidæ.
Merychyus elegans.
medius.
major.
Camelidæ.
Procamelus robustus.
occidentalis.
gracilis.
Homocamelus caninus.
Megalomeryx niobrarensis.
Merycodus necatus.
Cervidæ.
Cervus warreni.

Ruminantia.
Antilopidæ.
Cosoryx furcatus.
Artiodactyla.
Suidæ.
Dicotyles.
Perissodactyla.
Rhinocerotidæ
Rhinoceros.
Proboscideæ.
Mastodon.
Elephas.
Solidungula.
Equidæ.
Hipparion.
Protohippus.
Merychippus.
Equus.
Rodentia.
Castoridæ.
Castor.
Hystricidæ.
Hystrix.

The Post-Pliocene forms are—

Carnivora.
Canidæ.
Canis.
Felidæ.
Felis.
Ursidæ.
Procyon lotor.
priscus.
Ursus americanus
amplidens.
Arctodon pristinus.
Mustelidæ.
Galera macrodon.
Ruminantia.
Camelidæ.
Camelops kansanus.
Cervidæ.
Cervus virginianus.
canadensis.
tarandus.
americanus.
Capridæ.
Ovis mammillaris.
Ovibos moschatus.
bombifrons.
cavifrons.
Bovidæ.
Bison americanus.
latifrons.
antiquus.
priscus.
Artiodactyla.
Suidæ.
Dicotyles nasutus.
Platygonus compressus.
Perissodactyla.
Tapiridæ.
Tapirus americanus.
haysii.

Perissodactyla.
Proboscideæ.
Mastodon.
Elephas.
Solidungula.
Equidæ.
Hipparion venustum.
Equus major.
fraternus.
pacificus.
conversidens.
tau.
fossilis.
Rodentia.
Leporidæ.
Lepus sylvatica.
Sciuridæ.
Arctomys monax.
Sciurus.
Castoridæ.
Castor canadensis.
Castoroides ohioensis.
Cavidæ.
Hydrochœrus æsopi.
Chinchillidæ.
Amblyrhiza inundata
Muridæ.
Neotoma magister.
Marsupialia.
Didelphys virginiana.
Edentata.
Megatherium mirabile.
Megalonyx jeffersoni.
dissimilis.
validus.
Megalocinus rodens.
Ereptodon priscus.
Mylodon harlani.

Here it is observable that, while this fauna has a general resemblance to that of the preceding period, most of the genera are distinct. Several existing genera make their appearance, as also a number of forms which appear to have migrated from South America, and after a temporary estab-

[1] *Journ. Acad. Nat. Sci.* Philadelphia, vol. vii. 1869.

lishment to have disappeared. One remarkable feature is the abundance of horses, which is such that North America may be regarded as the land of horses during the Pliocene and Post-Pliocene period.

N. America: Mammalia. The existing mammals of North America must now be considered. We can only refer to a few of the more conspicuous species here. South America has numerous families peculiar to itself, but North America has none which are not also represented in South America. There are numerous representatives of the *Canidæ* or dog family, such as the prairie, Mexican, and maned wolves, and several foxes, of which the Arctic, common American, cross, and silver foxes are of high commercial value on account of their furs. Amongst the cats are three or four species of lynx, which afford valuable furs. The beaver, though abundant in some places, is, like the bison, fast diminishing before the encroaching steps of the colonists. The grizzly, the black, and the polar bears are common in the more mountainous and colder regions of the continent, and are much hunted by the fur traders. Racoons and Virginian opossums are prevalent in the south portion of the United States. The Rocky Mountain goat reigns supreme amidst the rocks in inaccessible fastnesses of the Rocky Mountain range; while the rein-deer, the elk, and the wapiti give a character to the mammalian fauna of the more level districts. Further details respecting the mammals of North America will be found under the names of the separate countries; and those who wish for still fuller information may consult the works of Lord, Small, Müller, Harlan, and Allen on the mammals of various regions, *The Quadrupeds of North America* by Audubon and Bachman, the articles by Gilpin in the publications of the Institute of Natural Science at Halifax, Adams' *Field and Forest Rambles*, *The North-West Passage* by Viscount Milton and Dr Cheadle, Morgan's work on the Beaver, and the numerous reports issued by exploration expeditions.

Birds. The birds of America are very numerous in almost every great family. The researches of Wilson, Charles Lucien Bonaparte, Audubon, Richardson, Dekay, Blakiston, Cassin, Gundlach, Lord Lawrence, Sclater, Salvin, and Baird, have beautifully illustrated the ornithology of North America; while those of Azara, Humboldt, Swainson, Waterton, Edmonstone, Darwin, Landbeck, Philippi, Cassin, &c., have thrown great light on that of South America. The North American species of birds already described amount to nearly 700; the species of South America are over 2300; so that we may fairly estimate the ornithology of America to include upwards of 3000 species. The fossil remains deserve particular notice. It is very probable that the footprints on the older secondary rocks of North America are those of birds. A large number of remarkable genera found in the Cretaceous rocks have recently been described by Professor Marsh and others.

Ophidia. The serpents of America are very numerous, and include amongst others, the following genera:—Tortrix, Calamaria, Coronella, Xenodon, Heterodon, Lycodon, Coluber, Herpetodryas, Psammophis, Dendrophis, Dryophis, Dipsas, Tropidonotus, Homalopsis, Boa, Elaps, Trigonocephalus, Crotalus.

Of these the genera Heterodon and Crotalus or rattlesnake are entirely peculiar to America, and the latter are by far the most deadly of serpents. The reptilia of North America have been well described by Dekay and Holbrooke.

The North American saurians belong to the genera Crocodile, Alligator, Anolis, Skink, Agama, Tropidolepis, Ophisaurus, Leptophis. Of the Ranidæ there are Rana, Bufo, and Hyla.

The North American and Asiatic regions form a zoological kingdom, according to Dr Strauch, which is characterised by the prevalence of Emydes and by the presence of Trionychides. In the North American region there are 44 species distributed over four sub-regions—viz., the north-west part, which lies west of the Rocky Mountains; the north-east part, which lies east of them; the south-east part and the south-west part, which embraces Central America. South America and Australia together form another kingdom, characterised by the prevalence of Chelydes, and the total absence of Trionychides. There are about 35 species in the South American region.

Fishes. The multitude of fishes in South America is extraordinary, and still more so is the marvellous variety of form which they exhibit. A large number of species have very circumscribed ranges, so that not only does each river basin have a distinct fauna, but a number of distinct faunas occupy different portions of the same river, as is well exemplified in the Amazons, Tocantins, Rio Negro, and other rivers, where most of the fishes at stations a few hundred miles apart are for the most part specifically distinct. Professor Agassiz, in his scientific journey through Brazil, collected about 2000 species from the Amazon basin only. In fishes, as in other classes, there is a remarkable difference between the faunas of North and South America, and in this class also North America has much in common with Europe and North Asia. The sturgeons abound in North America, but are absent in South America, where the corresponding group is the Goniodonts; the Siluroids are abundant in both portions of the continent; the perches are numerous throughout North America, but none occur in South America, where, however, they are represented by the Chromids. The Cyprinoids are abundant in North America, but absent in South America, where we have the allied group of Cyprinodonts. The Characines of South America represent the Salmonidæ of North America, each group being confined to its own portion of the continent. There are several other small families present in South America, such as the Erythrinoids, Gymnotines, and others.

Botany. In the meagre outline of American vegetation which it is possible to attempt here, we shall more or less strictly adhere to the principle laid down by Schouw, viz., that in constituting a botanical region, at least one-half of the species and one-fourth of the genera should be peculiar to it. We shall therefore divide the horizontal range of the vast continent into zones, commencing with the Arctic, and proceeding towards the Antarctic Circle.

In the *Arctic Region* or *Region of Saxifragaceæ*, as near to the Pole as man has yet penetrated, is found the red snow plant (*Protococcus nivalis*), penetrating the snow itself, sometimes to the depth of 12 feet, and covering for miles with its crimson tints the cliffs and ice-floes of the Polar Sea. Greenland is botanically distinguishable from Arctic America proper, inasmuch as it produces heath (*Calluna vulgaris*), which, it is somewhat remarkable, is nowhere to be found on the continent.

The most remarkable of the sub-arctic lichens is that known as *Tripe de Roche*, which has often preserved the lives of famished "trappers," who, but for its sustenance, must have perished of hunger. The *Saxifrages* which distinguish this region vary in species, and sometimes in genera, from those of Europe, but, generally speaking, there is a strong resemblance, which amounts almost to identity, as the Arctic shores are approached.

Emerging from the region of *Saxifragaceæ*, we find ourselves in that of the *Asters* and *Solidagos*, extending to the parallel of 36° N. This region not only produces many species of aster and solidago, but also a great variety of oaks and firs, and numerous species of Vaccinium. Among the oaks of Canada and the United States are, the lime oak (*Quercus virens*), the laurel oak (*Quercus laurifolia*), the black oak (*Quercus tinctoria*), the white or iron oak

(*Quercus alba* and *Quercus obtusiloba*), and the scarlet oak (*Quercus coccinea*). None of these, in regard to the quality of their timber, can stand comparison with the British oak, though some of them are very valuable.

The western or Californian and Oregon districts of this region are in many respects distinct in character. *Polemoniaceæ* abound; also *Eschscholtzia californica*, species of *Platystemon*, *Nemophila*, *Gilia*, *Collinsia*, *Clarkia*, *Bartonia*, and *Eutocha*. Coniferæ also exist in abundance, some of them possessing great botanical interest, such as *Abies Douglasii*, *Pattoniana*, *nobilis*, *amabilis*, *grandis*, *lasiocarpa*, *Pinus Lambertiana*, *Sabiniana*, *insignis*, *Jeffreyi*, *ponderosa*, *monticola*, *californica*, *Fremontiana*, *Coulteri*, *flexilis*, *Thuja gigantea*, *Sesquoia gigantea*, *Juniperus dealbata* and *occidentalis*, and *Castanea chrysophylla*. *Pinus ponderosa* predominates in the forests of Upper Oregon, and along with it occur *Abies balsamea*, *canadensis*, *Douglasii*, *nobilis*, and *alba*. Vivid colours mark the basaltic region of Upper Oregon. *Rhododendron macrophyllum* is found in Vancouver Island. Barley, oats, rye, wheat, buckwheat, and maize, along with the common fruit-trees and culinary vegetables of the temperate regions, are cultivated.

The region of *Magnolias* lies between parallels 30° and 36°, embracing the southern portion of North America. Nearly seventy species are known to exist. *Cycadaceæ*, *Anonaceæ*, *Sapindaceæ*, *Zingiberaceæ*, *Melastomaceæ*, *Cactaceæ*, and numerous other tropical forms, show themselves.

The forest trees display either broad shining foliage like the *Liriodendron and Æsculus*, or pinnated leaves like the *Acacia* and *Robinia*. They are, moreover, decked with magnificent blossoms. Rice, sugar-cane, and cotton are the special objects of culture in this region.

The region of *Cactuses* and *Peppers* includes Mexico, Guatemala, and South America to the Amazon (to an elevation of 5000 feet above the sea-level), as also Guiana, certain parts of Peru, and New Granada. The leaves of the plants of the isthmus of Panama are covered with hair and tomentum, while greenish and yellow flowers predominate. The included portion of South America produces *Mauritia flexuosa*, the *Murichi* or *Ita Palm*, and *Victoria regia*. The vegetable-ivory palm (*Phytelephas macrocarpa*) is a native of Columbia and Peru. Yams, plantains, chocolate, sugar, coffee, cocoa-nut, &c., are cultivated in this region.

The Mexican highlands, rising over 5500 feet above the sea-level, produce *Pinus religiosa*, *Pinus apulcensis*, *Pinus Hartwegii*, *Pinus Montezumæ*, and *Taxodium distichum*. European grains are cultivated with success.

The region of medicinal bark trees (*Cinchonas*) embraces the Cordilleras between parallels 5° N. and 20° S., where the elevation ranges between 5000 and 9600 feet. In the lower parts of this region coffee, maize, and potato are cultivated.

The region of *Calceolarias* and *Escallonias* is, generally speaking, coextensive with the preceding, but at an elevation greater than 9600.

The West Indian region is marked by the prevalence of ferns and orchids, and has a vegetation intermediate between that of Mexico and the north of South America.

We next come to the region of *Palms* and *Melastomas*, which lies to the east of the Andes, between the Equator and the Tropic of Capricorn. Here the luxuriance of vegetable life is almost startling to European eyes. The forest trees of Brazil tower to an almost incredible height, while the very underwood is composed of Palms, Melastomaceæ, Myrtaceæ, Crotons, and Tree Ferns. In the treeless belts are found Heliconias, Dorstenias, and tall grasses. Immense Compositæ, Vernonias, arborescent Solanums, and species of Fuchsia, Solandra, Lasiandra, Laurus, Ficus, and Cassia abound. The trees are covered, stem and branch, with Ferns, Araceæ, Tillandrias, Orchids, Cactuses, Peperomias, Gesneras, and innumerable other epiphytic plants.

The region of arborescent *Compositæ*, extending from the Tropic of Capricorn to lat. 40° S., embraces Southern Brazil, La Plata, and Chili. The distinctive features of the Upper Cordilleras reappear here; Calceolarias and Escallonias abound. *Thuja tetragona*, *Podocarpus chiliana*, *Thuja chilensis*, and Chili pine (*Araucaria imbricata*), are native to this region, the last-named being a hardy conifer, extending along the Chilian Andes from 37° to 40° S. In the neighbourhood of Rio Janeiro is found *Araucaria braziliana*. Wheat, vine, peach, and many European plants are cultivated to great perfection in this region.

The Antarctic region comprehends the Strait of Magalhaens, Tierra del Fuego, and the Falkland Islands. Many European, and more especially British, genera appear in this region, and species of Saxifraga, Gentiana, Arbutus, Primula, and other Arctic and North Temperate forms are common. In Fuegia the evergreen beech (*Fagus Forsteri*), the deciduous beech (*Fagus antartica*), and *Drymis Winteri*, correspond to the birch, oak, and mountain ash of Scotland. The Fuchsia is a native of Fuegia. Among shrubs may be mentioned *Chiliotricum amelloides*, *Veronica elliptica* and *decussata*, *Empetrum rubrum*, and *Pernettya empetrifolia*; among ferns, *Lomaria alpina* and *Magellanica*; and among lichens, *Usnea melaxantha*.

Chief indigenous products of the American continent.

Northern America, though its vast forests have now been exposed for centuries to the axe of civilised man, is still one of the best wooded regions of the world. Among the principal forest-trees are the pine, oak, ash, hickory, red-beech, Canadian poplar, chestnut, black walnut, maple, tulip-tree, and white cedar.

Central America produces extensively mahogany, pimento, sarsaparilla, vanilla, Peruvian balsam, and many other valuable woods and drugs.

Nearly two-thirds of the surface of South America are still covered with gigantic forests, which must ultimately disappear, like many of those in the north, before the combined efforts and necessities of commerce and agriculture. The most distinctive and valuable forest-trees of South America are the greenheart and the mora. The cow-tree, which yields a juice very like milk in its properties, is also a remarkable product of this region.

Maize is by far the most important farinaceous product of the New World. It was the only grain which the earliest European settlers found cultivated, to some extent, by the natives. For nutrition it is inferior to wheat, but it is much more prolific, and is suited to a greater variety of soils. Tobacco is also indigenous to America, whence its use has extended over the whole world. Among roots the potato, which we also owe to America, is without a rival. Millet, tapioca, arrow-root, cocoa, copaiva, cinchona, jalap, sassafras, nux-vomica, the cochineal plant, the agave or American aloe, and the pine-apple are also indigenous to the continent.

It is impossible here to do more than touch on the vast subject of the botany and the indigenous vegetable products of the New World. For fuller information, in addition to that contained in articles in the present work that treat of the geographical distribution of plants, the reader is referred to the numerous valuable American works of such authors as Beck, Bigelow, Breckenridge, Brown, Carson (Medical Botany), Darby, Darlington (Agricultural Botany), Asa Gray, Harvey (Algæ), Ravenel, Sprague, Strong, Torrey, &c. An extended description of the forest trees of North America will be found in the great work of Michaux and Nuttall, *The North American Sylva*.

Ethnology.

The origin, history, languages, and condition of the American nations present ample materials for speculation; but before touching on these subjects, the question present-

itself, What is the total of the indigenous population? Humboldt, in 1823, estimated the number of Indians at 8,610,000. Bollaert estimated the number existing in 1863 as follows:—

Mexico	4,000,000
Peru	1,600,000
Bolivia	1,400,000
Central America	1,000,000
Paraguay	700,000
Ecuador	500,000
United States	500,000
Other countries	1,314,710
Total	11,014,710

It is probable that these numbers have been diminished: the latest official returns for the United States, in 1872, estimate the Indian population at 300,000. (See INDIANS.)

The indigenous population of America presents man under many aspects, and society in various stages, from the regular but limited civilisation of Mexico and Peru, to savage life in its most brutal state of abasement. At one extremity of the country we find the pigmy Esquimaux of four feet and a half in height, and at the other the Patagonian standing above six feet. In complexion the variety is great, and may be said to embrace almost every hue known elsewhere on the face of the earth, except the pitchy black of the Negro. About one-half of all the known languages belong to America; and if we consider every little wandering horde a distinct community, we have a greater number of nations here than in all the rest of the world. Amidst all this diversity philosophers have thought they were able to discover certain general characters, sufficiently marked to distinguish the American nations from those of the old continent. It is foreign to our purpose to inquire whether the varieties of form, stature, and complexion, in the human species, are modifications produced by external causes operating differently on distinct portions of the progeny of one primitive pair, or whether several races were originally created, and have given birth, by their mixture, to the amazing varieties we witness. We assume the former opinion as true, because the probabilities seem to be in its favour; but the phenomena present themselves to us in the same light in whichever way they originated.

Aborigines: Divisions of race.

Physiologists are not at one in their accounts of the characteristics of the aborigines of the new world, nor are they agreed as to whether they should be considered one race or several. Blumenbach places them all under one class, except the Esquimaux. Bory St Vincent divides them into four races, or five if we include the Esquimaux, under the following designations:—1. The *Colombian*, which comprehends the tribes formerly inhabiting the Alleghany Mountains, Canada, Florida, the eastern coasts of Mexico, and Central America; and the Caribs, who occupied the West India Islands and Guiana. 2. The *American*, embracing the tribes which occupy all the other parts of South America east of the Andes, except Patagonia. 3. The *Patagonian* race, inhabiting the southern extremity of the continent. 4. The *Neptunian*, inhabiting the western coasts of both divisions of the continent, from California to Cape Horn, and which he considers as essentially the same with the race spread over the Malay Peninsula and the Indian Archipelago. With this race are classed the Mexicans and Peruvians. By another writer the species are reduced to two, the *Colombian* and the *American;* the former including all the North American tribes, with the Caribs, the Mexicans, and Peruvians, and other inha itants of the Cordillera; and the latter the Brazilian In ians and Patagonians. Neither of these systems, when tested by facts, is very satisfactory. Dr Prichard thinks that the mutual resemblance among the American nations has been exaggerated by some writers; yet it is certain that there is more of a common family character in their organisation than in that of the indigenous population of Asia or Africa. "The Indians of New Spain," says Humboldt, "bear a general resemblance to those who inhabit Canada, Florida, Peru, and Brazil. We have the same swarthy and copper colour, straight and smooth hair, small beard, squat body, long eye, with the corner directed upwards towards the temples, prominent cheek-bones, thick lips, and expression of gentleness in the mouth, strongly contrasted with a gloomy and severe look. Over a million and a half of square leagues, from Cape Horn to the river St Lawrence and Behring's Straits, we are struck at the first glance with the general resemblance in the features of the inhabitants. We think we perceive them all to be descended from the same stock, notwithstanding the prodigious diversity of their languages. In the portrait drawn by Volney of the Canadian Indians, we recognise the tribes scattered over the savannahs of the Apure and the Carony. The same style of features exists in both Americas."

On the authority of Dr Morton, the most natural division of the Americans is into two families, the *Toltecan* and the *American;* the former of which bears evidence of centuries of half-civilisation, while the latter embraces all the barbarous nations of the New World, with the exception of the Polar tribes, which are evidently of Mongolian origin. In each of these, however, there are several subordinate groups, which may be distinguished as the *Appalachian*, the *Brazilian*, the *Patagonian*, and the *Fuegian*. The Appalachian branch includes all the nations of North America, except the Mexicans, together with the tribes of South America north of the river Amazon and east of the Andes. In this race the head is rounded, the nose large, salient, and aquiline; the eyes dark brown, with little or no obliquity of position; the mouth large and straight; the teeth nearly vertical; and the whole face triangular. The neck is long, the chest broad but rarely deep, the body and limbs muscular, and seldom disposed to fatness. In character these nations are warlike, cruel, and unforgiving; they turn with aversion from the restraints of civilised life, and have made but little progress in mental culture or the useful arts. The Brazilian branch is spread over a great part of South America, east of the Andes, including the whole of Brazil and Paraguay, between the River Amazon and 35° S. latitude. Their physical characteristics differ but little from those of the Appalachian branch; they possess, perhaps, a larger and more expanded nose, with larger mouths and lips. The eyes are small, more or less oblique, and far asunder; the neck short and thick, the body and limbs stout and full, even to clumsiness. In character, also, they differ little. None of the Americans are less susceptible of cultivation; and what they are taught by compulsion seldom exceeds the humblest elements of knowledge. The Patagonian branch includes the nations to the south of the Plato, as far as the Strait of Magalhaens, including also the mountain tribes of Chili. They are chiefly distinguished by their tall stature, handsome forms, and indomitable courage. The Fuegians, who call themselves *Yacannacunnee*, rove over the sterile wastes of Tierra del Fuego, which is computed to be half the size of Ireland, and yet their whole number has been computed as not exceeding 2000. The physical aspect of the Fuegians is altogether repulsive. They are of low stature, with large heads, broad faces, and small eyes. Their chests are large, their bodies clumsy, with large knees, and ill-shaped legs. Their hair is lank, black, and coarse, and their complexion a decided brown, like that of the more northern tribes. Their expression of face is vacant, and their mental operations are to the last degree slow and stupid; they are almost destitute of the usual curiosity of savages, caring little for anything that does not minister to their present wants.

American form and complexion

The American race is distinguished by the form of the skull, which, except in its greater length, resembles the Mongol type. The cheek-bones are prominent, but not so angular, as in the Mongol head; the occiput is rather flat, the cavity for lodging the cerebellum small, the orbits large and deep. The nose is generally aquiline, but in some tribes flat, and the nasal cavities are large. Compared with the head of the Negro, that of the American is broader, and the teeth are less prominent: when placed by the side of the Caucasian head, it is seen to be smaller in size, less rounded and symmetrical, and less developed in the part before the ear. The skull is generally thin and light. There are, however, many deviations from this typical form. The Carib skull and the Araucanian are large; the Peruvian small, and singularly flattened behind, so as to present a short line from the forehead to the occiput.

The colour of the Americans, though it includes a considerable diversity of shade, is more uniform than that of the inhabitants of Asia or Africa; and, what is more remarkable, its varieties do not bear any visible relation to the temperature of the climate. A brownish yellow, or copper colour, as it has been called, pervades nearly all the numerous tribes from the Arctic Ocean to Cape Horn, but still with many different degrees of intensity. The eastern nations of Chili have but a slight tinge of the brown colour, and the Boroanes are still whiter. On the north-west coast, from latitude 43° to 60°, there are tribes who, though embrowned with soot and mud, were found, when their skins were washed, to have the brilliant white and red which is the characteristic of the Caucasian race. But within the tropics, the Malapoques in Brazil, the Guaranis in Paraguay, the Guiacas of Guiana, the Scheries of La Plata, have tolerably fair complexions, sometimes united with blue eyes and auburn hair; and, in the hot country watered by the Orinoco, Humboldt found tribes of a dark, and others of a light hue, living almost in juxtaposition. It is remarkable, too, that the nations whose colour approaches nearest to black are found in the temperate zone, namely, the Charruas of the Banda Oriental, in latitude 33° S., and the Cochimies, Pericus, and Guaycurus, spread over the peninsula of California. These people have skins of a very deep hue, but are not absolutely black; and they have neither the woolly hair of the Negroes, nor their social and good-humoured disposition. The Charruas, especially, are distinguished by a high degree of that austerity and stern fortitude which are common to the American nations. The Caribs and some Brazilian tribes have the yellowish hue of the Chinese, and the same cast of features. Among the nations dwelling on the west side of the Alleghanies, and near the northern lakes, there is also a considerable vairety of complexion; but the brown or copper shade is found more or less in them all. It may be said, then, of the American nations, that, with the exception of two or three tribes on the north-west coast, who probably arrived from Asia at a later period than the others, the two extremes of complexion, the white of Northern Europe and the black of Ethiopia, are unknown amongst them; and that, when compared with the Moors, Abyssinians, and other swarthy nations of the Old World, their colour inclines less to the yellow, and more to the reddish brown.

Long, black, lank hair is common to all the American tribes, among which no traces of the frizzled locks of the Polynesian, or the woolly texture of the African Negro have ever been observed. The beard is very deficient, and the little that nature gives them they assiduously root out. A copper-coloured skin has been also assumed by most writers as a characteristic distinction of the Americans; but their real colour is in general brown, of the hue most nearly resembling that of cinnamon; and Dr Morton coincides in opinion with Dr M'Culloch, that no epithet derivable from the colour of the skin so correctly designates the Americans as that of the brown race. There are, however, among them occasional and very remarkable deviations, including all the varieties of tint from a decided white to an unequivocally black skin. That climate has a very subordinate influence in producing these different hues must be inferred from the fact that the tribes which wander in the equinoctial regions are not darker than the mountaineers of the temperate zone. The Puelches, and other tribes of the Magellanic regions, beyond 55° S. latitude, are darker than the Abipones, Mocobies, and Tobas, who are many degrees nearer the equator; and the Botocudos are of a clear brown colour, sometimes approaching nearly to white, at no great distance from the tropic; while the Guiacas under the line are characterised by a fair complexion; the Charruas, who are almost black, live at the 30th degree of S. latitude; and the still blacker Californians are 25° north of the equator. Everywhere, indeed, it is found that the colour of the American depends very little on the local situation which he actually occupies; and never, in the same individual, are those parts of the body which are constantly covered of a fairer colour than those which are exposed to a hot and moist atmosphere. Children are never white when they are born, as is the case among even the darkest of the Caucasian races; and the Indian caciques, who enjoy a considerable degree of luxury, and keep themselves constantly dressed, have all parts of their body, except the palms of the hands and the soles of the feet, of the same brownish-red or copper colour. These differences of complexion are, however, extremely partial, forming mere exceptions to the general tint which characterises all the Americans, from Cape Horn to Canada. The cause of such anomalies is not easily ascertained; that it is not climate is sufficiently obvious; but whether or not it arises from partial immigrations from other countries remains yet to be decided.

The Americans of indigenous races might also be divided into three great classes distinguished by the pursuits on which they depend for subsistence, namely, hunting, fishing, and agriculture. The greater number of them are devoted to hunting; the fishing tribes are not numerous, and are wholly destitute of the spirit of maritime adventure, and even of fondness for the sea. A few tribes were strictly agricultural before the arrival of Europeans, but a much greater number have become so since. Many tribes regularly resort to all these modes of subsistence, according to the seasons; employing the spring in fishing, the summer in agriculture, and the autumn and winter in hunting.

Intellectual faculties.

The intellectual faculties of this great family appear to be decidedly inferior, when compared with those of the Caucasian or Mongolian race. The Americans are not only averse to the restraints of education, but are for the most part incapable of a continued process of reasoning on abstract subjects. Their minds seize with avidity on simple truths, but reject whatever requires investigation and analysis. Their proximity for more than two centuries to European institutions has made scarcely any perceptible change in their mode of thinking or their manner of life; and, as to their own social condition, they are probably in most respects exactly as they were at the earliest period of their national existence. They have made few or no improvements in constructing their houses or their boats; their inventive and imitative faculties appear to be of very humble capacity, nor have they the smallest taste for the arts and sciences. One of the most remarkable of their intellectual defects is the great difficulty they find in comprehending the relations of numbers; and Mr Schoolcraft, the United States Indian agent, assured Dr Morton that this deficiency was one cause of most of the misunderstanding in respect to treaties entered into between the United States Government and the

native tribes. The natives sell their land for a sum of money, without having any conception of the amount; and it is only when the proceeds come to be divided that each man becomes acquainted with his own interest in the transaction. Then disappointment and murmurs invariably ensue.

Languages of American Indians.

Every unwritten tongue is subject to continual fluctuations, which will be numerous and rapid in proportion as the tribe using it is exposed to frequent vicissitudes of fortune, and the individuals composing it have little intercourse with one another. When the population of one of these societies increases, it splits into several branches; and if these have little intercourse, the original language divides by degrees into as many dialects. These smaller societies subdivide in their turn with the same effects; and, in such continual subdivisions, the dialects of the extreme branches deviate farther and farther from one another, and from the parent tongue, till time, aided by migrations and wars, producing mixtures of different hordes, obliterates all distinct traces of a common origin. The cause of these changes becomes more obvious when we reflect on the principles which give stability to a language. These are—1. The abundant use of writing; 2. The teaching of a language as a branch of education; 3. Frequency of intercourse among all the people speaking it; 4. The existence of an order of men, such as priests or lawyers, who employ it for professional purposes; 5. Stability of condition in the people, or exemption from vicissitudes and revolutions; 6. A large stock of popular poetry, which, if universally diffused, may almost become a substitute for writing. All these conditions were wanting (with some trifling exceptions) in the whole of the wandering tribes of America. The great multiplication of languages, therefore, proves two things—first, that the people are in a low state of savage life; and, secondly, that they have been for many ages in this condition; for time is a necessary element in the process of splitting human speech into so many varieties.

Among the seven or eight millions of American aborigines, it is estimated that there are as many languages spoken as among the seven or eight hundred million inhabitants of the Old World. Just as there is a marked physiological resemblance attaching to all the New World tribes, so judged by the evidence of language, the native American is *sui generis*, having no connection, except the most remote, with the rest of the human family. The few corresponding words in Old and New World languages, which are not of an imitative character, bear the stamp of fortuitous coincidence rather than that of common origin. Vater, in his *Linguarum Totius Orbis Index*, estimated the number of American aboriginal languages at about 500, and Balbi at 423, of which 211 belonged to North, 44 to Central, and 158 to South America. In the absence of certain data, it may be safe to set down the number of native American languages at about 450.

Throughout the whole of these runs a thread of connection. They are all characterised by *polysynthesis*, as Duponceau calls it, or *holophrasm*, to adopt the phraseology of Dr Lieber. Holophrasm is a process more or less common to every language at a particular stage of its development. We have glimpses of it in most of the Turanian group of languages, and it appears, in a faint degree, in the Basque; but it belongs to a very large proportion of the languages of America, so extremely numerous, and many of which have nothing else in common. This diffusion of a peculiar and common character over materials so dissimilar has been plausibly accounted for by the supposition of a community of origin in the tribes, whether few or many, which peopled the continent. As no person has the full command of all the vocables in his native language, individual terms must be continually dropping out of dialects preserved by oral communication; and new ones will be introduced as new wants and new objects solicit attention. But during the gradual change which thus takes place, the new words will be combined and modified according to the rules which belong to the genius of the spoken dialect with which they are incorporated; and thus it may happen that the grammatical forms of an ancient language may live, while its materials perish. The changes of structure which present themselves in the history of European languages, it must be remembered, took place in *progressive* communities. Among nations like the American Indians, whose barbarism, we may suppose, remained almost stationary, the forms of speech might be more permanent, though its substance was in a state of slow but constant mutation. But even were this community of origin admitted, it cannot be looked on as entire and absolute among the American nations.

Analysis and generalisation are processes that distinguish the languages of reflective and civilised races. "Nothing," says Schoolcraft, "could apparently be further removed from the analytical class of languages than the various dialects spoken by the Indians of America, who invariably express their ideas of objects and actions *precisely as they are presented to their eyes and ears, i.e.*, in all their compound associations." To "encapsulate" words, as Dr Lieber expresses it, "is the striking feature of all these languages, and hence a word will consist sometimes of seven or eight syllables, each one conveying one individual idea, like a set of boxes each one contained in the other." This common feature of American languages is both psychologically and philologically of the greatest interest. Of all the groups of American languages, the various dialects of the Algonquin stock furnish the most inviting field for the philologist. It is from the Algonquin, therefore, that we draw the following examples of the process of syllabical agglutination:—

Thus, *waub* is the root of the verb *to see*, and of the word *light*. *Waubun* is the *east* or *sunlight*, and inferentially *place* of *light*. *Aub* is the *eye*-ball; hence, *aiaub* = to *see*, to *eye*. *Waub* itself appears to be a compound of *aub* and the letter *w*, which is the sign of the third person. *Waubuno* is *a member of a society of men who continue their orgies till daylight*. The simplest concrete forms of the verb to *see* are as follow:—

Ne waub = I see.
Ke waub = Thou seest.
O waub = He or she sees.

But all this is vague to the Indian mind until the verb is made transitive, and the class of objects acted on is thereby shown. The Indian order of thought, moreover, requires that the object should generally precede the verb, *e.g*—

Inine ne wau bum au = man, I see him. *Wah kie-gun ne ne wau bun daun* = house, I see it.

Such examples show the tendency of these languages to accretion. The verb is made to include within itself, as it were, the noun, pronoun, and adjective. "Declension, cases, articles, are deficient," says Bancroft, "but everything is conjugated. The adjective assumes a verbal termination, and is conjugated as a verb; the idea expressed by a noun is clothed in verbal forms, and at once does the office of a verb. . . . . Then, since the Indian verb includes within itself the agent and the object, it may pass through as many transitions as the persons and numbers of the pronouns will admit of different combinations; and each of these combinations may be used positively or negatively, with a reflex or a causative signification. In this manner changes are so multiplied, that the number of possible forms of a Chippewa

verb is said to amount to five or six thousand; in other words, the number of possible variations is indefinite." The formidable array of syllables arises partly from the fact, that there are some sixteen modes of forming the plural of nouns represented in the verb by sixteen corresponding modifications. Nouns are divided, as in the Dravidian languages of South India, into animate and inanimate.

The best account of those peculiarities, as well as the best general distribution of the American languages, are given by Professor Whitney of Yale College, in his work on *Language and the Study of Language*, pp. 346–351:—

"The conditions of the linguistic problem presented by the American languages are exceedingly perplexing, for the same reason as those presented by the Polynesian and African dialects, and in a yet higher degree. The number, variety, and changeableness of the different tongues is wonderful. Dialectic division is carried to its extreme among them; the isolating and diversifying tendencies have had full course, with little counteraction from the conserving and assimilating forces. The continent seems ever to have been peopled by a congeries of petty tribes, incessantly at warfare, or standing off from one another in jealous and suspicious seclusion. Certain striking exceptions, it is true, are present to the mind of every one. Mexico, Central America, and Peru, at the time of the Spanish discovery and conquest, were the seat of empires possessing an organised system of government, with national creeds and institutions, with modes of writing and styles of architecture, and other appliances of a considerably developed culture, of indigenous origin. Such relics, too, as the great mounds which are scattered so widely through our western country, and the ancient workings upon the veins and ledges of native copper along the southern shore of Lake Superior, show that other large portions of the northern continent had not always been in the same savage condition as that in which our ancestors found them. Yet these were exceptions only, not changing the general rule; and there is reason to believe that, as the civilisation of the Mississippi valley had been extinguished by the incursion and conquest of more barbarous tribes, so a similar fate was threatening that of the southern peoples: that, in fact, American culture was on its way to destruction even without European interference, as European culture for a time had seemed to be during the Dark Ages which attended the downfall of the Roman empire. If the differentiation of American language had been thus unchecked by the influence of culture, it has been also favoured by the influence of the variety of climate and mode of life. While the other great families occupy, for the most part, one region or one zone, the American tribes have been exposed to all the difference of circumstances which can find place between the Arctic and the Antarctic oceans, amid ice-fields, mountains, valleys, on dry tablelands, and in reeking river-basins, along shores of every clime. Moreover, these languages have shown themselves to possess a peculiar mobility and changeableness of material. There are groups of kindred tribes whose separation is known to be of not very long standing, but in whose speech the correspondences are almost overwhelmed and hidden from sight by the discordances which have sprung up. In more than one tongue it has been remarked that books of instruction prepared by missionaries have become antiquated and almost unintelligible in three or four generations. Add to all this, that our knowledge of the family begins in the most recent period, less than four hundred years ago; that, though it has been since penetrated and pressed on every side by cultivated nations, the efforts made to collect and preserve information respecting it have been only spasmodic and fragmentary; that it is almost wholly destitute of literature, and even of traditions of any authority and value; and that great numbers of its constituent members have perished, in the wasting away of the tribes by mutual warfare, by pestilence and famine, and by the encroachments of more powerful races—and it will be clearly seen that the comprehensive comparative study of American languages is beset with very great difficulties.

"Yet it is the confident opinion of linguistic scholars that a fundamental unity lies at the base of all these infinitely varying forms of speech; that they may be, and probably are, all descended from a single parent language. For, whatever their differences of material, there is a single type or plan upon which their forms are developed and their constructions made, from the Arctic Ocean to Cape Horn, and one sufficiently peculiar and distinctive to constitute a genuine indication of relationship. This type is called the incorporative or polysynthetic. It tends to the excessive and abnormal agglomeration of distinct significant elements in its words; whereby, on the one hand, cumbrous compounds are formed as the names of objects, and a character of tedious and time-wasting polysyllabism is given to the language—see, for example, the three to ten-syllabled numeral and pronominal words of our western Indian tongues; or the Mexican name for 'goat,' *kwa-kwauh tentsone*, literally 'head-tree (horn) - lip - hair (beard),' or 'the horned and bearded one'—and, on the other hand, and what is of yet more importance, an unwieldy aggregation, verbal or *quasi*-verbal, is substituted for the phrase or sentence, with its distinct and balanced members. Thus, the Mexican says, 'I-flesh-eat,' as a single word, compounded of three elements; or if, for emphasis, the object is left to stand separate, it is at least first represented by a pronoun in the verbal compound; as, 'I-it-eat, the flesh;' or, 'I-it-him-gives the bread, my son,' for 'I give my son the bread.'

"The incorporative type is not wholly peculiar to the languages of our continent. A trace of it (in the insertion, among the verbal forms, of an objective as well as a subjective pronominal ending) is found even in one of the Ugrian dialects of the Scythian family, the Hungarian; and the Basque, of which we shall presently speak more particularly, exhibits it in a very notable measure. It is found, too, in considerably varying degree and style of development in the different branches of the American family. But its general effect is still such that the linguist is able to claim that the languages to which it belongs are, in virtue of their structure, akin with one another, and distinguished from all other known tongues.

"Not only do the subjective and objective pronouns thus enter into the substance of the verb, but also a great variety of modifiers of the verbal action, adverbs, in the form of particles and fragments of words; thus, almost everything which helps to make expression forms a part of verbal conjugation, and the verbal paradigm becomes well-nigh interminable. An extreme instance of excessive synthesis is afforded in the Cherokee word-phrase *wi-ni-taw-ti-ge-gi-na-li-skaw-lung-ta-naw-ne-li-ti-se-sti*, 'they will by that time have nearly finished granting [favours] from a distance to thee and me.'

"Other common traits, which help to strengthen our conclusion that these languages are ultimately related, are not wanting. Such are, for example, the habit of combining words by fragments, by one or two representative syllables; the direct conversion of nouns, substantive and adjective, into verbs, and their conjugation as such; peculiarities of generic distinction—many languages dividing animate from inanimate beings (somewhat as we do by the use of *who* and *what*), with arbitrary and fanciful details of classification, like those exhibited by the Indo-European languages in their separation of masculine and feminine; the possession of a very peculiar scheme for denoting the degrees of family relationship; and so on.

"As regards their material constitution, their assignment of certain sounds to represent certain ideas, our Indian dialects show, as already remarked, a very great discordance. It has been claimed that there are not less than a hundred languages or groups upon the continent, between whose words are discoverable no correspondences which might not be sufficiently explained as the result of accident. Doubtless a more thorough and sharpsighted investigation, a more penetrating linguistic analysis and comparison—though, under existing circumstances, any even distant approximation to the actual beginning may be hopeless—would considerably reduce this number; yet there might still remain as many unconnected groups as are to be found in all Europe and Asia. It is needless to undertake here an enumeration of the divisions of Indian speech: we will but notice a few of the most important groups occupying our own portion of the continent.

"In the extreme north, along the whole shore of the Arctic Ocean, are the Eskimo dialects, with which is nearly allied the Greenlandish. Below them is spread out, on the west, the great Athapaskan group. On the east, and as far south as the line of Tennessee and North Carolina, stretches the immense region occupied by the numerous dialects of the Algonquin or Delaware stock; within it, however, is enclosed the distinct branch of Iroquois languages. Our southeastern states were in possession of the Florida group, comprising the Creek, Choctaw, and Cherokee. The great nation of the Sioux or Dakotas gives its name to the branch which occupied the Missouri valley and parts of the lower Mississippi. Another widespread sub-family, including the Shoshonee and Comanche, ranged from the shores of Texas north-westward to the borders of California and the territory of the Athapaskas; and the Pacific coast was occupied by a medley of tribes. Mexico and Central America, finally, were the home of a great variety of tongues, that of the cultivated Aztecs, with its kindred, having the widest range."

For further information regarding the aboriginal languages of America, the reader is referred to the researches of Balbi, Gallatin, Vater, and Schoolcraft; to Lewis H. Morgan's Tables, with accompanying text and forms, vol. xvii. of the *Smithsonian Contributions to Knowledge* (1871), entitled "Systems of Consanguinity and Affinity of the Human Family," and to an invaluable work, *The Literature of American Aboriginal Languages*, by Dr Ludewig, edited by Nicolas Trübner, 1858.

Though any attempt to reduce the American population under a few general classes, either on physical or

ethnographical grounds, would be idle, we may notice one or two of the most remarkable nations or families.

Esquimaux. All the northern coast of the continent is tenanted by the Esquimaux, a dwarfish race, rarely exceeding five feet in height. Their territories commence near Mackenzie's River, in 68° N. lat., and extend to the Arctic Ocean. They occupy all the northern Archipelago, the shores of Hudson's and Baffin's Bays, of Labrador, and of Russian America round by Behring's Straits, to the peninsula of Alaska. They live entirely by fishing, the whale and the seal being their most common food; they inhabit skin tents during their short summer, and in winter caves or houses built with snow in the shape of domes, within which a single rude lamp is kept perpetually burning. They are crafty and dirty, but appeared to Captain Franklin more intelligent and provident than the northern Indians. There is a wide diversity in their dialects, which still display decided marks of identity in their roots.

The north-west coast of Alaska, from Cook's Inlet to the 48th parallel, is inhabited by four tribes, of whom the Kaluschi are the most remarkable. These people are distinguished from all the native races of America by having as fair a complexion when their skins are washed as the inhabitants of Europe; and this distinction, accompanied sometimes with auburn hair, has been considered as indicating an origin different from that of the copper-coloured tribes who people all the rest of the continent.

Indian Tribes. The Indians of the east coast belong almost entirely to three stems; and, before the arrival of the English colonists, occupied both sides of the Alleghany Mountains, from the Gulf of Mexico to Canada and New Brunswick. 1. The Delaware or Algonquin Indians, comprehending the Ottogamies, Shawnees, Narragansets, Chippeways, Knisteneaux, Delawares, and other nations, to the number of thirty or forty, were spread over the space between the Mississippi and the Atlantic, as far north as Hudson's Bay, and all spoke dialects of one language. 2. The Iroquois, often called the "Five Nations," and the "Six Nations," but comprehending 15 tribes or more, among whom were the Mohawks, Oneidas, Hurons, and Senecas, all spoke dialects of one language. They lived on the south side of the great lakes, and finally obtained a complete ascendency over the Algonquin race. 3. The Florida Indians, including the Creeks, Seminoles, Choctaws, Chickasaws, Natches, and Mobiles. Tribes belonging to these three families (with the Wocons and Catawbas) occupied nearly all the region east of the Mississippi, from the Gulf of Mexico to Hudson's Bay, comprising more than a million of square miles. The Catawbas alone, however, are said to have included 20 tribes, and nearly as many dialects. The Powhattans were a confederacy of 33 tribes, comprehending 10,000 persons. It is probable that when the English settlers landed in the country, the region mentioned was inhabited by a quarter of a million of Indians, divided into many tribes, and speaking dialects belonging to half a dozen radically distinct languages.

These nations have the virtues of savage life—a high sense of honour, according to their perceptions of duty, mutual fidelity among individuals, a fortitude that mocks at the most cruel torments, and a devotion to their tribe which makes self-immolation in its defence easy. On the other hand, they treat their wives cruelly, and their children with indifference. The apathy under the good and ill of life which the Stoic affected, is the grand element of the Indian's character. Gloomy, stern, and severe, he is a stranger to mirth and laughter. All outward expression of pleasure or pain he regards as a weakness; and the only feeling to which he ever yields is the boisterous joy which he manifests in the moment of victory, or under the excitement of intoxication. He is capable of great exertions in war or the chase, but has an unconquerable aversion to regular labour. He is extremely improvident; eats enormously while he has abundance of food, without thinking of the famine which may follow; and, when liquors are supplied to him, will continue drunk for days.

Most of the Indians of North America believe in the existence of a supreme being, whom they call the Great Spirit; and of a subordinate one, whose nature is evil and hostile to man. To the latter their worship is principally addressed; the Good Spirit, in their opinion, needing no prayers to induce him to aid and protect his creatures. They generally believe in a future state, in which the souls of brave warriors and chaste wives enjoy a tranquil and happy existence with their ancestors and friends, spending their time in those exercises in which they delighted when on the earth. The Dakotas believe that the road to these "villages of the dead" leads over a rock with an edge as sharp as a knife, on which only the good are able to keep their footing. The wicked fall off, and descend to the region of the Evil Spirit, where they are hard worked, and often flogged by their relentless master.

Polygamy is allowed; and a number of wives is considered as adding to a man's consequence. Marriage customs differ in different tribes, but in every case the presenting of gifts to the father of the intended wife is an essential feature of the transaction, and shows that the wife is considered as procured by purchase. Deformed children, and lame or decrepit old persons, are destroyed sometimes; but the practice is uncommon. Incest and unnatural vices are practised in some tribes, but they are always viewed as matters of reproach. The Indian funerals are conducted with much decorum. The deceased is dressed in his best clothes, and laid in a grave, in a vertical, horizontal, or inclined position, according to his own previous directions, with his moccasins, knife, money, and silver ornaments beside him, and a small quantity of food near his head. It is usual to mark the graves with a post, on which figures are carved expressive of the nature of the pursuits and achievements of the deceased. Customs.

Some nations of Indians wear little or no clothing; but the general dress of the men in the temperate and cold parts of the country, previous to the arrival of the Europeans, consisted of three articles: a cloak of buffalo-skin hanging from the shoulders, a piece of skin used as an apron, and a pair of moccasins or loose boots, made of undressed skin also. The women wore a long robe of the same material, which was fastened round the waist; but among the tribes living near the whites, coarse woollens are now frequently substituted for the hides of wild animals, except for the moccasins. The habitations of the Indians are huts or cabins, generally of a circular form and small size, but sometimes of 30 or 40 feet in diameter, formed by stakes fixed in the ground, and covered with the bark of trees. Sometimes the spaces between the stakes are filled up with twigs, grass, and mud, and the roof is covered nearly in the same way. A hole in the top serves for the escape of the smoke, and the skins of wild beasts form the beds and seats. When they go to a distance to hunt, they erect for temporary use large tents, which are covered with skins. On the west side of the Mississippi, where the ground is open, many of the tribes make use of horses, which are seldom employed amidst the woods covering the territories east of that river. The custom of painting their bodies is nearly universal. They introduce the colours by making punctures on their skin; and the extent of surface which this ornament covers is proportioned to the exploits they have performed. Some paint only their arms, others both their arms and legs, others again their thighs; while those who have attained the summit of warlike Clothes, houses, and ornaments.

renown have their bodies painted from the waist upwards. This is the heraldry of the Indians, the devices of which are probably more exactly adjusted to the merits of the persons who bear them than those of more civilised countries. Besides these ornaments, the warriors also carry plumes of feathers on their heads, their arms, or ancles. Their arms were the tomahawk, the war-club, knife, the bow and arrow, but now they have muskets.

Government and warfare.

Each tribe is governed by a chief and council, who are elective; but in matters of importance the whole warriors are consulted; and Mr Keating informs us that questions are not decided by the votes of a majority, but the resolution adopted must have the consent of every individual warrior. Their assemblies are conducted with much formality and decorum. The eldest chief commences the debate, which is often carried on by set speeches, abounding in bold figures and metaphors, and bursts of a rude but impassioned eloquence. The young are permitted to be present and to express their approbation by cries, but not to speak. In their wars the object commonly is, to secure the right of hunting within particular limits, to maintain the liberty of passing through their accustomed tracts, and to guard from infringement those lands which they consider as their own tenure. War is declared by sending a slave with a hatchet, the handle of which is painted red, to the nation they intend to break with. They generally take the field in small numbers. Each warrior, besides his weapons, carries a mat, and supports himself till he is near the enemy by killing game. From the time they enter the enemy's country, no game is killed, no fires lighted, or shouting heard, and their vigilance and caution are extreme. They are not even permitted to speak, but must communicate by signs and motions. Having discovered the objects of their hostility, they first reconnoitre them, then hold a council; and they generally make their attack just before daybreak, that they may surprise their enemies while asleep. They will lie the whole night flat on their faces without stirring, and, at the fit moment for action, will creep on their hands and feet till they have got within a bow-shot of those they have doomed to destruction. On a signal given by the chief warrior, which is answered by the yells of the whole party, they start up, and, after discharging their arrows, they rush upon their adversaries, without giving them time to recover from their confusion, with their war-clubs and tomahawks. If they succeed, the scene of horror which follows baffles description. The savage fury of the conquerors, the desperation of the conquered, the horrid yells of both, and their grim figures besmeared with paint and blood, form an assemblage of objects worthy of pandemonium. When the victory is secured, they select a certain number of their prisoners to carry home: they kill the rest in cold blood, take their scalps, and then march off with the spoil. The prisoners destined to death are soon led to the place of execution, where they are stripped, have their bodies blackened, and are bound to a stake. In this situation, while the burning faggots embrace his limbs, and the knives of his revengeful enemies are inflicting a thousand tortures, it is common for the warrior to recount his exploits, boast of the cruelties he has committed upon his enemies, and to irritate and insult his tormenters in every way. Sometimes it happens that this has the effect of provoking one of the spectators to dispatch him with a club or tomahawk. Sometimes the male adult prisoners are given as slaves to women who have lost their husbands in the war, and by whom they are often married. The women taken are distributed among the warriors; the boys and girls are considered as slaves.

Subsistence.

Nearly all the Indian tribes raise maize, beans, and pumpkins, by the labour of their women, but only to a small extent, and as a resource against famine, their chief reliance being upon the chase. The buffaloes which wander over the prairies of the west, in herds of tens of thousands, are their great support; but deer, bears, and in time of need otters, beavers, foxes, squirrels, and even reptiles, are devoured.

Toltecan races—Mexico and Peru.

The Toltecan family embraced the civilised nations of Mexico, Peru, and Bogota, extending from the Rio Gila in 33° N. latitude along the western shore of the continent to the frontiers of Chili; and on the eastern coast, along the Gulf of Mexico, in North America. In South America, on the contrary, this family chiefly occupied a narrow strip of land between the Andes and the Pacific Ocean, bounded on the south by the great desert of Atacama. Farther north, however, in New Granada, were the Bogotese, a people whose civilisation, like their geographical position, was intermediate between that of the Peruvians and the Mexicans. But, even before the Spanish conquest, the Toltecan family were not the exclusive possessors of the regions which we have assigned to them; they were only the dominant race or caste, while other tribes of the American race always constituted a large mass of the population. The arrival of the Spaniards reduced both classes alike to vassalage; and three centuries of slavery and oppression have left few traces of Mexican and Peruvian civilisation, except what may be gleaned from their history and antiquities. These nations can no longer be identified in existing communities; and the mixed and motley races which now respectively bear the name, are as unlike their predecessors in moral and intellectual character, as the degraded Copts are unlike the ancient Egyptians. It is in the intellectual faculties that the great difference between the Toltecan and the American families consists. In the arts and sciences of the former we see the evidences of an advanced civilisation; their architectural remains everywhere surprise the traveller and confound the antiquary. Among these are pyramids, temples, grottoes, bas-reliefs, and arabesques; while their roads, aqueducts, and fortifications, and the traces of their mining operations, sufficiently attest their attainments in the practical arts of life.

Origin of American populations.

The origin of the populations of America is a problem which has yet to be solved. It is known that in Europe man was in existence at a very remote period; and there are facts which lend some support to the view that man has also been a denizen of America for ages. Thus there have been found portions of the human skeleton and fragments of human handiwork, associated with the bones of mammals which now have no existence, under circumstances which imply great antiquity. In most instances, however, it is not certain that such relics are of the age of the deposit in which they have been found. Human skeletons and bones in a fossilised state, or associated with bones of extinct mammals, have been found at Guadaloupe, in Missouri, near Natchez, at New Orleans, in the coral reef of Florida, near Charleston, in California, in Orchilla, at Petit Anse, and in Kansas. Some of these are referred to a very distant period. Thus the conglomerate in which the remains occur in the Florida reef is estimated by Agassiz to be 10,000 years old; but, what is still more amazing, the skeleton found by Dr Dowler beneath four buried forests in the delta near New Orleans, is said to be 50,000 years old, and the remains from California were found in a deposit beneath Table Mountain, which deposit was formed in an old river of the Post-Pliocene, or Pliocene period. At any rate, when this deposit was formed there was a river valley here, down which an overflow of volcanic matter was poured. Since that time denudation has been so great, and the volcanic matter so hard, that the sides of the valley have been swept away, leaving the valley bottom with its pro-

Antiquity of man in America.

tecting cover standing up far above the level of the neighbouring country. Articles made by man also occur under conditions indicating great antiquity. Thus along the coast of Ecuador there are volcanic deposits which belong to the period of volcanic activity preceding the present, which may probably be referred to the Post-Pliocene period. This matter is arranged in terraces, and in one of these terraces, now 24 miles from the coast and 150 feet above the sea, Mr Wilson has found beneath the vegetable mould, beds of clay with sand and gravel which contain fragments of pottery. These beds, it is believed, were deposited beneath the sea, implying an elevation of 150 feet since their formation. On the coast there is a pottery-containing stratum, which has been followed for 80 miles, and patches of a similar bed occur over a further distance of 200 miles. These facts, taken in conjunction with what we learn from the traditions and histories of numerous nations, as also the characters of the present natives, render it highly probable that man existed in America long before the origin or arrival of the civilised communities to which allusion will be presently made. The histories of these communities generally agree that civilisation was introduced by persons who first appeared as strangers amidst the people already in possession of the country. Hence the question has a twofold aspect, viz., the origin of the earliest uncivilised as well as that of the earliest civilised tribes. It is possible, as the traditions suggest, that people have arrived from various quarters and at various times. As yet we have little positive evidence to rely upon, and caution is required in drawing conclusions from resemblances in customs or religion. For instance, to take one remarkable case. Amongst tribes living high up the Amazon basin there are customs which correspond with those in Borneo. In both areas we find blow-pipes for discharging arrows; large houses inhabited by several families and similarly constructed; baskets and bamboo boxes of almost identical form and construction; and the smoke-dried heads of enemies hung up in the houses. In one tribe on the Amazon the throwing-stick is used, and not the blow-pipe, which is employed by all the surrounding tribes; the throwing-stick is also used by the Esquimaux, the Andaman Islanders, and the Australians. On the Amazon an arrow or spear is used for catching turtle, which has the barb loosely attached to the shaft, so that when the turtle disappears the shaft floats on the surface and indicates its movements and position. The Australians catch turtle in precisely the same way. Again, many other customs are common to the Americans and tribes living in areas far remote from them, with which they have no apparent direct relationship. If these analogies were always proofs of affinities, then we might infer, as has been done, that America was first peopled by emigrants from the opposite shores of Africa, W. Europe, E. Asia, and Polynesia.

Antiquities.

In the great valley of the Mississippi and its mighty tributaries, the Ohio and Missouri, are the remains of the works of an extinct race of men, who seem to have made advances in civilisation far beyond the races of *red men* discovered there by the first European adventurers. These remains consist chiefly of tumuli and ramparts of earth, enclosing areas of great extent and much regularity of form. Some of them recall the barrows of Europe and of Asia, or the huge mounds and ramparts of Mesopotamia, as displayed at Babylon and Nineveh; while others remind us of the ruined hippodromes and amphitheatres of the Greeks and Romans. In that part of North America the barrows are usually truncated cones; but in advancing farther south, they often assume the figure of four-sided pyramids in successive stages, with flattened tops, like the *Teocallis*, or temples of Mexico and Yucatan. They have been accurately described, and many of them delineated in the *Smithsonian Contributions to Knowledge*, from the researches of Messrs Squier and Davis.

The barrows and ramparts are constructed of mingled earth and stones; and from their solidity and extent, must have required the labour of a numerous population, with leisure and skill sufficient to undertake combined and vast operations. The barrows often contain human bones, and the smaller tumuli appear to have been tombs; but the larger, especially the quadrangular mounds, would seem to have served as temples to the early inhabitants. These barrows vary in size, from a few feet in circumference and elevation, to structures with a basal circumference of 1000 or 2000 feet, and an altitude of from 60 to 90 feet, resembling, in dimensions, the vast tumulus of Alyattes near Sardis. One in Mississippi is said to cover a base of six acres. The ramparts also vary in thickness, and in height from 6 to 30 feet, and usually enclose areas varying from 100 to 200 acres. Some contain 400; and one on the Missouri has an area of 600 acres. The enclosures generally are very exact circles or squares, sometimes a union of both; occasionally they form parallelograms, or follow the sinuosities of a hill; and in one district, that of Wisconsin, they assume the fanciful shape of men, quadrupeds, birds, or serpents, delineated with some ingenuity, on the surface of undulating plains or wide savannahs.

These ramparts are usually placed on elevations or hills, or on the banks of streams, so as to show that they were erected for defensive purposes, and their sites are judiciously chosen for this end. The area enclosed, therefore, bears no proportion to the relative labour bestowed on such ramparts: thus, in Ohio, an area of not more than 40 acres is enclosed by mounds of a mile and a half in circumference; and on the Little Miami, in the same state, is found an enclosure fully four miles round, that contains an area of about 100 acres. These remains are not solitary and few, for in the state of Ohio they amount to at least 10,000.

The enclosures in the form of animals are more rare than those now noticed, and seem nearly confined to Wisconsin. One of these represents a gigantic man with two heads, the size of which may be estimated, by the body being 50 feet long, and 25 feet across the breast. Another on a slope near Brush Creek, represents a tolerably designed snake, with an oval ball in its mouth; the undulating folds of its body and spiral of its tail extending to a length of 700 feet. The forms of quadrupeds and birds are also characteristically represented in these works. Those that have been explored rarely contain human bones; though the Indians deposit their dead within them occasionally, they have no tradition of their having belonged to their ancestors. The most probable supposition respecting them is that of Mr R. C. Taylor, that each was the sepulchral monument of a different tribe, who have all disappeared from America.

The question immediately suggests itself, to what people must we ascribe those vast works? They can scarcely be the works of the ancestors of the red men discovered by Europeans in North America. Neither can we ascribe them to the early Greenland and Iceland colonists, who seem never to have passed westward of the Alleghanies. We can scarcely attribute them to the somewhat apocryphal advent of the Welsh Madoc. Can their authors be the people obscurely mentioned in the Icelandic *sagas*, as the inhabitants of *New Iceland?*

A curious tradition of the present Iroquois records, that when the *Lenni Lenapi*, the common ancestors of the Iroquois and other tribes, whose language is still widely spread among the Indians, advanced from the north-west to the Mississippi, they found on its eastern side a great nation more civilised than themselves, who lived in fortified towns and cultivated the ground. This people at first granted the Lenni Lenapi leave to pass through their territories to seek

an eastward settlement, but treacherously attacked them while crossing the river. This conduct gave rise to inveterate hostilities, that terminated in the extermination or subjugation of their opponents, and the establishment of the red men in those regions. This not improbable, though imperfect, account of such rude communities, where neither letters nor hieroglyphics existed, is probably all that we shall ever learn of the people who executed those works that now excite our surprise.

Central American antiquities. As we advance southward we find proofs of still greater refinement on the table-land of Anahuac or Mexico; and on descending into the humid valleys of Central America, the peninsula of Yucatan, and the shores of Honduras, we find striking remains of the semi-civilisation of the races that inhabited those countries before the Spanish invasion. The barbarous policy of Cortez and other invaders was to eradicate every trace of the former grandeur of the native races, and thereby to inure them to a degrading servitude. The systematic destruction of the native works of art and gorgeous buildings in Mexico was relentlessly carried on for ages, to the infinite regret of the modern ethnographical inquirer. Little positive information on these subjects can be gleaned from the early Spanish historians of the conquest; and it was not until the publication of Humboldt's *Researches* that Europe knew anything of the state of the Great Mexican pyramid, or of the wonderful remains of Palenque and Papantla.

In the middle of the last century, however, some Spanish adventurers penetrated with difficulty the dense forests of the Mexican province of Chiapas, in which they discovered the remains of an ancient city, of which all memory had been lost, and to which they gave the name of PALENQUE, from a poor adjacent village. Stimulated by their report, the Spanish Government some years afterwards despatched two intelligent travellers to explore those wilds; but the report of Del Rio and Du Paix, from the commotions that agitated Europe and convulsed Spain, remained unpublished until a few years ago. It has since appeared, with very interesting designs of the ruins they explored. Our knowledge of such remains, however, has been greatly enlarged by the labours of an enterprising North American traveller, Mr Stephens, given to the world in four volumes, entitled *Incidents of Travel in Central America, Chiapas, and Yucatan*, 1838, and *Incidents of Travel in Yucatan*, 1842. This gentleman discovered, in the almost impenetrable forests of those regions, the remains of no less than 44 towns, some of them with extensive and highly decorated structures. These exhibit walls of hewn stone, admirably put together with mortar, often enriched by sculptures in bold relief, and hieroglyphical inscriptions, exactly resembling the Aztec MSS. in the museums of Europe, and in the publications of Humboldt; well executed *vaulted* roofs, and obelisks covered with mythic figures and pictorial or hieroglyphical inscriptions. These curious remains have been concealed for ages by a luxuriant tropical vegetation, so dense that they seem to have been unknown to people living within half a mile of their site.

The most conspicuous ruins are those of temples and palaces, which almost invariably have a pyramidal form, in several stages, with wide intervening terraces, the ascent to which is by grand flights of steps. The chambers in those buildings have generally a length disproportioned to their width, they have no windows, but receive their light from the doors, just as the rooms do at this day in Barbary and some other eastern countries. The apartments are in two parallel rows, a narrow corridor or series of chambers runs along the front, and the apartments behind this receive their light only from the front rooms into which they open. Yet these interior apartments are often richly decorated with sculptures, ornamented with stucco, and gaily painted red, yellow, white, and black.

The ruins of Palenque, as may be seen in the researches of Humboldt, have the characters just mentioned. They are covered with hieroglyphics, and sculptures in relief, with ornamental cornices. The largest building stands on a terrace, faced with stone, measuring 310 by 260 feet; the building itself is 200 by 180 feet; its walls are 25 feet high. The stone has been originally covered with painted stucco; fronts the east, and contains 14 doors, separated by piers ornamented with stucco figures. In this building some of the figures are erect, while others sit cross-legged, in what we term the oriental fashion; one statue, 10½ feet high, was found at Palenque; and two fragments of two *torsos* and a head were also discovered that exhibited a severe but fair style of sculpture, that recalls something of the early style of Greek art.

The ruins at Copan, in Honduras, are of vast extent. Here a pyramidal structure remains, with an elevation of 150 feet measured along its slope, and this appears to be a principal temple, included with several smaller structures within a *sacred enclosure*, in the manner of the temples of ancient Egypt. On its walls are many skulls of a quadrumanous animal, well executed in high relief; a large figure of a baboon was discovered among the ruins, bearing no inconsiderable resemblance to the cynocephalus of the Egyptians. Here also several sculptured obelisks occur, from 11 to 13 feet in height, and from 3 to 4 feet wide, which, as well as the walls of the temple, were highly ornamented with sculptures in bold relief.

The similarity between the ruins at Copan and Palenque, and the identity of the hieroglyphic tablets in both, show that the former inhabitants of Chiapas and Honduras had the same *written* language, though the present Indians of those provinces do not understand each other.

At several places, but more especially at Uxmal, in Yucatan, are very magnificent ruins of the same kind. Here are found sculptured obelisks, bearing on their principal face the figure, probably, of some deity, with a benignant countenance represented in full, and the hands applied to the breast. The other sides of the obelisks are covered with hieroglyphical tablets, proving that the same race once inhabited the plains of Honduras and the table-land of Anahuac. The principal building at Uxmal seems to have been a very magnificent pyramid in three stages or terraces, faced with hewn stone, and neatly rounded at the angles. The first terrace is 575 feet long, 15 feet broad, and 3 feet high, serving as a sort of plinth to the whole: the second terrace is 545 feet long, 250 feet wide, and 20 feet high; the third terrace is 360 feet long, by 30 feet wide, and 19 feet in height. From the centre of the second terrace, the upper part is gained by a vast flight of well constructed steps 130 feet wide. This leads to the temple, the façade of which is no less than 322 feet long, but has not had a greater elevation than 25 feet; yet its grandeur is enhanced by the rich sculpture that covers the upper part above a fillet, or cornice, that surrounds the whole building at about half its elevation. The interior consists of two parallel ranges of chambers, 11 in each row. The front apartments are entered by 11 doorways, enriched with sculpture, which gives sufficient light to those rooms; but the posterior row receives no light except what enters by their doors from the exterior rooms. The roofs here, unlike those of Palenque and Copan, are not stone arches, but are supported on bearers of a very hard wood, that must have been brought from a distance of some hundred miles, and these beams too are covered with hieroglyphics. The flat roof of this building has been externally covered with a hard cement. In a building placed on a lower level is a rectangular court, which has been once wholly paved with well-

carved figures of tortoises in demi-relief. These are arranged in groups of four, with their heads placed together; and from the dimensions of the court, this *sala de las Tortugas* must have required 43,660 of such carved stones for its pavement.

The ruins of Chichen, also in Yucatan, extend over an area of two miles in circumference. One of the best preserved buildings with an ambit of 638 feet, is constructed in three terraces, which gave it an apparent altitude of 65 feet. The buildings here, on the second terrace, have the façades highly sculptured, both above and below the horizontal fillet; and the doorways are enriched with mouldings, and *truss*-like ornaments supporting a drip-stone. The staircase here is 56 feet wide. The front apartments are 47 feet long and only 9 wide. There are three doors in the front, and in the central apartment are nine niches. The roofs are stone arches; and all has been once painted of various colours. A curious adjoining structure consists of two parallel stone walls, 274 feet long, and 30 feet apart. The walls are 30 feet thick. It has been conjectured to have been connected with the celebration of some public games, like the *palæstræ* of the Greeks.

In several of the ruins now noticed are found buildings to which there is no access. They have doorways, but these seem to have been walled up when the buildings were erected. Their use is unknown; they are named *casas cerradas*, or "shut up houses." Their interior does not differ from the other apartments above described.

It is worthy of notice, that the builders of those cities took great pains to supply them with one of the prime essentials of human comfort—abundance of good water, by means of wells and cisterns of excellent construction.

The remains in all the 44 ancient towns visited by Stephens have a similar character; so that we can have no hesitation to ascribe them to the same nation, or to kindred races of men, who had certainly attained no inconsiderable civilisation, although unacquainted with the use of iron, or even of bronze. Many of these towns are repeatedly referred to in the native histories, and it is almost certain that a large proportion of them were founded and inhabited by the Tutul-Xius, Nahoas, and other tribes speaking the Nahuatl tongue. In not a few instances the dates and the names of the founders have been preserved.

Native American civilisation.

It has been generally admitted by physiologists, that the temperate regions of the globe are best fitted to develope all the powers of our nature; and it is a fact in accordance with this opinion, that among the aborigines of America, civilisation followed very closely the chain of the Andes, and was found either upon their sides or the table-land of their summits, where the elevation of the ground moderates the heat of the tropical sun, and produces a climate analogous to that of Central and Southern Europe. This civilisation did not exist merely at the two distant and isolated points of Mexico and Peru, but presented itself at intermediate places, and may be said to have formed a continuous line from lat. 35° N. to lat. 35° S, with few interruptions, except at those parts where the mountainous chain disappears, or sinks down to a trifling elevation. Some large buildings near the Rio Gila, in lat. 33° N., with fragments of porcelain, indicate the existence of a people there who had some knowledge of the arts. These were most probably a branch of the Aztecs or Toltecs, who afterwards occupied Mexico, as the annals of that country tell. Though some pursued their march southward, it may be reasonably supposed that a part remained in the district; and the Indians living here, who cultivate corn, weave cloth, and live in villages consisting of houses built of solid materials, sometimes two stories in height, may either be their descendants, or have borrowed from them the improvements they possess. Next in order as we proceed southward, are the various nations of Mexico, of whose condition we shall speak by and by. In Chiapa were the Zapotecs, in Yucatan the Mayas, in Guatemala the Quiches and Kachiquels, all nearly as much advanced in civilisation as the Mexicans, and probably of the same primitive stock. From this point, where the Andes lose their elevation, or break into isolated cones, no distinct traces of civilisation appear till we enter the southern continent. Here were found the Muyscas or Moscas, on the table-land of Bogota, a nation consisting of several tribes, who worshipped the sun and practised some of the useful arts. To these succeeded the nations of Peru, living under the Incas, whose dominion extended from the equator to the 35th degree of S. latitude. Beyond this boundary were the Chilian tribes, who, though inferior to the Peruvians, had made some advances beyond the rudeness of the savage state. It is proper to mention that some of the nations named were extinct before the arrival of the Spaniards; but the degree of civilisation they had attained is attested by the monuments they have left behind them. There were no other tribes in the new continent which had made any progress in social improvement. We would not except the Guaranis of Brazil, and a few others, who derived their subsistence chiefly from agriculture, but were in other respects savages. We place among the exceptions, however, the extinct race of the Allegewis, or whatever was the name of the people, who erected the military works existing between the Ohio and the northern lakes; but they also, it must be remembered, inhabited a temperate climate, though not a mountainous country. It may be affirmed, then, as a general proposition, that from 35° of N. to 35° of S. latitude, the sides and summits of the Andes were the exclusive seats of American civilisation. We admit that some of the tribes in Chiapa, Oaxaca, and Yucatan, inhabited low districts; but they were still near the Cordillera, and may be fairly considered as offsets from the nations dwelling upon it. The fact is important, as marking the effect of climate on the active energies of our species. There is no doubt that, with the improved arts of modern times, civilisation can subsist under the burning sky of the torrid zone, but not in such vigour as in countries which enjoy a more moderate temperature. Perhaps it will be found that the moral and physical powers of man attain their highest perfection in those regions where he is accompanied by *wheat* and the *vine*. The zone occupied by the former extends from the 30th to the 57th or 58th parallel; and within the tropics the corresponding climate is found on the flanks or summits of mountains, from 4500 to 10,000 feet above the level of the sea.

Mexico.

It is remarkable that the Mexican annals reach to a very remote date, although they were preserved merely by picture-writing. We do not pretend to enter into the question as to the authenticity of the records themselves, and their correctness. It is enough that they have received credit from Humboldt, Vater, and other men of learning and judgment. From the annals thus preserved, of which further details will be subsequently given, we learn that at the earliest dawn of history the Quinames were in possession of the country, that civilisation was introduced by strangers coming from the east, and that several nations belonging to one race migrated in succession from the north-west, and settled in *Anahuac* or Mexico. The Toltecs, it is stated, left their original seat, far to the west, in 544 of our era, and after a long journey invaded Mexico, then occupied by wandering hordes, in 648. This people, who penetrated to Nicaragua, if not to South America, were nearly destroyed after the lapse of some centuries; but were followed by the Chichimecs, a half savage tribe, about 1120, and these a few years afterwards by the Anahautlels,

or seven tribes, including the Acolhuans, the Tlascaltecs, and the Aztecs or proper Mexicans. All these people spoke dialects of one language, and had similar arts, customs, and institutions. The town of Mexico or Tenochtitlan was founded in 1325, and the series of Mexican kings which commenced in 1352 was continued through eight monarchs to Montezuma. The monarchy was small at first, and passed through many vicissitudes; but it was gradually enlarged, especially by the policy and enterprise of the later princes of the line. When Cortes arrived, it embraced what are now the provinces of Vera Cruz, Oaxaca, Puebla, Mexico, and part of Valladolid, a surface of 130,000 square miles; but within this were comprehended three small independent states, Tlascala, Cholullan, and Zapeaca. The pastoral state, which forms the intermediate stage between savage and civilised life, had never existed in Mexico; for the native wild ox had not been tamed, and the use of milk as food was unknown. The Mexican nations derived their subsistence from agriculture, which, however, was conducted in the rudest manner, with very imperfect instruments. They cultivated maize, potatoes, plantains, and various other esculent vegetables. They raised cotton, and understood the art of spinning and weaving it into cloth, of a texture which excited the admiration of the Spaniards. They had no iron, but showed considerable skill in fashioning the gold, silver, and copper, found in a native state, into domestic utensils and ornamental articles. In some of their buildings the stones were hewn into regular forms, and accurately joined; and from the ruins of the palace of Mitla, in Oaxaca, still existing, it appears that they had the art of designing ornaments like arabesques, in paste, with great neatness, and attaching them to the walls; but solid structures of masonry evincing any considerable skill are extremely rare in the country. Their carvings in wood were tolerably well executed, but the figures were disproportioned and uncouth. The same remark applies to their hieroglyphical drawings, which were far inferior in taste and design to those of the Hindoos, Japanese, and Thibetians. For paper they employed sometimes the large leaves of the aloe, sometimes cotton cloth, or the skins of deer dressed. Their books consisted of strips or webs of such materials, composed of pieces neatly joined, one or two feet broad and twenty or thirty long, which were divided into pages by folding them in a zig-zag manner; and two pieces of thin deal attached to the outermost folds served as boards, and gave these manuscripts, when closed, an appearance very much like our old folios in wooden binding. The written language of Mexico contained a few real hieroglyphics or symbols, purely conventional, to designate such objects as water, earth, air, day, night, speech, and also for numbers; but it was essentially a system of *picture-writing* in which objects were represented by coloured figures having a resemblance more or less exact to themselves. With all its necessary imperfections, this instrument was familiarly employed to a prodigious extent in deeds and instruments for effecting the transmission and sale of property. The government kept couriers for conveying intelligence from all parts of the empire; and the capital was watched and cleaned by a sort of police establishment. This is the bright side of Mexican civilisation. On the other hand, it must be kept in view, that the Mexicans had no tame animals, no made roads, no money to serve as a universal medium of exchange in commercial transactions. The government was originally a perfect feudal monarchy, in which all power was monopolised by a numerous nobility and the priesthood. The great mass of the people were serfs, attached to the soil, and transferred with it from owner to owner by descent or purchase. The peasants or slaves of a nobleman were allowed a certain portion of land, which they cultivated in common for their subsistence: the rest of their labour belonged to their lord. The country swarmed with beggars, and thousands were swept off every few years by famine. As among the ancient Egyptians and the Chinese, immutable custom, regulating every act of civil and common life, chained up the course of improvement, and spread a languid monotony over society. The crown was elective, and the powers of the monarch small, till the privileges of the nobles were destroyed by the policy and ambition of Montezuma. The religion of the Mexicans breathed a savage spirit, which degraded them, in a moral point of view, far below the hordes of wandering Indians. Their deities, represented by mis-shapen images of serpents and other hideous animals, were the creation of the darkest passions of the human breast, of terror, hatred, cruelty, and revenge. They delighted in blood, and thousands of human sacrifices were annually offered at their shrines. The places of worship, called Teocallis, were pyramids composed of terraces placed one above another, like the temple of Belus at Babylon. These were built of clay, or of alternate layers of clay and unburnt bricks, but in some cases faced with slabs of polished stone, on which figures of animals are sculptured in relief.[1] One or two small chapels stood upon the summit, enclosing images of the deity. The largest known, which is composed of four stories or terraces, has a breadth of 480 yards at the base, and a height of 55. These structures served as temples, tombs, and observatories; and it is remarkable that their sides are always placed exactly in the direction of the meridian. This leads us to the most interesting fact connected with Mexican civilisation, we mean the perfection of their calendar. The civil year was composed of 365 days, divided into 18 months of 20 days, and 5 supplementary days. The Mexicans had besides a ritual or religious year for the regulation of their festivals; and, by means of a cycle of 52 years, and a very complicated method of computation, the religious and civil periods were connected with one another, and the civil year was made to correspond with the natural by the intercalation of 13 days at the end of the cycle. The month was divided into four weeks of five days, but each day of the month had a distinct name; and Humboldt has given strong reasons for believing that these names were borrowed from an ancient zodiac formed of 27 or 28 lunar houses, which was made use of from the remotest antiquity in Tartary, Thibet, and India. The calendar of the Mexicans bespeaks a degree of scientific skill, and an accuracy of observation, which are not easily reconciled with their semi-barbarous habits, their general ignorance in other things, and the recent date of their civilisation according to their own account. It is here, indeed, and not in their language, that we find distinct traces of their connection with Asiatic nations. The character of the Mexicans is probably the same at this day as before the conquest, which, we are disposed to think, made less change in the situation of the people than is often supposed, though it annihilated the rank and privileges of the nobles. The Mexican Indian is grave, suspicious, and taciturn; quiet and placid in his external deportment, but rancorous in his spirit; submissive to his superiors, harsh and cruel to those beneath him. His intellect is limited, and chiefly developes itself in imitative labours and mechanical arts. Slow, cautious, and persevering, he loves, both in his acts and thoughts, to travel in a beaten track. The people, though speaking many different languages, have nearly the same physical character. The Mexicans have olive complexions, narrow foreheads, black

The arts in Mexico.

Calendar

[1] Robertson was mistaken in believing that the Teocallis were in all cases mere masses of earth, without masonry. See Humboldt's *Researches*, vol. i. p. 111, English translation.

eyes, coarse glossy black hair, and thin beards. They are of the middle size, and well-proportioned in their limbs. A person with any defect or deformity is rarely seen amongst them. They are healthy, and live to an advanced age, when life is not shortened by drunkenness. The Toltec and Aztec races, when they established themselves in the country, diffused their own language partially from the Lake of Nicaragua to the 37th parallel. They reclaimed, by degrees, many of the neighbouring savage tribes to a settled mode of life, and spread a feeble degree of civilisation over a mixed mass of nations, speaking, according to Clavigero, 35 languages, of which Humboldt tells us that 20 still exist. The Aztec language is one of the most copious and polished of the American tongues, and abounds in words of the immoderate length of 12 or 15 syllables. It is uncertain what was the number of subjects over whom Montezuma ruled. The ruins in the valley of Tenochtitlan, on which the capital stands, show that it must have been more populous before the conquest than now; but the population at present is diffused over an incomparably wider space; and, upon the whole, there are no good grounds for believing that the number of civilised Indians was much greater when Cortes landed, than in 1803, when it amounted to 2,000,000.

The civilisation of Mexico, as well as of Peru, owed its existence to a single cause,—the patient, submissive, and superstitious character of the people, which fitted them to be beasts of burden, under an aristocracy of priests and nobles, who were led, perhaps, partly by influences from abroad, partly by the instinct of self-interest, to devise means for holding the mass of the community in subjection. Many of the nations which continued savage, such as the Algonquins and Iroquois, were probably equal to the Mexicans in intellect; but their propensity to superstition was less, and their energy of character was too great to permit of their being enslaved by their chiefs. It is chiefly in the variety of their primitive character that we must seek for the cause of the diversity of manners and institutions we find among the American nations.

Peru.

The ancient empire of Peru, more extensive than that of Mexico, embraced the whole sea-coast from Pastos to the river Maule, a line of 2500 miles in length. Its breadth is uncertain; but as it included both declivities of the Andes, it must have extended in some cases to 500 miles, and the entire surface of the empire probably exceeded 500,000 square miles. It is plain, however, from the imperfect history of the Incas which has been preserved, that within this space there were many districts where their authority was feeble, and others inhabited by tribes which were entirely independent. One part of the country, besides, consisted of a sandy desert, while the most elevated tracts were uninhabitable from cold. It must not therefore be supposed that the capacity of the country to support population was commensurate with the extent of its surface. Still the magnitude of the Peruvian empire, in the midst of an immense multitude of independent savage communities, so extremely minute, that a hundred of them might have been planted without crowding in one of its provinces, is an extraordinary phenomenon. The creating and maintaining of such an empire is a proof that the Peruvians had made no trifling progress in the useful arts and in the science of government. To keep in subjection so many remote provinces, there must have been an efficient military force, rapid means of communication, considerable revenues, and an organised magistracy capable of understanding and executing the plans of rulers, who had sufficient political skill and knowledge of human nature to adapt their institutions and arrangements to the wants, habits and character of a great variety of dissimilar nations, spread over a territory reaching as far as from Lisbon to the banks of the Volga. It is clear that the ruling tribe, which was able to extend its dominion, and to a considerable extent its language, over a space of 2500 miles, must have possessed a marked superiority of some kind over the hordes that surrounded it. We must remember, besides, that the Peruvians lay under the disadvantage of being destitute of even such an imperfect instrument of communication as the hieroglyphic language of the Mexicans, and that they were extremely deficient in military spirit. Indeed, it is one of the most singular facts connected with the history of America, that by far the largest empire it contained was formed by the most unwarlike people in it. The dominion of the Incas was founded entirely on policy, superstition, and the arts. It could only be by the intelligence and skill which civilisation developes, that the Peruvians conquered tribes superior to themselves in courage; and it was by policy and superstition that the Incas tamed the rudeness of savage tribes, and held distant countries in subjection. Robertson justly observes, that the Peruvians "had advanced far beyond the Mexicans, both in the necessary arts of life, and in such as had some title to the name of elegant." In two points only were they inferior; in their calendar or mode of computing time, and in their want of such a substitute for writing as the Aztecs possessed in their hieroglyphics.

Arts in Peru.

Agriculture was conducted with greater care and success in Peru than in Mexico. The lands capable of cultivation were divided into three shares. One was consecrated to the service of religion, the erection of temples, and the maintenance of priests; the second was set apart as a provision for the support of the government; and the third and largest share, which was reserved for the people, was parcelled out, not among individuals, but among the hamlets and villages, according to the number and rank of the inhabitants; and a new division was made every year to meet any change that might arise in the circumstances of the parties. The members of each little community went to the fields under overseers, and cultivated the land by their joint labour. The produce was distributed among the families and individuals according to their wants, while the evils of famine were provided against by storing up the corn in granaries. The Peruvians having no draught animals, and no ploughs, turned up the earth with wooden mattocks; but their skill and care were exemplified in irrigation, which they practised extensively, and in their employing as manure guano, or the dung of sea birds, which abounds on the islands near the coast. Their masonry was superior to that of the Mexicans. Like the ancient Egyptians, they understood mechanics sufficiently to move stones of vast size, even of 30 feet in length, of which specimens are still existing in the walls of the fortress of Cuzco. They had the art of squaring and cutting blocks for building with great accuracy; and they did not effect their purpose, as Robertson supposes, merely by chipping the stones, or rubbing them together so as to fit the surface of the one to that of the other, without regard to symmetry of form. It is now known that they had hard chisels, made of copper, with a mixture of 6 per cent. of tin,—a proof of considerable skill in the working of metals. With these they hewed the stones into parallelopipeds, which were disposed in "courses as regular," says Humboldt, "as those of Roman workmanship." They are joined with such nicety, that the line which divides the blocks can scarcely be perceived; and the outer surface is in some cases covered with carving. The palaces or lodges of the Incas, of which there are many remains, had doors with slanting sides like the

Buildings.

Egyptian; sloping roofs, which, it is supposed, were covered with rushes or stone slabs; no windows, but niches symmetrically distributed.[1] Ancient stone structures, which are so rare in Mexico, are pretty abundant in Peru,—a fact for which we can only account by the difficulty with which the Mexicans erected buildings, in consequence of their inferiority in the art of masonry. The architecture of the Peruvians, like everything else connected with their social state, displays a remarkable uniformity, not only of style, but of plan. "It is impossible," says Humboldt, "to examine a single edifice of the time of the Incas, without recognising the same type in all the others which cover the ridge of the Andes, along an extent of 450 leagues."

Roads. The ancient public roads of Peru are justly considered as striking monuments of the political genius of the government. One of these extended along the sides of the Andes from Quito to Cuzco, a distance of 1500 miles. It is about forty feet broad, and paved with the earth and stones which were turned up from the soil; but in some marshy places it is formed, like the old Roman roads, of a compact body of solid masonry. A tolerably level line is preserved, by filling up hollows, cutting down small eminences, and winding round the sides of large ones. At proper distances tambos or storehouses were erected, for the accommodation of the Inca and his messengers. A similar road was made along the coast in the low country. Fissures a few yards in breadth were passed by bridges formed of beams laid horizontally; and an invention, at once bold and ingenious, afforded the means of crossing deep ravines, or the channels of rivers, which happened to intersect the route. This consisted of a suspension bridge, perfectly analogous in its principle to those with which we are familiar. It was formed of half a dozen of cables of twisted osiers, passed over wooden supports, and stretched from bank to bank; then bound together with smaller ropes, and covered with bamboos. Humboldt passed over one of these pendulous bridges, of 120 feet span; and Mr Miers crossed one of 225 feet span, over which loaded animals might travel. In low grounds the rivers were crossed on rafts with a mast and sail, which, by a particular contrivance, could be made to tack and veer. In this respect the Peruvians were a stage in advance of all the other American races, who had nothing superior to the canoe with paddles. The Peruvians manufactured a rude species of pottery: they understood the art of spinning, and, in an imperfect degree, that of weaving. They procured native gold by washing the gravel of rivers; and silver, and perhaps copper, by working veins downward from the outcrop. They knew how to smelt and refine the silver ore; and they possessed the secret of giving great hardness and durability to copper by mixing it with tin. Their utensils and trinkets of gold and silver are said to have been fashioned with neatness and even taste. On the other hand, they had no money, no knowledge of iron or glass; and they were ignorant of the mode of mortising or joining beams, and of casting arches. They had no animals fitted for draught; but the llama, a small species of camel, which they had tamed, was employed to some extent as a beast of burden.

Manufactures.

Laws and customs. The political organisation of Peru, which was artificial in a high degree, reminds one, in some of its features, of the old system of the Saxons in England, but bears a more general resemblance to that of the ancient Egyptians. The mass of the people were in a state of servitude, except a small number, who were free; above these in rank were the Curacas, or chiefs of districts, who formed a sort of nobility; and above the whole, the family of the Incas, the members of which, by intermarrying only with themselves, formed a numerous and distinct caste. For the purposes of police and civil jurisdiction, the people were divided into parties of ten families, like the tithings of Alfred, over each of which was an officer. A second class of officers had control over five or ten tithings, a third class over fifty or a hundred. These last rendered account to the Incas, who exercised a vigilant superintendence over the whole, and employed inspectors to visit the provinces as a check upon maladministration. Each of these officers, down to the lowest, judged, without appeal, in all differences that arose within his division, and enforced the laws of the empire, among which were some for punishing idleness, and compelling every one to labour. It is probable that the tithings and hundreds, as in England, would lose their numerical signification in course of time, and become mere local allotments. In the hamlets and villages a person mounted a tower every evening, and announced where and how the inhabitants were to be employed next day. The taxes were paid in the produce of the fields, and magazines for receiving them were established in every district. Such is the account given by Acosta and Garcilasso of the civil institutions of Peru, which may be correct with regard to the oldest possessions of the Incas near Cuzco, where their power had been long established; but it is not probable that such a complicated system was ever fully in operation in the more distant parts of the empire.

Government and Religion. The government of Peru was a theocracy. The Inca was at once the temporal sovereign and the supreme pontiff. He was regarded as the descendant and representative of the great deity the sun, who was supposed to inspire his counsels, and speak through his orders and decrees. Hence even slight offences were punished with death, because they were regarded as insults offered to the divinity. The race of the Incas was held sacred. To support its pretensions, it was very desirable that it should be kept pure and distinct from the people; but human passions are often too strong for the dictates of policy; and though the marriages of the family were confined to their own race, the emperor, as well as the other males of the blood royal, kept large harems stocked with beauties drawn from all parts of the empire, and multiplied a spurious progeny, in whom the blood of the "children of the sun" was blended with that of the "children of the earth." Among a simple-minded and credulous people the claims of the Incas to a celestial origin seem to have been implicitly believed. They were blindly obeyed, and treated with a respect bordering on adoration, by the nobles as well as the common people. The Peruvians worshipped the sun, the moon, the evening star, the spirit of thunder, and the rainbow, and had erected temples in Cuzco to all these deities. That of the sun, which was the most magnificent, had its walls covered with plates of gold. The sacrifices consisted of the objects most prized by the people, of grain and fruits, of a few animals, and of the productions of their own industry. Sabianism, as it is the most rational of all the forms of idolatry, is also generally the most mild; and doubtless this results from the tendency which it has to fix the thoughts on the marks of beneficence and wisdom which are displayed in the works of nature. The Peruvian temples were accordingly never polluted, like those of Mexico, with the blood of human victims; and the Incas even went farther, and signalised their zeal against such horrid rites, by suppressing them in all the countries they conquered. Though their history exhibits some bloody deeds, the general character of their government

[1] See Humboldt's account of the ancient buildings of Callo and Cunnar, vols. i. and ii. of his *Researches*.

was the reverse of cruel. The severe punishments prescribed by their laws were rarely inflicted, and rebellion was scarcely known in their dominions. The Inca not only assumed the title of the father of his people, but the vices as well as the merits of his government sprung partly from the attempt made to construct the government on the model of paternal authority, and partly from the blending of moral and religious injunctions with civil duties. Hence the idle pretension of the state to reward virtuous conduct, as well as to punish crimes; hence too the plan of labouring in common, the extinction of individual property, the absurdities of eating, drinking, sleeping, tilling, building, according to fixed universal rules; in fine, that minute and vexatious regulation of all the acts of ordinary life, which converted the people into mere machines in the hands of an immense corps of civil and religious officers. Such a system may have served to reclaim some tribes from the savage state; but it must have stifled the seeds of improvement, and left the mass of the people more stupid and imbecile than it found them. The government was as pure a despotism, probably, as ever existed; but its theocratic character, no doubt, helped to mitigate the ferocity of its spirit. Superstition and force are the two bases on which tyranny rests in all countries; and in proportion as it is firmly seated on the one, it stands less in need of the support of the other. The Inca had so completely enslaved the minds of his subjects, and the apparatus he wielded for directing and controlling their acts was so perfect, that he was able in a great measure to dispense with those terrific examples of cruelty and bloodshed, by which the pure military despot operates on the fears of those who live under his authority.

Origin of Peruvian laws.

This system of the Peruvian monarchs, by which the people were kept in a state of perpetual tutelage, merits the greater attention, because it is precisely that which the Jesuits employed, in Paraguay and other districts, to reduce the natives to a settled mode of life; and it seems, in fact, to be the only method by which a semblance of civilisation can be introduced amongst the American nations. Two things must be supposed to account for its prevalence: first, a certain amount of timidity, passiveness, and superstition, in the body of the people, implying weak passions, but not necessarily smallness of intellect; and, secondly, a few minds of a higher class, to give an impulse to the rest, and to control and regulate their acts. In the case of Peru, did these ruling intellects spring from the body of the people, and, after striking out new lights in morals and legislation for themselves, devise a complex and artificial system for establishing their power over the minds of the rest, by the help of superstition and force? or were they strangers from another country, and imbued with the principles of a higher civilisation? If we may believe the Peruvian annals, the latter was the case. About the year 1000 of our era, or perhaps a century later, Manco Capac, with his wife and sister Mama Ocello, appeared as strangers on the banks of the lake Titicaca. They were persons of majestic appearance, and announced themselves as "children of the sun," sent by their beneficent parent to reclaim the tribes living there from the miseries of savage life. Their injunctions, addressed to a people who probably worshipped the god of day, were listened to by a few, who settled around them, and founded Cuzco. By degrees, other tribes were induced to renounce their wandering habits. Manco Capac instructed the men in agriculture and the arts, and Mama Ocello taught the women to spin and to weave. Laws, institutions, and religious rites, were added. The form of a civilised society arose, which was gradually extended by persuasion or conquest,—the Incas having always planted their arts and religion wherever they established their authority. Huayna Capac, the twelfth in succession from the founder of the dynasty, occupied the throne when the first party of Spaniards visited Peru in 1527, and the empire was then still in a state of progress. There is, however, little doubt that some advance in civilisation had been made in times before the Incas.

Foreign legislators and teachers.

Such is the account which the Peruvians give of the origin of their civilisation, which we should be disposed to reject as a fable, if there were not peculiar circumstances which give it some credibility. First, their institutions, taken in the mass, do not present what may be called the American type. The mild and paternal character which they display, the injunction to "love one another" raised to the rank of a positive precept, the preference of the useful arts to war, all breathe a spirit, not only foreign to the genius of the American tribes, but exactly opposed in character to anything which a native self-taught legislator was likely to produce. Secondly, the artificial and systematic form of the Peruvian institutions renders it improbable that they were developed by the natural action of political causes, but strongly favours the idea, that they were framed by a few designing heads, as an instrument to tame and govern a patient, feeble, and credulous people of rude or savage habits. A small number of Jesuits were led, by a sagacious study of the savage character, to devise a system extremely similar in its nature, which worked admirably. These missionaries were the Manco Capacs of Paraguay; and, like the Incas, might, in the course of two or three centuries, have extended their theocracy over as large a space as Peru, if their situation had permitted them to employ force. Thirdly, a million of native Peruvians yet survive, the living descendants of those who built the temples of Cuzco; and their extreme stolidity, apathy, and feebleness of character, sufficiently testify that the chances were nearly as great against a legislator like Manco Capac arising amongst them, as against the Jews in the time of Augustus producing a being like Jesus Christ. They have the weakness and passiveness which fit them to receive an impression from superior directing minds; but they discover no trace of the intelligence, energy, and originality which must have been united in the persons who planned and carried into effect the political system of the Incas. We admit that oppression may have degraded their character, but it cannot have entirely changed it.

If, then, the civilisation of Peru was exotic, whence was it derived? To us it appears most probable, that the legislators of Peru were either Chinese, or persons who had received at second-hand a knowledge of the arts and institutions of China; and our opinion is grounded on traits of resemblance in the manners, laws, arts, and institutions of the two nations, which, in our opinion, are too numerous, striking, and peculiar, to be the effect of chance. We shall mention some of the most prominent.

Peruvians and Chinese compared.

1. The first and most obvious resemblance is in the singularly artificial frame of society in both countries. In China, as in Peru, the legislation is *directive* as well as punitive, and is distinguished by that minute and elaborate system of regulation, inspection, and control, which interferes with the most trifling actions of ordinary life, and reduces the mass of the people to the condition of automata, moved and guided in everything by the rulers. China, says Mr Barrow, is a great school, in which the magistrates are the masters, and the people the scholars. It might be more correctly compared to a large monastic establishment, in which each person has his place and his duty assigned to him, and all his acts directed by superiors, whose wisdom and authority he is not permitted to question. The Chinese have the same immense multitud

of civil officers which the Peruvians had, and the same chain of subordination from the emperor down to the petty constable. In China this system was undoubtedly the growth of many centuries; but it was too artificial to occur to the thoughts of a cacique, educated amongst a tribe of savages on the sides of the Andes. 2. In China as in Peru, the emperor assumes the title of the "father of his people;" and his government is modelled upon this figure of speech. He affects to be sprung from progenitors who *descended from heaven* like the children of the sun, and he unites the character of supreme pontiff with that of temporal prince. There are vestiges, too, of the worship of the heavenly bodies in China.[1] 3. The Chinese emperor extends an ostentatious patronage to agriculture, by celebrating an annual festival in its honour, on which occasion he proceeds to the field in great pomp, and takes a part in the labour of cultivating the ground with his own hands. This singular custom existed in Peru, where the Incas went through an annual ceremony perfectly similar. How foreign was such an institution to the spirit of the American tribes! 4. In China agriculture is in a rude state, and exhibits proofs of intelligence and skill only in two things—the use of manures, and a laborious system of irrigation. Precisely the same circumstances characterised the agriculture of Peru. 5. The internal taxes of China, like those of Peru, are paid in kind (maize, rice, silk, cotton, &c.), and stored in public magazines or granaries. 6. The Chinese government maintained public roads, even in those provinces where neither carriages nor beasts of burden were used, of course for the use of pedestrians, and storehouses or places of refreshment were built upon them at proper distances. The Peruvians constructed roads on precisely the same plan, and for the same purposes; and this was done by no other people in America. 7. The Chinese do not inter the bodies of the dead, but lay them on the ground and raise a tumulus or conical heap of earth over them. Such was also the practice in Peru. The only barbarously cruel rite practised in Peru, that of immolating the Inca's domestics at the obsequies of their master, was brought into China by the Tartars. Its existence is an anomaly in each case, for the genius of both nations was peaceful and mild. 8. The architecture of the Chinese displays little taste, but is distinguished by two peculiarities—the power shown of cutting and moving immense masses of stone, and the uniformity of style which pervades their structures, of every size and description. "All the buildings," says Mr Barrow, "from the meanest hut to the viceroy's palace, are upon one plan." Humboldt remarks the same adherence to a single model among the Peruvians, and the walls of Cuzco show that they were acquainted with the method of moving stones of prodigious size. The Chinese were fond of covering their walls with carving, and examples of the same practice occur in Peru. If any of the Peruvian buildings had remained entire with their roofs on, it would perhaps have been found, that the type or primary architectural form employed in the two countries was not very dissimilar, and some allowance should be made for the circumstance, that Peru must have borrowed her models from China 700 or perhaps 1000 years ago. 9. The Peruvians made coarse pottery, and all the world knows that this is an art in which the Chinese excel. The Peruvians were the only American nation who had made any progress in the art of fusing and alloying metals, in which the Chinese have long been distinguished by their skill. 10. The Peruvians had dramas and dramatic spectacles. Whence could a people so uninventive have derived the idea of such entertainments, if not from China, where they have been long familiar to the people? There were mimics and buffoons in Mexico, but nothing, we believe, to which the term drama could be applied. 11. But perhaps the most remarkable coincidence is found in an invention entirely confined to the two countries. We have described the suspension bridges made of ropes, employed by the Peruvians in crossing deep ravines. Now, it is singular that bridges of the very same description, some of chains, and *some of ropes*, are found in the south of China, and nowhere else except in Thibet, which has interchanged arts and customs with China from time immemorial. This single fact we would consider as a proof of communication between the two countries. The Peruvians made their ropes of twisted osiers, and the Chinese had ropes also of this description. 12. From what people nearer than the Chinese could the Peruvians borrow the idea of rafts with a mast and sail? These rafts, supporting covered huts, may be considered as literal copies of some that are used in China; and the peculiar mechanism employed in lieu of a rudder is no doubt borrowed from the paddles attached to the Chinese boats, fore and aft. 13. The Chinese in ancient times made use of quipus or knotted cords to facilitate calculation. Is it not probable that this invention had passed from them to the Peruvians, the Mexicans, the Kaluschi, and other American nations who employed it? It would be easy to trace similar analogies in many other customs, laws, and institutions of the two nations. Both had nunneries or religious societies of women, who lived under a vow of celibacy; both had a class of literary men (the Haravecs and Amautas, or poets and philosophers, in Peru), patronised by the government; both divided the year into twelve months, and placed the beginning of it in January (a coincidence the more remarkable, as the year of the Mexicans and other northern nations consisted of 18 months); both were strangers to the use of milk, cheese, and butter.[2] These facts may suffice, for we have not room for lengthened inquiries, neither are we anxious to press our argument beyond its proper limits. Our position is, not that the Peruvians are descended from the Chinese, but simply that Peru had been inoculated with civilisation by persons who derived their ideas from China. If it be asked why these persons did not import from China the use of letters, the method of casting arches, and many other arts practised there, our answer is, that no individual, and still less any casual assemblage of individuals such as the purposes of trade or navigation might bring together, possesses a knowledge of every art and science which exists in his country. How many men are there in England at this day, who could not even carry the knowledge of the alphabet to another country? We must remember, too, that all the arts existing in China do not exist in every province of it, and have not always existed in those provinces where we now find them.[3] As to the means of communication, it is evident that the trade-wind renders Peru almost unapproachable from Eastern Asia, between the parallels of 30° N. and 30° S. latitude.

[1] See accounts of the temples at Pekin dedicated to the heavens, the north star, the moon, the earth, &c., and of the festival kept at the summer solstice, like the grand solar festival in Peru.

[2] Sir John Barrow is our authority for this fact, which is the more remarkable, as the Mongols, the neighbours and conquerors of the Chinese, had the use of all the three articles immemorially.

[3] The uniformity and unchangeableness of customs in China have evidently been much exaggerated. The empire is formed of an assemblage of small states, conquered one after another, each of which must have had its peculiar laws, manners, and superstitions; and common sense tells us, that to blend these into one perfectly homogeneous mass, must have required a much longer period than has elapsed since the empire attained its present magnitude. It would be easy, too, to find instances of the Chinese having changed their customs, both in matters of business and matters of domestic economy.

But beyond these limits the west winds prevail, and hence China, in point of facility of access, is nearer to Peru than the Society or Marquesas Islands. The Chinese have long exposed themselves to the casualties of a maritime life, in vessels of large size, provisioned for many months; and at this day they perform voyages of 3000 or 4000 miles, to Ceylon and Polynesia.

Peruvian language. The Quichua language, or that of Peru, was spread, by the care of the Incas, over all the countries which they conquered, so far at least as to be understood, if not spoken, by the great variety of tribes subject to their sway. It is understood at present as far as Santiago del Estero, 1200 miles of direct distance south-east from Cuzco. This single fact proves both the long duration of their power, and the efficiency of their internal administration. It is said to be the most rich, polished, and harmonious of the South American languages, abounding in vowel sounds, but wanting those corresponding to the Spanish consonants *b, d, f, g, l, x, v*. Like all the other American tongues, it wants terms for abstract and universal ideas, such as *time, space, being, substance, matter, body*, and even such as *virtue, justice, liberty, gratitude*. There are five dialects of the Quichua, which are spoken in Peru proper, and in Quito, New Granada, and a considerable part of La Plata, and not only by the aborigines, but by many Spaniards of the higher classes. The Peruvians had no alphabetic writing. They possessed a very rude species of hieroglyphics, of which little use was made, and the quipus or knotted cords of various colours, which last were originally employed simply as aids to calculation, but latterly as records of facts, laws, &c. Each quipu required a verbal commentary. About ten years ago a copy of an old MS. was discovered, which contained an account of the Maya alphabet of Yucatan —the only alphabet yet known to have existed in America.

The people. The Peruvians of the aboriginal Quichua race are of a copper colour, with a small forehead, the hair growing on each side from the extremities of the eye-brows; they have small black eyes, a small nose, a moderately sized mouth, with beautiful teeth; beardless chin (except in old age), and a round face. Their hair is black, coarse, and sleek, the body well proportioned, the feet small, the stature rather diminutive. Their intellectual qualities, according to M. Ulloa, are of the lowest order. The most prominent trait in their character is an imperturbable and incurable apathy. Though half-naked, they are as contented as the Spaniard in his most splendid raiment.

Manners. Gold and silver have so little influence over them, that the greatest recompense will not induce them to perform the slightest service voluntarily. Neither power nor dignity moves them, and they receive with the same indifference the office of alcalde and that of executioner. They are habitually slow in their motions, and extremely indolent. When employed at any piece of labour, if the master withdraws his eye for a moment, they cease to work. They are timid, shy, secretive, and always grave, even in the dances, which are their favourite pastime. The love of intoxicating liquors is deeply rooted in their nature. They prepare a fermented beverage called chicha from maize, by a process known to them before the conquest, and at their festivals drink till their senses fail them, day after day. This vicious habit, however, is common to all the American nations, and is confined to the men, for the women are in general strictly sober. The Peruvians are a gentle and mild people; they are fond of their dogs, and breed up hogs, geese, and chickens, for which they have so tender a regard, that they will often neither kill nor sell them. Their huts, says Mr Stevenson, consist of stones laid upon one another without any cement or mortar, thatched over with long grass or straw, affording no defence from either the wind or the rain. One small room contains the whole family; their bed a sheep-skin or two; their furniture one or two earthen pots. The principal food of the Peruvians is maize; but they raise also potatoes, wheat, beans, tomatos, yucas, pumpkins, and other vegetables. Christianity, imposed upon them dogmatically, by priests who take no pains to enlighten them, has scarcely gained admission to their understandings, and has no hold on their affections. They attend divine service from the dread of chastisement, and give an outward assent to whatever they are taught, but without any real religious impression being made upon their minds. They meet death with the same stupid indifference as the ordinary accidents of life, and rather decline than seek the assistance of a priest in their last hours. It ought not to be forgotten, however, that the intellectual torpor which the Peruvians display may be attributed in part to the deadening and debasing effects of three centuries of brutal oppression. They still cherish in secret a strong veneration for their ancient faith and their native government, which displays itself even in the large towns. The story of Manco Capac (whom, since numbers of our countrymen appeared in Peru, they affect to call an Englishman) and Mama Ocello, the wealth, power, and beneficence of the Incas, are still fresh in their memories, and are handed down from father to son with a degree of fond admiration which three centuries of humiliation and misfortune seem only to have rendered more intense. The barbarous murder of the Inca Atahualpa by Pizarro is annually represented in the form of a tragedy. "In this performance," says Mr Stevenson, "the grief of the Indians is so natural, though excessive, their songs so plaintive, and the whole is such a scene of distress, that I never witnessed it without mingling my tears with theirs. The Spanish authorities have endeavoured to prevent this exhibition, but without effect. The Indians in the territory of Quito wear black clothes, and affirm that it is mourning for their Incas, of whom they never speak but in a doleful tone."

The oppression of the *mita*, or forced labour in the mines, with the introduction of the small-pox and the use of spirituous liquors, has destroyed prodigious multitudes of the Indians since the conquest. What their number was before that event it is impossible to tell; but, judging from the extent of the Inca's dominions, he probably had not less than three or four millions of subjects. A pretended Spanish account, assigning a population of eight millions to Peru shortly after the conquest, is known to be fictitious. An official estimate in 1862 made the number of Indians in Peru amount to 1,600,000, being three-fourths of the entire population.[1] Population.

In Chili there were several tribes who possessed nearly all the arts known to the Peruvians, but were distinguished from them by a finer physical constitution and an unconquerable spirit. When the Spaniards arrived, Chili, according to Molina, was inhabited by fifteen tribes independent of each other, who were spread over the country on both sides of the Andes, from latitude 30° to the Strait of Magalhaens. They all spoke dialects of one language, which is described as rich, harmonious, abounding in compound words, and having, like the other American tongues, very complicated grammatical forms. It has no affinity to the Quichua or Peruvian. The inhabitants of the plains are a stout people, of middle stature; those Chili.

[1] In this account of the Peruvians we have chiefly followed Garcilasso, Acosta, Frezier, and Ulloa, of whose statements a copious digest is given by Prevost in the 13th volume of his *Histoire Générale des Voyages*. We have also taken some facts from Humboldt's *Researches*, Balbi's *Ethnographical Atlas*, and W. B. Stevenson's *Narrative of Twenty Years' Residence in South America*, a useful work, although the author has shown rather too great an anxiety to exalt the character of the Indians.

of the mountains are tall; and one tribe, the Tehuels or Patagonians, surpass in size every other nation in the world. All the tribes inhabiting the plains, except those of the extreme south, now make use of horses. The complexion of the Chilian tribes is, like that of the other American nations, a reddish brown; but one tribe is said to be of a clear red and white. They do not paint their bodies. The Chilians lived partly by hunting, but chiefly by agriculture, before they had any intercourse with Europeans. They cultivated maize, magu, guegen, tuca, quinoa, the potato, pumpkins, and some species of pulse; and to these they added, as food, the flesh of the bizcacho, and of the llama or Araucanian camel, of whose wool they are said to have manufactured cloth. Like the Peruvians, they understood the use of manure, practised irrigation with considerable skill, and turned up the ground with a wooden spade or mattock. They boiled their grain in earthen pots, or brayed it into meal after roasting it in hot sand; of the meal they made puddings or bread, which they knew how to leaven, and various species of fermented drink. They had gold, silver, copper, tin, and lead, procured probably by washing; but they seem to have had few or no edge-tools of metal, those found being almost always of basalt. They made baskets and mats, extracted salt from sea-water, and were able to give various dyes to their cloths. They used *quipus* or knotted cords for calculation, and, according to Mr Stevenson, for the transmission of intelligence and for recording events. They lived in villages formed of houses standing at a distance from one another, under hereditary chiefs, but whose power was limited. It is remarkable that the Chinese mode of catching wild ducks on the rivers, by covering the fisher's head with a gourd, was practised in Chili.

Araucanians.

The Araucanians, the most intelligent, improved, and warlike of the Chilian tribes, occupy about 200 miles of the sea-coast, between the 37th and 39th parallels. They are of ordinary stature, but vigorously formed; bold, hardy, hospitable, faithful to their engagements, generous to a fallen enemy, ardent, intrepid, and enthusiastic lovers of liberty. Their vices are drunkenness, and a contempt of other nations, springing from pride. Their government, in the regularity of its form and its sub-division of authority, has an outward resemblance to the Peruvian; but the spirit of the two systems differs as widely as the genius of the two nations. Araucania contains four tetrarchies, under four *toquis* or princes, who are independent of one another, but confederated for their joint security against foreign enemies. Each tetrarchy is divided into five provinces, ruled by five chiefs called *apo-ulmen;* and each province into nine districts, governed by as many *ulmen*, who are subject to the apo-ulmen, as the latter are to the toquis. These various chiefs (who all bear the title of ulmen, as our nobility of all orders are barons) compose the aristocracy of the country They hold their dignities by hereditary descent in the male line, and in the order of primogeniture. The supreme power of each tetrarchy resides in a diet or great council of the ulmen, who assemble annually in a large plain, like the Poles and Germans in old times; but as the people are all armed, and have a high love of liberty, no resolution of the diet is of any avail if it has not their hearty concurrence. The chiefs, indeed, are little more than leaders in war; for the right of private revenge, which is fully admitted, limits their authority in judicial matters; and they receive no taxes. Their laws are merely primeval usages. The Araucanians can raise altogether 6000 or 7000 men, besides a body of reserve. When war is declared by the great council, messengers bearing "arrows dipt in blood" are sent to all parts of the country to summon the men to arms. Unlike many barbarous nations, which are immovably attached to their ancient customs, the Araucanians were not slow in copying the military arts and tactics of the Spaniards. Their troops now consist of infantry and cavalry; the former armed with pikes or clubs, the latter with swords and lances. The infantry are formed into regiments of ten companies, each company containing a hundred men. When they take the field, they carry parched meal with them for provisions; they station sentinels, send out scouts, and have advanced guards preceding their main body. When necessary for their security, they dig ditches, and plant stakes along their sides, and throw up mounds of earth. They advance to battle in lines, well formed, and fight with intrepidity. Their history affords a brilliant example of what a brave nation, animated by an enthusiastic love of liberty, can accomplish under the greatest disadvantages. After resisting the best troops and the best generals of Spain for two hundred years, they at last compelled their proud enemies to acknowledge their independence. The Araucanians were indebted for their success to a deliberate species of courage, to which even the bravest of the North American tribes are strangers; and they combined with it a degree of sagacity and intelligence which led them to adapt their mode of fighting to the new circumstances in which they were placed. Experience having taught them the inefficiency of their old missiles when opposed to musket balls, they soon laid aside their bows, and armed themselves with spears, swords, or other weapons fitted for close combat. Their practice was to advance rapidly within such a distance of the Spaniards as would not leave them time to reload after firing. Here they received without shrinking a volley, which was certain to destroy a number of them, and then rushing forward in a close column, fought their enemies hand to hand. In this way they gained many victories, and impressed the Spaniards with such a respect for their courage that an individual of that nation made their achievements the subject of an epic poem. Combining the moral, intellectual, and physical qualities of the Araucanians, they were certainly the finest native race in the New World. They had nearly all the germs of civilisation which belonged to the Mexicans and Peruvians, without the ferocity of the former, the apathy of the latter, or the slavish habits common to both; and without having their minds stupified by that grovelling superstition which the rulers of these two nations seem to have considered as the only secure foundation of their authority. In true courage, in manliness and energy of character, they take precedence of all the American nations.

The Araucanians believe in a supreme being, and in many subordinate spirits, good and bad. They believe also in omens and divination, but they have neither temples nor idols, nor religious rites; and discover upon the whole so little aptitude for the reception of religious ideas that the Catholic missionaries who have settled among them have had very little success in imbuing their minds with a knowledge of Christianity. They believe in a future state, and have a confused tradition respecting a deluge, from which some persons were saved on a high mountain. They divide the year into twelve months of 30 days, which have significant names, and add five days by intercalation. They esteem poetry and eloquence, but can scarcely be induced to learn reading or writing. Chess, a game of oriental origin, is said to have been known among them from time immemorial; and it may be further observed, that the numbers 5 and 9, employed in their geographical and civil divisions, are favourite numbers in China.

The other Chilian tribes are all much behind the Arau-

canians in civilisation; but some, as the Puelches and the Tehuels, surpass them in strength and stature. Part of them live on horse flesh, part by keeping sheep and cattle, and part by hunting. Some of these tribes paint their faces. With regard to the height of the Patagonians, M. Lesson, an eminent French naturalist, has collected the authorities on the subject in a note published by Balbi in his *Ethnographical Atlas;* and they appear to us to remove every rational doubt as to the fact of a race of men existing there whose average stature is about six feet, and among whom men seven feet high are perhaps more frequently to be met with than among an equal number of men in any other country. They have large heads, but their hands and feet are small, and they are not strong in proportion to their tall stature. They ride on horseback, and hunt the huanaco or the ostrich with a sling, which they cast so as to entangle the animal's legs. They dwell in tents, and lead a wandering life.

Patagonians.

Indians of Brazil: Guaranis.

Of the numerous nations that inhabited Brazil there is only one to which we can afford any special notice in this article. The Guaranis have at one time formed a numerous people, which seems to have been spread over a larger surface than any other now existing in America. Tribes, or remnants of tribes, whose relationship to the Guaranis is attested by the strong evidence of their language, are found diffused over the wide space between the Orinoco and the embouchure of the Plata, or more than the half of South America. They are met with among the Andes of Peru, in the province of Chiquitos, in Matto Grosso, in Paraguay, in Minas Geraes; and the Omaguas, in the republic of Ecuador, who, from their nautical habits, and the influence they obtained on the upper part of the Amazon, have been called the Phœnicians of the new world, are believed to be of the same race. They constituted the bulk of the native population of Brazil when the Portuguese gained possession of it, but were divided into many distinct tribes, quite independent of one another, and living, not in contiguity, but mixed with other nations. They are of low stature, two inches shorter than the Spaniards, according to Azara; of a square form, fleshy, and ugly. Their colour has a strong shade of the copper red, while that of the other Brazilian tribes inclines generally to the tawny or black. Their character, like their physical form, resembles that of the Peruvians. They are patient, torpid, silent, downcast in their mien, mild, and passionless. Nearly all the Indians whom the Portuguese have civilised or converted belong to this race. It is difficult to account for their dissemination through the southern continent, amidst nations much more brave and powerful than themselves. May we suppose that, like the subjects of the Incas, they had been at one time the dominant tribe of an extensive empire, which derived its force from union and civilisation? But if such a state did exist, its date cannot be very ancient; for the identity or close resemblance of the dialects spoken by the scattered portions of the Guaranis shows that their dispersion from a common point did not happen at a very remote period.[1] Yet no memorial of its existence survives, either in traditions or monuments. The supposition, therefore, that the Guarani tribes are the remnants of a once powerful and united people, is scarcely admissible; and Azara thinks it more probable that they have crept gradually from north to south. Their dispersion is the more remarkable, as they are not a wandering but an agricultural people. They live in the woods, or in small open spaces in the forests; cultivate maize, beans, gourds, yams, mandioc; and eat also wild honey, and the flesh of monkeys and various small quadrupeds.

Paraguay mission settlements.

The Indians whom the Jesuits civilised and collected into communities in the celebrated settlements of Paraguay belonged chiefly to the nation of the Guaranis. These missionaries are said to have borrowed the plan of the theocracy which they established here from that which the Incas had introduced into Peru. There is no doubt that the spirit of their system was the same; and, considering that they were precluded from any other means of extending and supporting their authority than persuasion, their success was remarkable. The settlements were commenced about 1610, and were gradually extended over the country watered by the Parana and Uruguay, between the 27th and 30th degrees of south latitude, till the order of the Jesuits was suppressed in 1767. The plan of the government may be called *parochial*, for it was administered entirely by the parochial clergy. The Indians were collected into villages. Each village had its church and its curate, who was assisted by one, two, or more priests, according to the number of Indians under his charge. The curate and assistant priests were nominated, not by the Spanish authorities, but by the father superior, also a Jesuit, who exercised a vigilant superintendence over the whole. Indians were appointed in each village with the titles of regidors and alcaldes; but they were merely instruments in the hands of the curate and his assistants, in whom all power was lodged. The curate gave his whole attention to religious offices, saying mass in the church, and visiting the sick; while the assistant priests managed all secular matters, directing the labour of the Indians who cultivated the ground, and training others to the crafts of the weaver, mason, carpenter, goldsmith, painter, and sculptor; for the fine arts were by no means neglected. Private property did not exist. The produce of the labour of the community was stored in magazines, from which each family was supplied according to its wants, special provision being made for aged persons, widows, and orphans. The surplus was sold by agents at Buenos Ayres, and the proceeds employed in paying the taxes to the king, in procuring ornaments for the churches, and various articles which the colonists could not manufacture for themselves. The religious instruction was of the most simple kind; but the service of the church was conducted with a well-trained choir, a pompous ceremonial, and every accessory calculated to strike the senses. The punishments were mild; and they were always accompanied with such admonitions as a parent would address to a child whom he was chastising. Crimes, in truth, were rare. The Indians, who regarded their spiritual chiefs with the veneration due to beneficent beings of a superior order, scarcely felt humbled in confessing their misdeeds; and offenders may have solicited correction, as Raynal says, for the quieting of their consciences. The incursions of the Portuguese compelled the Jesuits to take means for repelling force by force. All the male Indians of the proper age were accordingly armed with muskets, and disciplined as a militia. In 1732, according to Dobrizhoffer, the thirty villages or parishes under the care of the missionaries contained a population of 141,000 souls. The Jesuits had another establishment of the same kind among the Chiriguas, a branch of the Guaranis, in the province of Chiquitos, containing 30,000 or 40,000 Indians; a third, of smaller size, in the province of Moxos; a fourth in California; and probably others. After the suppression of the order, all these were committed to the care of friars of other descriptions; and we believe they have universally fallen into a state of decay. The social system established in Paraguay was the most effectual ever contrived for reclaiming the Indians from their savage mode of life; but even its success shows how hopeless the attempt is to raise the American tribes to

[1] Dr Prichard's *Researches*, vol. ii. p. 487.

the rank of thoroughly civilised nations. The Jesuits were able to introduce settled habits and a slight knowledge of religion and the arts among the Indians only by means of the personal ascendancy they acquired over them. It was a few superior minds gaining the respect and confidence of a horde of savages, then employing the influence they acquired to lead them as children; giving them such portions of instruction as taught them to trust implicitly in their guides, working alternately on their fears, their pride, their kind affections, but never fully revealing to them the springs of the machinery by which they were governed. The incurable indolence of the savages rendered it necessary to prescribe the labour as task-work, and to carry it on under the constant inspection of the missionaries. The plan of cultivating the ground in common, and of storing the produce in magazines, out of which the wants of each family were supplied, was resorted to as a check upon their improvident habits. In short, the eye and the hand of the missionaries were everywhere; and the social system was held together entirely by their knowledge and address. When these were withdrawn, the fabric soon fell into ruins, and the Indians relapsed into their idolatry and savage habits.

Other races of Indians.

To complete our general view of the aboriginal races, a few particulars remain to be mentioned. Many of the tribes who inhabit the Pampas of South America make use of horses. Dobrizhoffer enumerates eight equestrian tribes in the province of Chaco, on the west side of the river Paraguay, who are generally distinguished by tall and vigorous forms, and a bold and active character. The Abipones and Mbayas are the most celebrated of these. The woods of Brazil are too dense for equestrians; but horses are used by a few hordes in the great plain of the Mississippi and in the north of Mexico. The American tribes in general either kill their prisoners or adopt them; but a few retain them as slaves, and compel them to work. The Guaycurus of Brazil are an example. The food of different tribes is extremely various. Maize, beans, pumpkins, and mandioc are raised in small quantities by some; natural fruits, berries, bulbous roots, and bananas are gathered by others. Those who dwell on the sides of rivers live greatly on fish; in the plains, buffaloes, horses, and sheep are killed. In the forests of Brazil, monkeys, pigs, armadillos, pacas, agoutis, and tapirs are the favourite food; but birds, turtles, deer, and the coati are also taken; and in an emergency the Indians do not scruple to feed on serpents, toads, and lizards, the larvæ of insects, and other disgusting substances. Salt is used where it can be easily obtained, and some season their food with capsicum. Some roast their meat, others boil it; and not only several savage tribes, but even the civilised Peruvians, ate their flesh raw. The Ottomaques, a tribe near the Orinoco, eat a species of unctuous clay; this strange diet, which no doubt owed its introduction to the stern monitor famine, is not extremely rare in Brazil, and Captain Franklin found the same food in use among an Indian tribe near the Frozen Ocean. The clay is stated by that traveller to have a milky and not disagreeable taste. A great proportion of the tribes in Brazil and the basin of the Orinoco, and some in other parts of America, indulge in the horrid banquet of human flesh. Shame, in our sense of the term, is nearly a stranger to the breasts of these savages. In the warm regions of Brazil men and women go entirely naked, except in the neighbourhood of the Portuguese settlements, where some wear a band of cloth round the loins. In such situations, where the want of shelter is little felt, their dwellings are often nothing more than a sort of arbour formed by interlacing the open space between two or three trees with twigs, and covering it with leaves so as to form a screen on the windward side, while it is left entirely open on the other. The manufacture of bows and arrows, war-clubs, baskets, mats (which, swung from a tree, serve them both as seats and hammocks), and in some cases a coarse pottery, comprises the sum of their practical skill in the arts. It has long been the practice of bands of Portuguese, consisting chiefly of outlaws and vagabonds, to make marauding expeditions among the Indians living near the great rivers, and to carry them off and sell them clandestinely for slaves. This infamous trade is carried on in despite of the orders of the government, which has issued many decrees for the protection of the Indians, and, besides employing missionaries to convert them, enjoined the governors of provinces to furnish them with hoes and other agricultural implements. Wherever the negroes are introduced in great numbers, as in the Capitanias of Santo Paulo and Rio Janeiro, and in the whole of the West India islands, the aborigines rapidly disappear, the former being more intelligent, more tractable in their habits, and more active and industrious. The negroes are indeed a superior race to the Indians; and the existence of one or two hundred blacks, as slaves, among some thousands of the Cherokees, does not detract from the accuracy of this opinion. Missions for the conversion of the Indians have been supported for more than two centuries by the governments of Spain and Portugal. They are thinly spread over those parts of Mexico, La Plata, Peru, Brazil, and Colombia, which are still occupied by the savages; but there are extensive districts in all these provinces in which they have never been established, owing to the fierce character of the tribes, or the remote and inaccessible nature of the country. A mission consists in general of one or two friars or priests, who settle among the savages, learn their language, and, besides teaching them the elements of Christianity, always endeavour to instruct them in the more simple and useful arts, and to train them to settled habits. We believe that many of these establishments have been abandoned, owing to the failure of the funds with which they were supported; and that the success of the others has been extremely trifling. The late revolutions in those countries, by liberating the Indians from their ancient state of tutelage under the whites, have in many cases broken up the little settlements which the missionaries had formed. This has been the result even in Brazil, where the political changes have been least felt.

Owing to the fanaticism of the Spaniards a large proportion of the manuscripts of the natives were destroyed, so that now we are unable to acquire so full and accurate a history of the more civilised nations as we might otherwise have done. The literature which still exists, together with the numerous remains of cities, temples, roads, bridges, and other works of art, testify to the general truth of the historical narratives. However obscure they may now be, or however difficult the reconciliation of statements, it seems clear they have been founded on facts. As in the case of other histories, there is much error and tradition, mingled with truth, which renders their correct interpretation difficult. Amongst some of the nations we know that historians were appointed by the government, and that such historians were severely punished if they ventured to tamper with the truth wilfully. The best connected account of these histories, so far as concerns the nations of Central America, is that given by the Abbé Brasseur de Bourbourg.[1] If we credit the native accounts, the earliest traces of civilisation originated in Yucatan and the neighbouring districts, a region which is amongst the most fertile in the New World.

Traditional history of Central America.

[1] *Histoire des Nations civilisées du Mexique et de l'Amérique centrale, durant les siècles antérieurs à Christophe Columb.* 4 tomes. 8vo. 1857–59.

It is stated that many centuries before the Christian era, Votan, the oldest of the American legislators, established himself in the region watered by the rivers Tabasco and Usumasinta. It is near the sources of this latter river, in the highlands of Vera Paz, that cities of civilised Indians still exist, according to travellers who have recently visited the adjoining districts. However this may be, this river was the principal highway into the interior of Central America for the earliest civilised tribes, as it is now for the existing natives. Near the mouths of the rivers mentioned the ground is scarcely above the level of the sea, and is for the most part a recent alluvial formation. During the rainy season it is covered with water, and all intercourse between village and village takes place by water. Just where the land acquires a slight rise, Palenque, said to be the oldest city in Central America, was founded. At this time, according to the tradition, the low land was occupied by a lake. Votan, it seems, came from some foreign land, and found the whole of the country from Darien to California occupied by a barbarous people, who used the skins of wild beasts for clothing, caverns and huts made with branches for shelter, and wild fruits and roots, with raw flesh, for food. Votan announced to these people a knowledge of the Supreme Deity, who was at first worshipped as the God "of all truth." At first no temples or altars were dedicated to him, and it was not until long after that Nezahualcoyotl erected a teocalli, or "house of God," as it means in the Mexican language, and dedicated it "to the unknown God." At a later period the religious ideas were considerably debased. In Votan's time there seems to have been but one language prevalent over a large area, and this language was probably the Maya, which is the stock of many of the languages formerly in use among the natives, and is still the language of Yucatan. The people apparently formed tribes differing somewhat in manners, the most prominent of which tribes are referred to as the Quinames or giants. Votan and his companions arrived in large ships, wore long flowing garments, and spoke the Nahuatl language. These strangers married the daughters of the country, and established a settled form of government. According to one document, the year 955 B.C. is assigned to these events; but it is quite impracticable to give any trustworthy fixed date. Votan, it is said, wrote an account of the origin of the Indians, and of their immigration into America. He attempted to prove that they were the descendants of Imos, of the race of Chan, or the serpent. Votan made four voyages to his original country, and described the route he followed. On one of these voyages he visited the dwelling of the thirteen serpents, as also the ruins of an old building which had been erected by men for the purpose of reaching heaven. The people who lived in its vicinity told him it was the place where God had given to each family its particular language. Allusion is also made by him to certain mysteries like those of Egypt and Greece, of which traces were still discoverable amongst the civilised nations of America. On returning from his first voyage to his native country he found the people at Palenque had attempted to usurp his authority and overturn his power. Thereupon he parted his monarchy into four divisions. One of these had for its capital the town of Tulha, the ruins of which may be seen near Ocosingo in Chiapa. Votan also is the reputed founder of Tsequil, which was afterwards called Ghowel, and the site of which is now occupied by a suburb of Ciudad Real. Some time, possibly not many years, after Votan, Zamna appeared in Yucatan. He introduced the Maya civilisation, founded the town of Mayapan, and called the country Maayha, or land without water, a term well applied to the extremity of the peninsula of Yucatan, where rivers are almost absent. Mayapan was once the capital of Yucatan, and in Zamna's time the sea covered the country to within a short distance of it. He lived to a great age, and during the later years of his life dwelt on the sea-coast, and was buried at this place. The spot became the site of a large temple erected to his honour, which was visited by pilgrims from great distances. A town sprung up around it called Itzamal, which is believed to correspond with the modern Isamal, now about 30 miles distant from the sea. The region to seaward is reported to be geologically very recent as land, and the remarkable absence of names of any antiquity in a country where almost every locality has its appellation is some confirmation of the traditions. The architectural character of the oldest towns also lends some support to the considerable antiquity claimed for them. The forest-covered ruins of Mexico and Central America present so many different architectural styles that it seems very probable they were built at different periods and by different people. Those which appear to be the oldest, and which are most uniform in style, are the substructures in Mayapan, some of the buildings in Tulha, many of those in Palenque, and others which occur in the country of the Lacandons.

The names of the successors to Votan are mentioned, but without details. One of the last of the dynasty was Chinax, in whose reign mention is made of the Nahuatl people. Not long after his death, this people, who were called Nahoas or Toltecs, obtained the dominion of the country, and the throne was occupied by Nahoa princes. They originally came from Huehue-Tlapallan (but where this country was situated is not known), having been induced to leave it in consequence of a revolution. This event seems to have occurred shortly before the Christian era. The journey to America from their native country was a long and painful one, and indicates that seas and lands intervened between them. The traditions report it to be in the far east, and that the first comers filled seven ships and disembarked at Tampico, near the mouth of the Panuco. The leader of the band bore the title of Quetzalcohuatl, and was the first known by that name. They then coasted along the shore as far as Tamoanclia, which place was evidently somewhere near the mouth of the Tabasco. In this district there was a tradition in the time of the Spaniards that twenty illustrious chiefs from the east landed there many centuries before, who had long flowing garments and large beards, of whom the principal was Cukulcan, a name which has the same meaning as Quetzalcohuatl. Quetzalcohuatl and his comrades soon obtained possession of the capital of the country, Xibalba, which is believed to be the same as Palenque. Their success induced others of the Nahoa nation to join the first colonists, and their power gradually spread over a large portion of Central America. The strangers, however, met with considerable resistance from the princes of Xibalba, who compelled the Nahoa to leave their country and disperse themselves over the surrounding region. This dispersion is stated to have occurred in A.D. 174. Before this date, the lunar calendar, so prevalent among the civilised nations of America, was introduced. It was one of these parties of Nahoa that established itself in Mexico, and founded many of the more important cities. They were called Olmeques, and were led by Olmecatl and Xelhua. The latter was one of Quetzalcohuatl's companions, and was once shipwrecked along with him. In order to commemorate his delivery he erected the great pyramid of Cholullan. Before the arrival of the Olmeques the valley of Mexico was inhabited by the Quinames or giants, and they continued to dwell in the mountains around for centuries after they had been driven from their native valley. The Totonacs, Mixtecas, and Othomis were the contemporaries, or possibly the

predecessors, of the Olmeques. The first mentioned people erected the pyramids of the Teotihuocan, or the City of the Gods, near Mexico. These tribes spoke a language quite distinct from the Nahuatl. The Totonacs placed the cradle of their race at Chicomoztoc, which was said to be far to the north; but the Othomis seem to have been in possession of the land from time immemorial. According to the traditions of the Quiches and other nations of North America, they originally came from Tulan. They allude to several places of this name. One was in the region of the setting sun and beyond the sea; and another, from which the Quiches came, was also in the direction of the setting sun and was apparently situated in California. In the descriptions given of the migrations from the more distant Tulan, which seem to have occurred at frequent intervals, each migration consisting of a moderate number of people, the difficulties and hardships are prominently noticed. They pointedly allude to the intense cold, to the long dark night, and to the sterility of the country, which allusions seem to point to travels in Arctic regions. The travellers were reduced to such extremities as to be obliged to suck juicy woods in order to sustain life. The name Chichimecs, which means suckers of maguey, given to the invading hordes from the north, may have some connection with this traditional fact. Chicomoztoc has been identified by some with the extensive ruins near the Rio Gila, in California. The history of these early nations is somewhat obscure, but it may be gathered from the preserved records that the worship of the sun and the practice of human sacrifice had nearly or wholly superseded the earlier and purer religions. Towards the end of the 7th century we first hear of the Chichimecs invading Mexico from the north. This name is a general one given to all invading hordes from the north, and is similar to that of barbarians applied to the people who invaded the Roman empire. The first invasion was by the Chichimecs-Culhuas, headed by Mixcohuatl Mazatzm. They commenced their march, or rather progress, from Chicomoztoc about 635, and reached the valley of Mexico about 40 years after. After many years' fighting the Toltec empire was established in about 686; and from this period we enter upon more detailed and trustworthy historical ground. At first the government of the Toltecs was republican and theocratical, but it soon became monarchical, and Nauhyotzin was elected the first king. The most illustrious of his successors was Topiltzin Ceacatl Quetzalcohuatl, during whose reign the Toltec empire arrived at its most flourishing condition. According to tradition, the Toltecs were taller and of larger build than the existing Indians, were great runners, and were as white as Europeans. They carried many of the arts to a high state of perfection, such as weaving, building, jewelling, and making ornaments with the feathers of birds. There were astrologers and poets, sorcerers and philosophers and orators. They were well acquainted with the medical properties of plants, and were in the habit of recording in books their observations on diseases. Quetzalcohuatl's reign was for the most part one of prolonged peace, but this peace was disturbed by the religious party who advocated human sacrifice, a practice which he used every effort to abolish. The rebellion becoming very formidable, Quetzalcohuatl left the country with a few chosen attendants, and founded a new Toltec empire on the plain of Huitzilapan, which corresponds with the one on which La Puebla now stands. This occurred in 895. The town of La Puebla stands on the site of the old Huitzilapan, and at the time of Quetzalcohuatl's arrival it was said that the pyramids of Chollullan had existed from time immemorial, and had been built by the giants. According to this legend, the country was inhabited by giants, all but seven of whom were either destroyed by a great inundation or turned into fishes. These seven took refuge in a cave, and when the waters abated, one of them, named Xelhua, went to Chollullan, and built the famous pyramid to commemorate his escape. Quetzalcohuatl built a temple here, which he dedicated to the "creator of light," and around this temple sprang up Chollullan, or the "town of the exile." His disciples carried the Toltec civilisation into Oaxaca. After having reigned at Chollullan about ten years, during which period his subjects enjoyed all the blessings of peace, he was attacked by enemies again. Huemac had ascended the throne which he had vacated, and being jealous of Quetzalcohuatl's power and prosperity, he suddenly resolved to march with his army against Chollullan. In order that the town might be spared the horrors of a siege, Quetzalcohuatl informed his priests of his intention to leave the place and to visit other countries. Accordingly he proceeded to the mouth of the Coatzocualco river, then entered a boat with four companions, and nothing more was heard of him. Huemac finding his enemy had escaped, wreaked his vengeance on Chollullan, and took up his residence there with a view to subjugating the surrounding districts. He also re-established the practice of human sacrifice. During Huemac's absence from his kingdom of Tulan, Nauhyotl was elected king in his stead. A battle took place between the rivals, which resulted in the defeat and subsequent death of Huemac and the establishment of Nauhyotl's power. His reign lasted for fifteen years, and as he was one of Quetzalcohuatl's disciples, he governed according to similar principles, so that the reign was a prosperous one. His death occurred in 945. After this a series of disasters broke over the country, and these, with constant civil war, weakened the power of the empire in Anahuac. This soon became known to other nations, and led to the Chichimecs-Teotenancas leaving their homes in Texas and New Mexico to make an irruption upon the valley of Mexico. This occurred between 1041 and 1047. The internal discord continued, and the disorder was increased by the uprising of the sect of Ixcuinames, the devotees of which practised the most abominable rites. In the midst of this corruption another horde of barbarians, the Teo-Chichimecs, poured down from the north, and took possession of the country. The Toltec power rapidly declined, and the last king of the empire was Huemac Atecpanecatl, who after his dethronement lived for some years at Chapultepec, and died there in 1070.

According to the Guatemalian traditions, four individuals of the Tutul-Xius, a nation speaking a Nahuatl language, left their country of Tulapan, to the west of Zuyna, in A.D. 174, and arrived the same year at Chacnouitan, which seems to be the name for some place in Yucatan. In 258 another migration of Tutul-Xius occurred, the new colony being established in the province of Zyan-Caan, which is believed to be the district around Chetumal Bay. About the end of the 10th century, it is stated that a venerable personage arrived in Yucatan, called Cukulcan, who retrieved the falling fortunes of the Tutul-Xius. According to the Abbé Brasseur de Bourbourg, this personage was no other than the Ceacatl Quetzalcohuatl whose departure from the Coatzocoalco river has already been mentioned. After reigning here ten years, he voluntarily abdicated the throne and left the country. According to a Mexican legend he went to Tlapallan, and died there. His successor transferred the capital of the Tutul-Xius from Mayapan to Uxmal, a town which seems to have been founded some centuries before, but which first rose to importance at this period, or near the end of the 10th century. Numerous temples and public buildings were erected, the ruins of which are now so abundantly met with in Yucatan. Artificial ponds or zonotes were constructed; and the number and magnitude of these indicate a large number of

towns as well as a thickly-populated country. At the present day they have all the appearance of being natural ponds, and indeed were long considered to be such, notwithstanding the repeated assertions of the Indians that they had been built by their ancestors, until chance led to the discovery that the muddy floor of one was entirely composed of flat stones, the interstices between which were stopped with a kind of clay not known in the neighbourhood. The centre was occupied by four artificial wells, the walls of which were formed of polished stones. Further research led to the discovery of numerous other zonotes. After the final fall of the Toltec empire there commenced the great movement of the northern tribes towards the south, a movement which continued throughout the 11th, 12th, and 13th centuries. The movement consisted of a succession of migrations, and its starting-point appears to have been in New Mexico and California, which region was evidently the seat of a semi-civilised empire. Amongst these invading tribes was one which subsequently rose to high importance. The Aztecs, or Mexicans proper, were living at Atzlan in the 11th century, a country which was surrounded by water, and where their usual occupation was as boatmen and carriers of wood. Other tribes also lived in this region, which is believed to be that of Lower California. The Aztecs commenced their journey towards Mexico in 1090. In 1116 they reached Chicomoztoc, and in 1177 they entered Anahuac. Settlements were gradually established in the valley, towards which peoples of various nations converged from the south as well as the north. The numbers of the Aztecs were slowly augmented by fresh arrivals; but it was not until 1325 that they were able to lay the foundations of Mexico-Tenochtitlan, and thus to inaugurate their assumption of power. In 1464 the empire of the Tutul-Xius was overthrown. The Mexican empire had, however, acquired large proportions, and was conducted with a magnificence and splendour scarcely equalled by any other court in America, and this empire continued up to the time of the Spanish conquest.

Discovery of America by Europeans.

The discovery of a continent so large that it may be said to have doubled the habitable world, is an event so much the more grand and interesting that nothing parallel to it can ever occur again in the history of mankind. America had of course been known to the barbarous tribes of eastern Asia for thousands of years; but it is singular that it should have been visited by one of the most enterprising nations of Europe five centuries before the time of Columbus without awakening the attention of either statesmen or philosophers. Iceland was discovered about 860, and colonised by the Norwegians in 874. About 50, or, according to other accounts, 100 years later, the same people planted colonies in Greenland. Into the disputes respecting the situation of these colonies we have not room to enter. Sir Charles Giesecke, a good authority, states that their ruins exist near the southern point of the peninsula. It is obvious that the same adventurous spirit which enabled these northern mariners to discover the southern extremity of the country, would not permit them to stop short without visiting what is now known to be the most habitable part of it—the western coast; and the fact has been established by an inscription in *runic* characters found on a stone four miles beyond Upernavik, at the 73d parallel, intimating that "Erling the son of Sigvat, and Enride Oddsoen, had cleared that place and raised a hillock on the Friday after Rogation day." The marking of the date is indistinct, but it is supposed by Professor Rask, the translator, to be either 1135 or 1170; and the runic characters show at any rate that it was anterior to the Reformation, when this mode of writing was prohibited.[1] Whoever looks at the map of Greenland, and reflects on the fact that the Norwegians must have been ascending through Davis' Straits as high as the latitude mentioned, annually, perhaps for two or three centuries, will admit that, with half the spirit of enterprise which had carried them so far, the discovery of some portion of the west coast of these straits was almost unavoidable. Now, the position and direction of this coast once known, it required no great effort to trace it southwards to Labrador and Newfoundland. We mention these particulars because Mr Murray, one of the few who have denied the discovery of America by the Norwegians, grounded his disbelief chiefly on the hypothesis that the colonies and the navigation of that people at the period alluded to were confined to the east coast of Greenland.

Norwegian Discoveries.

In 1001 an Icelander, sailing to Greenland, was driven away by a tempest far to the south-west, where he saw a level country covered with wood. The wind abating, he turned his course homeward, and on his arrival gave such a flattering account of the country he had seen as induced Lief, the son of the founder of the Greenland colony, to undertake a voyage thither. Lief and Bjorn, who sailed together, first reached a rocky island, to which they gave the name of Helluland; then a low country, thickly wooded, which they called Markland; and some days afterwards they found trees loaded with fruits on the banks of a river. They spent the winter in the country; and one of them, who was a German, having found wild vines growing, they called it Vinland. They had some intercourse and traded for furs with a people who came in leathern boats, and were called *Skrælings*, from their dwarfish size. A colony was planted, and remained for many years in the country, the situation of which is indicated by a fact casually mentioned, that the sun remained nine hours above the horizon at the shortest day. This indicates the 41st parallel of latitude; and the actual latitude of Rhode Island, the country which every collateral circumstance would lead us to fix upon as the seat of the colony, is from 41° to 42°. The Skrælings were of course the Esquimaux.[2] The *vine* appears to be the fox grape (*Vitis vulpina*), which grows wild in that part of America. Only a few unimportant particulars respecting the settlement are preserved; but it was probably abandoned or destroyed, like the Greenland colonies, of which it was an offset. The account, though meagre, is distinct and consistent. Its authenticity can scarcely be disputed; and it is almost equally obvious that the country it refers to under the name of Vinland is in the vicinity of Rhode Island. A conclusion resting on such strong grounds scarcely requires to be supported by the high authority of Humboldt and Malte-Brun. That the colony disappeared, and that the discoveries made were not prosecuted farther, are not circumstances which will shake the credit of the narrative in the minds of those who know the numerous reverses which befell the early colonies in New England and other parts of America. The hostilities of the Skrælings was no doubt the principal cause of the abandonment of the colony. The Norsemen describe Vinland as a rich country, with a delightful climate. Helluland, Markland, and Vinland, were no doubt regarded as countries either connected with or similar to Greenland, the flattering descriptions of which, given by the first discoverers were sadly belied by later experience.[3] The interest excited by the obscure accounts

[1] Ferussac, *Bulletin des Sciences Historiques*, Julliet 1828.

[2] See the curious work of Torfæus called *Vinlandia Antiqua*, Hafn, 1705; and the valuable *Antiquitates Americanæ*, published at Copenhagen in 1837. Also Humboldt's *Cosmos*, vol. ii. p. 233, Sabine's transl. 1848.

[3] M. Rafn, a Dane, who was much engaged in researches respecting these early voyages, announced that he had ascertained, from original documents, various facts previously unknown; among others, that America (first discovered in 985) was repeatedly visited by the Icelanders in the 11th, 12th, and 13th centuries; that the embouchure of the St Lawrence, and in particular the bay of Gaspe, was their principal station; that they had penetrated along the coast as far south as Carolina; and that they introduced a knowledge of Chris-

of these countries was probably such as the announcement of a new island eastward of Spitzbergen would produce at the present day. No reasonable doubt can exist, however, that the north-eastern portions of America (considering Greenland as a distinct country) were familiarly known to the Norwegians in the eleventh century.

Discovery of America by Columbus.

The obscure allusions of Aristotle, Plato, and Seneca, to a country hid in the Western Ocean, must have derived fresh importance from the discovery of the Canary Isles, Madeira, and the Azores in the early part of the fifteenth century. The love of maritime adventure was excited by these events; and among the active spirits who were attracted to nautical life by the career of distinction which was then opened up, was Christopher Columbus. Our limits do not permit us to enter into details respecting this great man, an outline of whose life will be found under the proper heading. He had received a learned education, and the study of the geographical systems then in vogue impressed him with a strong conviction that a voyage to India by a course directly westward was quite practicable with the degree of nautical science which his contemporaries possessed. From the old and imperfect maps of Ptolemy he was led to believe that the parts of the globe known to the ancients embraced 15 hours, or 225 degrees of longitude, which exceeds the truth by more than one-third. The discovery of the Azores on the west side had lengthened the space by one hour; and the accounts gleaned by Marco Polo in Asia induced him to think that the isles connected with this continent stretched out so far to the eastward that their distance from Europe could not be great. Columbus was, however, without the fortune necessary to fit out ships; and when he attempted to interest some of the princes of those times in his project, he encountered neglects and difficulties which would have exhausted the patience of any mind less ardent than his own. At length, after many delays and discouragements, Ferdinand and Isabella of Spain supplied him with three small vessels, two of them only half-decked; and in this little armament, accompanied by 120 men, he set sail from the port of Palos on the 3d of August 1492. He proceeded first to the Canary Isles, where he was detained three weeks in repairing one of his vessels. On leaving these isles he entered on a region of ocean where all was mystery. The trade-wind, however, bore him steadily along, and the labour of the ships proceeded cheerfully, till the increasing length of the voyage, the failure of prognostics which had from time to time kept alive the hopes of the crew, and various circumstances interpreted by their superstition as evil omens, produced a mutinous spirit, which all the address and authority of Columbus would not have been able to quell had the discovery of land happened one day later than it did. Columbus, says Humboldt, on sailing westward of the meridian of the Azores, through an unexplored sea, sought the east of Asia by the western route, not as an adventurer, but according to a pre-conceived and steadfastly-pursued plan. He had on board the sea-chart which the Florentine astronomer Toscanelli had sent him in 1477. If he had followed the chart, he would have held a more northern course, along a parallel of latitude from Lisbon. Instead of this, in the hope of reaching Zipangu (Japan), he sailed for half the distance in the latitude of Gomera, one of the Canary Islands. Uneasy at not having discovered Zipangu, which, according to his reckoning, he should have met with 216 nautical miles more to the east, he after a long debate yielded to the opinion of Martin Alonzo Pinzon, and steered to the south-west. The effect of this change in his course curiously exemplifies the influence of small and apparently trivial events on the world's history. If Columbus, resisting the counsel of Pinzon, had kept his original route, he would have entered the warm current of the Gulf Stream, have reached Florida, and thence perhaps been carried to Cape Hatteras and Virginia. The result would probably have been to give the present United States a Roman Catholic Spanish population, instead of a Protestant English one, a circumstance of immeasurable importance. Pinzon was guided in forming his opinion by a flight of parrots towards the south-west. Never, says the Prussian philosopher, had the flight of birds more important consequences. It may be said to have determined the first settlements on the new continent, and its distribution between the Latin and Germanic races. It was on the 12th of October that the western world revealed itself to the wondering eyes of Columbus and his companions. What a triumph for this extraordinary man, who had treasured in his breast for twenty years, amidst neglect, discouragement, and ridicule, the grand truth which his own incomparable skill, wisdom, and firmness had now demonstrated in the eyes of an incredulous world! The spot which he first touched was Guanahani, or Watling Island, as was suggested by Muñoz in 1793, and proved by Mr R. H. Major in 1870. After spending nearly three months in visiting Cuba, Hispaniola, and other isles, he returned to Spain. He made three other voyages, and in the second coasted along a part of South America, which he rightly judged to be a continent from the volume of water poured into the sea by the Orinoco. But he died ignorant of the real extent and grandeur of his discoveries, still believing that the countries he had made known to Europe belonged to that part of Eastern Asia which the ancients called India. Hence the name of West Indies which the tropical islands and part of the continent have ever since received.

Progress of discovery and colonisation.

We should extend this article to an unreasonable length were we to describe in detail the discoveries and settlements made by the several nations of Europe in America. We shall therefore confine ourselves to a very brief chronological notice of the more important events.

1495. The first place in which the Spaniards established their power was the large island of Hayti or Hispaniola, which was inhabited by a numerous race of Indians of a mild and gentle character, a third part of whom are said to have perished within two or three years after the Spaniards conquered them.

1497. John Cabot discovered Newfoundland June 24th, and coasted along the shores of North America to Florida.

1498. Columbus first saw the mainland, May 30.

1500. Cabral, a Portuguese, visited the coast of Brazil, and discovered the mouth of the Amazon. It was probably colonised before 1515. In 1500, too, Cortereal touched at Labrador.

1508. Vincent Pinzon is said to have entered the Rio de la Plata. It was in the same year that the Spaniards, finding the aborigines too weak for the labour of the mines in Hayti, first imported negroes from Guinea, and thus laid the foundation of a traffic which continued to disgrace the civilisation of Europe for three centuries.

1511. Diego Columbus conquered the island of Cuba with 300 soldiers, of whom he did not lose one.

1513. Balboa crossed the Isthmus of Darien with 290 men, and discovered the South Sea.

1519. Hernando Cortes sailed from Cuba with 11 ships and 550 men, and landed on the coast of Mexico, which had been discovered in the previous year. The conquest of the empire was finished in 1521 by 950 Spaniards, assisted by a vast number of the Indians of Tlascala.

tianity among the natives. The announcement was contained in a letter addressed to a person in Washington, and published in Nile's *Register* (Baltimore), in November 1828. But M. Rafn afterwards found reason to change his opinion as to the site of the Icelandic colony, and he latterly considered that it was at the mouth of the River Taunton, which falls into the sea in Narraganset Bay, at the north end of Rhode Island.

1531. Peru invaded by Pizarro, and conquered in little more than one year, with a force of 1000 men.

1535. Jacques Cartier, a Frenchman, discovers the Gulf of St Lawrence.

1535. Mendoza, a Spaniard, with 2000 followers, founds Buenos Ayres, and conquers all the country as far as Potosi, at which silver mines were discovered nine years after.

1537. Cortes discovers California.

1541. Chili conquered; Santiago founded; Orellana sails from the sources of the Rio Napo down the Amazon to the Atlantic.

1578. New Albion, on the north-west coast of America, discovered by Sir Francis Drake.

1586. The Spaniards found St Thomas' Island, in Guiana.

1587. Davis' Straits and Cumberland Islands discovered by John Davis.

1604. De Monts, a Frenchman, founded the first settlement in Nova Scotia, then called Acadie.

1607. After many ineffectual attempts during more than twenty years, the first permanent settlement of the English in North America was made this year, on the banks of the James River, in Virginia.

1608. Quebec founded by the French, who had had a small neglected colony in Canada from 1542.

1611. Newfoundland colonised by the English; a Dutch colony established at Hudson's River.

1614. New York founded.

1618. Baffin penetrates to the 78th degree of latitude, in the bay which bears his name.

1619. First negroes imported into Virginia. They were brought by a Dutch vessel.

1620. It was in this year that the first English colony was established in New England at Plymouth.

1635. A French colony established in Guiana.

1655. Jamaica conquered by the English.

1664. The Dutch colonies on Hudson's River capitulate to the English.

1666. The Buccaneers begin their depredations on the Spanish colonies.

1682. William Penn establishes a colony in Pennsylvania. La Salle takes possession of Louisiana in the name of the French king.

1698. A colony of 1200 Scots planted at Darien. In the following year the settlement was attacked by the Spaniards, and abandoned.

1733. Georgia colonised by the English.

1760. Canada and all the other French settlements in North America conquered by the English.

British colonies.

We must pause at this point to give a very short account of the colonial system introduced by the principal European nations who occupied extensive tracts of the new world. The English settlements extended from the 31st to the 50th degree on the east coast, and were divided into 15 or 16 provinces. The colonists had carried the love of liberty characteristic of their countrymen with them; and after many struggles with their British rulers, all the provinces, with one or two exceptions, were permitted to enjoy a form of government extremely popular. The executive power was vested in a governor appointed by the king. He was assisted by a council, which sometimes conjoined the functions of a Privy Council and a House of Peers. The people were represented by a House of Assembly, consisting of persons chosen by the freeholders in the country parts, and the householders or corporations of towns. The governor could levy no money without the consent of the House of Assembly: the British parliament, however, claimed, but scarcely ever exercised, the privilege of imposing taxes upon the colonists without consulting them. Against this assumption of power the local legislatures always protested as an infringement of their rights. The vessels of foreign states were not permitted to trade with the colonies; but the colonists were allowed to trade in their own ships with one another, with the mother country, and, to a limited extent, with foreign states. Their taxes, which were always small, were all consumed in defraying internal expenses; and, compared with any other people in the new world, they enjoyed an unexampled degree of commercial and political liberty. It was the growing prosperity of the colonies and the increasing debt of the mother country, which induced the British ministers, for the first time, in 1764, to attempt raising a revenue in America, for purposes not colonial. The experiment was made by imposing a stamp-duty on newspapers and commercial writings. The sum was trifling; but the Americans, far-sighted and jealous of their rights, saw in it the introduction of a principle which deprived them of all security for their property. The people declared themselves against it as one man, in local assemblies, and by petitions and publications of all kinds. The ministers became uneasy, and repealed the tax; but, as a salve to the pride of the mother country, a declaratory Act was passed, asserting her right "to bind the colonies in all cases whatsoever." The idea of raising a revenue in America was not renounced, but another mode was to be tried. Duties were laid on glass, colours, paper, and tea, and were met by an opposition in the colonies still more zealous and determined. The British ministers, irritated, but wavering in their purpose, dropped all the taxes but that on tea, and commenced at the same time a series of alarming innovations. They closed the port of Boston, changed the charter of the province, placed judges and juries on a footing to render them more subservient to the views of the government, and introduced a strong military force to overawe the people. On the other side, the colonists passed resolutions not to import or consume any British goods, and hastened to supply themselves with powder and arms. Blood was at length shed in April 1775, at the village of Lexington; and in the following year the American Congress published their celebrated declaration of independence. We shall not enter into the details of the war, which was closed in 1782. Suffice it to say that, on the part of the Americans, it rested on high grounds; it was a war to vindicate a principle—for the practical grievance was admitted to be slight; and it was conducted with a regard to humanity of which there are few examples in history.

Spanish colonies.

The Spanish possessions in America before the revolution formed nine distinct governments, all constructed on the same plan and independent of one another. Four of these, of the first rank, were vice-royalties, viz., Mexico, Peru, La Plata, and New Granada; and five were captain-generalships, viz., Yucatan, Guatemala, Chili, Venezuela, and the island of Cuba. The government was vested in the viceroy or captain-general, who was held to represent the king, and to enjoy all his prerogatives within the colony. But in these countries, as in others where the supreme power is apparently unlimited, it was indirectly restrained by the influence of the courts of justice, corporations, and other public bodies. The royal audiencias or supreme courts, composed of Spaniards nominated by the crown, had extensive judicial powers, and were independent of the viceroys. The cabildos or municipalities, and the fueros or corporations (similar to our guilds), also possessed considerable privileges, which derived security and importance from long prescription. Lastly, the clergy, who were numerous and rich, necessarily possessed great influence among a supersti-

tious people. The vices naturally inherent in the colonial system existed in full force in the Spanish American dominions. There was tolerable security for all classes except the miserable Indians, who were regarded and treated precisely as beasts of burden, out of whose toil and sufferings a provision as ample as possible was to be extracted, first to supply the wants of the royal treasury, and next to provide for and satisfy the cupidity of a shoal of do-nothing public officers and priests. Edicts were indeed issued for the protection of the Indians, and persons appointed to enforce them; but these were feeble correctives of the evils rooted in the system, and not unfrequently increased their weight. The Indians, after the conquest, were at first slaves; they paid a capitation tax to the crown, and their labour was entirely at the disposal of their lord. This system was modified from time to time; but all the changes introduced down to the revolution did not release them from their state of vassalage. They still continued liable, in a less or greater degree, to the performance of compulsory labour, under the orders of persons against whom they had no protection, This was an enormous grievance; but, what was equally bad, being held incompetent in law to buy or sell, or enter into any pecuniary engagement beyond the value of a few shillings, without the agency of white men, the swarm of public functionaries had an unlimited power of interfering in their concerns, of vexing, harassing, and plundering them, under the forms of law. The memoir of Ulloa, long buried amidst the Spanish archives, with various other documents published since the revolution, depicts acts of extortion, perfidy, cruelty, and oppression practised upon the Indians which have rarely been paralleled. Men rose to affluence in offices without salaries; and the priests rivalled the laymen in the art of extracting money from those whom they ought to have protected. As the sole aim of the Spaniards in the colonies was to enrich themselves, so the government at home made all its acts and regulations subordinate to the grand object of raising a revenue. Spain retained in her hands the whole trade of the colonies, and guarded her monopoly with the most severe penalties. The price of all European commodities was enhanced three, four, or six fold, in America. The colonists were not allowed to manufacture or raise any article which the mother country could supply; they were compelled to root up their vines and olives; and for a long period one colony was not even permitted to send a ship to another. To support such a system it was necessary to keep the people in profound ignorance, and to cherish prejudices and superstition. The schools were extremely few, and permission to establish them was often refused, even in towns where the Spaniards and Creoles were numerous. The importation of books, except books of Catholic devotion, was rigorously prohibited. Even the more grave and dry sciences, such as botany, chemistry, and geometry, were objects of suspicion. And the more effectually to crush all mental activity, natives of America could rarely obtain leave to go abroad, to seek in foreign countries what was denied them in their own. On the other hand, the priests, sharing in the spoil, filled the minds of the people with childish superstitions, as a means of confirming their own power, and employed the terrors of religion to teach them patience under oppression. To create a race of servants devoted to its purposes, the court bestowed all offices, from the highest to the lowest, on natives of the peninsula exclusively. The wisdom of the plan seems questionable, but that it was adhered to with wonderful pertinacity is certain. "It was the darling policy of Spain," says Mr Ward, "to disseminate through her American dominions a class of men distinct from the people in feelings, habits, and interests, taught to consider themselves as a privileged *caste*, and to regard their own existence as intimately connected with that of the system of which they were the principal support." With all those means and appliances, it is extraordinary that Spain should have been able to uphold for three centuries a system in which the interests of so many millions of human beings were so habitually and unrelentingly sacrificed. It was the course of events, much more than its own inherent weakness, which ultimately caused its subversion.

Revolutions in Spanish America.

After the seizure of Ferdinand and the elevation of Joseph Buonaparte to the throne of Spain, orders were dispatched to all the colonies with the view of securing their obedience to the new dynasty. The men in office were generally disposed to submit, but the treacherous conduct of the French excited a universal hatred of their cause among the people; and when the regency established in Spain presented the semblance of a patriot government, the loyalty of the Americans blazed forth, and poured large contributions of money into the hands of Ferdinand's adherents. The weak and suspicious conduct of the regency, however, and its subserviency to the grasping spirit of the merchants of Cadiz, at length alienated the colonists, and roused them to take measures for their own security. But the diversity of views and interests among the colonists rendered the course to be adopted a matter of some delicacy. Ferdinand, being a prisoner, was, politically speaking, a nonentity. Napoleon's brother was clearly an usurper, odious to, and rejected by, the mass of the Spanish people. The regency, shut up in Cadiz, without troops or revenue, was but a phantom; and the little power it had was so employed as to raise doubts whether its members were not secretly in league with the enemy. In these circumstances, when the only government to which the colonists owed allegiance had fallen into abeyance, the wisest course they could have pursued was to declare themselves independent. This would at once put a stop to the machinations of France, which they dreaded, and prevent the regency from compromising or sacrificing their interests by its weakness or treachery. The Spaniards, however, who occupied all public situations, were averse to a change which they foresaw must lead to the downfall of their power. This was perfectly understood by the other classes; and in the first movements which took place in the different colonies nothing was said derogatory to the supremacy of Spain, though independence was clearly aimed at. By spontaneous efforts of the people "juntas of government" were formed, at Caraccas in April 1809, at La Paz in Upper Peru in July, at Quito in August, at Santa Fe and at Buenos Ayres in May 1810, and at Santiago in Chili in September the same year. In 1810, also, the first insurrection broke out in Mexico. The colonists unluckily had been too long the slaves of superstition and tyranny to be fit for conducting so bold an experiment; and after a struggle, which was generally short, but almost everywhere bloody, the juntas were all put down except in Colombia and Buenos Ayres. But in the stir and tumult of the contest old prejudices had received a shock, and the seeds of political change had struck their roots too deep in the soil to be eradicated. A desultory war was carried on for six years between Buenos Ayres and Upper Peru, with little advantage on either side. At length, in 1817, the former state, which had assumed the style of an independent republic four years before, sent an army across the Andes to Chili, under General San Martin, and defeated the Spaniards at Chacabuco. A second victory, gained at Maipo in April 1818, led to the entire subversion of the Spanish power in this colony. The war was now transferred to Peru, where the Spaniards continued

Chili and Peru.

to lose ground, till the decisive battle of Ayacucho put an end to their power in December 1824. Rodil and Olaveta, with the obstinacy of their nation, held out for some months longer, when every chance of success was gone; but after the surrender of Callao in January 1826, the Spanish flag no longer waved on any spot in the land of the Incas.

New Granada. In New Granada and Venezuela the struggle was more bloody, variable, and protracted than in any other part of South America. As this portion of the dominions of Spain was comparatively easy of access, and from its central position was in some measure the key to the whole, she made immense efforts for its preservation. No less than ten thousand troops were sent out to it within the course of one year. The patriots, on the other hand, possessed advantages here, in the greater intelligence of the population, and the easy intercourse with the West Indies. From 1809, when juntas were established in Caraccas and Quito, to the surrender of Porto Cabello in 1823, the vicissitudes of the war were numerous and extraordinary. The patriots were repeatedly on the eve of a complete triumph, and as often the state of their affairs seemed nearly hopeless. But the spirit of resistance never was entirely subdued. The cause was rooted in the hearts of the people, and was insensibly gaining ground even during its reverses. To attempt the faintest outline of the military operations would lead us beyond our proper limits. It is enough to state that the decisive victory of Carabobo, gained by the patriots in 1819, gave them an ascendancy which they never afterwards lost; but the Spaniards, according to their custom, continued to maintain the contest as long as they had a foot of land in the country, and were only finally expelled in 1823.

Mexico. In Mexico the revolutionary movement began at Dolores in 1810, and soon wore a very prosperous appearance; but the weakness or false pride of the Creoles, who were cajoled into the ranks of their oppressors the old Spaniards, armed against the patriots those who should have been their firmest supporters, and by one or two mischances the force of the independent party was ruined in November 1815, when Morelos, their able leader, was taken prisoner and executed. For six years after this period many guerilla bands maintained themselves in the provinces, and greatly annoyed the Spaniards; but they did not act in concert, and no congress or junta professing to represent the Mexican people existed. Even during this interval the desire for independence was making great progress among the population; but the establishment of a constitutional government in Spain in 1820, and its extension to the colonies, gave a new aspect to the affairs of Mexico. The viceroy Apodaca, while outwardly yielding obedience to the new system, was silently taking measures to effect its overthrow; but he mistook the character of the agent he employed. This person, the celebrated Iturbide, turned his own arms against him, proclaimed a constitution under the name of "the three guarantees," and put an end to the dominion of Spain in 1821, almost without bloodshed. Iturbide, who had nothing in view but his own aggrandisement, called a congress, which he soon dissolved after getting himself proclaimed emperor. His usurpation kindled a spirit of resistance. He was exiled in 1823, made a new attempt on the liberties of his country in 1824, was taken prisoner, and expiated his crimes by a military death within a few weeks after he landed.

Guatemala. Guatemala was the last portion of the American continent which threw off the Spanish yoke. In 1821 the persons in office assembled and formed a junta. Divisions arose, which were fomented by the intrusion of a Mexican army sent by Iturbide. This force, however, was beaten, and an elective assembly called, which declared the country independent, and established a constitution in July 1823. Spain now retains none of her possessions in the new world but Cuba and Porto Rico.

Portuguese colony of Brazil. The government of Brazil was conducted by the Portuguese on a system extremely similar to that of the Spanish colonies. The monopoly which the mother country retained of the commerce of the colony was equally rigorous; the restrictions on its internal industry as severe; and the same means were employed to keep the people in a state of pupilage and ignorance. Down to 1806 a single printing-press had never existed in Brazil. In 1807, when the emperor Napoleon had resolved to possess himself of Portugal, and if possible to get the royal family into his power, the king, seeing no other means of escaping from the clutches of his enemy, embarked with his suite in several ships, and sailed for Brazil, where he arrived in January 1808. He was received with joy by the colonists, who anticipated great benefits from his residence, of which they were not disappointed. One by one the fetters of colonial dependence fell off. Within a few months printing-presses and newspapers were established, the ports were opened to the trade of all nations, and the people were invited and encouraged to prosecute all those branches of internal industry from which they had till now been interdicted. To crown and secure these advantages, Brazil was declared an independent kingdom in 1815, subject to the crown of Portugal, but entitled to its separate administration and its own laws. The revolutionary spirit pervading the Spanish colonies now found its way into Brazil, and produced an insurrection at Pernambuco in 1817. It was soon subdued, but received a new impulse from the constitutional systems suddenly introduced into Spain and Portugal in 1820. To quiet the popular feeling, it was announced that the Portuguese constitution would be extended to Brazil. Before this had been done, however, the old king had sailed for Europe, leaving his son Dom Pedro to rule in his absence. The people now discovered, or believed, that the object of the king was to degrade Brazil again to the rank of a colony, and to restore the old system in all its rigour. Meetings were held, and resolutions adopted to maintain the independence of the country at all hazards; and the patriots, gaining confidence by degrees, called loudly for the establishment of a legislature, and besought Dom Pedro to put himself at the head of the independent government. Ambition or policy induced Pedro to listen to the solicitation: in 1822 he was proclaimed emperor, and had his own title and the independence of Brazil acknowledged by his father three years afterwards. A representative system was at the same time introduced. An unlucky war now arose with Buenos Ayres, which weakened both countries; but it was at length terminated in 1828 by the recognition of the disputed territory as an independent state under the title of the Banda Oriental.

Empire of Brazil.

Existing Political Divisions. Having finished this brief notice of the series of revolutions which broke the fetters of America, we shall now give a very short sketch of the new political order of things which has arisen out of these changes, referring for a detailed account of the several states to the articles appropriated to them in the different volumes of the present work.

America, with its islands, embraces at present (1874) twenty-one independent states, and various colonies belonging to six European powers. The former are—1. The United States of North America; 2. Brazil; 3. Mexico; 4. Venezuela; 5. Colombia; 6. Ecuador or Quito; 7. Peru; 8. Bolivia or Upper Peru; 9. Chili; 10. La Plata, or the Argentine Republic; 11. Uruguay; 12. Paraguay,

13. Patagonia; 14. Costa Rica, 15. Mosquitia; 16. Guatemala; 17. Honduras; 18. Nicaragua; 19. San Salvador; 20. Hayti; 21. San Domingo. The colonies belong to Britain, Denmark, Sweden, Holland, France, and Spain. Patagonia is merely the geographical name of a district of Chili, occupied by independent tribes of Indians; Mosquitia, or the Mosquito coast, is a small Indian state ruled by a native king; and Hayti is a negro republic proclaimed in 1867. For detailed accounts of these various states and colonies we refer to the articles under the proper heads. At present we must confine ourselves to a brief notice of the more important ones.

United States. The United States were colonised a century later than Spanish America; but their brilliant and rapid progress shows in a striking light how much more the prosperity of nations depends on *moral* than on *physical* advantages. The North Americans had no gold mines, and a territory of only indifferent fertility, covered with impenetrable woods; but they brought with them intelligence, industry, a love of freedom, habits of order, and a pure and severe morality. Armed with these gifts of the soul, they have converted the wilderness into a land teeming with life and smiling with plenty; and they have built up a social system so pre-eminently calculated to promote the happiness and moral improvement of mankind, that it has truly become the "envy of nations." The republic is bounded on the north by Canada, on the south-west by Mexico, and on the other sides by the sea. In the year 1874 it consisted of thirty-seven states, with one *district* and eleven *territories*, which latter will be converted into *states* as soon as each acquires a sufficient population. The extent of the country, including the Indian lands stretching west to the Pacific Ocean, over which it claims a right of pre-emption, embraces 3,603,844 square miles of land. The agriculture of the United States partakes to some extent of a tropical character. The sugar-cane is cultivated in Louisiana, Florida, and other states as far north as the latitude of 31½°. Cotton is raised in all the south-east states S. of the 37th parallel, and tobacco chiefly in the middle states. Wheat succeeds in the middle and northern states, and maize thrives in every part of the Union. Agriculture is conducted with considerable skill; but the "high farming" practised in England would not pay in America, where money is of much value and land of little. Scarcely any portion of the soil is rented in the United States: the farmers are almost universally proprietors; and when their property is extensive, which rarely happens, it is soon broken into small occupancies under the law of equal division. The advance the Americans have made in manufactures may be judged of from the fact that in 1870, according to the census then taken, there were upwards of 35,000 operatives employed in 969 cotton factories, and 77,870 in 1938 manufactories of woollen goods. The iron industries gave employment to upwards of 140,000 hands, the iron produced in the country reaching nearly two millions of tons. In the useful arts generally America is on a level with France and England. The internal commerce of the United States is conducted with extraordinary spirit. The amount of capital expended on roads, canals, harbours, bridges, and other public works, is very great. The length of the lines of railway open for traffic now exceeds 70,000 miles, and is rapidly increasing. The extent of the foreign trade of the country, and the amount of its shipping, place it next to Great Britain in the list of commercial nations.

The population of the United States in 1870 was by census	38,558,371
In 1800 it was	5,308,483
Increase in 70 years	33,249,888

Since 1800 the rate of increase has been remarkably uniform at nearly 3½ per cent. per annum. In 1871 the number of immigrants was 346,938, of whom 198,843 migrated from the British Isles, 107,201 from Germany, 6030 from China, and the remainder from British North America, Sweden, Norway, France, Austria, Italy, Switzerland, Denmark, and Russia.

Slaves were first introduced in 1619. In 1775 slavery was abolished in Rhode Island; in 1780 Massachusetts abolished it; then numerous northern states followed, and in December 1865 slavery was abolished throughout the United States. By subsequent amendment of the constitution all negroes were admitted to all the privileges of citizenship. Thus it was enacted on March 30, 1870, that "no discrimination should be made in the United States among the citizens of the United States in the exercise of their elective franchise, or in the right to hold office in any state, on account of race, colour, nativity, property, education, or creed." Every person born or naturalised in the United States is recognised to be a citizen thereof.

The American government is a pure representative democracy in which the people are recognised as the fountain of all power; and the sole object of all its mechanism is to give effect to their deliberate opinions. The federal government and the governments of the separate states are constituted on the same plan. The legislature consists in every case of two bodies, a House of Representatives chosen for one or two years, and a Senate for a period varying from two years to six—all chosen by popular election, except in the case of the Federal Senate, which is elected by the legislatures of the thirty-seven states. The President holds his office for four years, but is occasionally re-elected for four years more.

The characteristic facts in the condition of America are the non-existence of titles, of privileged classes, of corporations in our sense of the term, of a landed aristocracy, of mendicity except to a very limited extent, and of an endowed church; the cheapness and efficiency of its government, the universality of education, the omnipresence of its periodical press, the high feeling of self-respect which exists in the very humblest classes, and the boundless spirit of enterprise which pervades all classes of society. The higher classes are less polished than in England, the middle are perhaps less carefully instructed; but the American people, taken collectively, are at least as well educated and have as much intelligence and manliness of character as any other nation in the world.

In 1867 the territory formerly known as Russian America was purchased by the United States, and called Alaska. It occupies the north-west corner of the continent, and extends along the coast as far south as Mount Elias, where it is bounded by British Columbia and the southern end of Prince of Wales Island, in 54° 40′ N. It comprises an area of about 570,390 square miles. Furs and fish are the most valuable commodities. Sitka is the capital. It is situated on an island in 57° 2′ 45″ N. and 135° 17′ 10″ W. It has a population of over 2000 persons. The Yukon river, which is about 2000 miles long, flows through the territory.

British North America. British North America is bounded on the south by the United States, on the north by the Arctic Ocean, and on the west by Alaska. In 1867 the provinces of Ontario (formerly Upper Canada), Quebec (formerly Lower Canada), Nova Scotia, New Brunswick, Manitoba (formerly Hudson's Bay Territory), and British Columbia, were united under the title of "The Dominion of Canada," while Newfoundland and Prince Edward Island still remained independent. The executive power is vested in the sovereign of the British empire, but is carried out by a Governor-General and Privy Council. The Parliament consists of a Senate and a House of Commons. The senators are nominated for life

by the Governor-General, and are 75 in number. The members of the House of Commons are elected by the people in the proportion of one member for each 17,000 souls. The seat is retainable for five years, and each member is allowed a salary and travelling expenses. Ottawa is the capital of the Dominion. According to the latest census, taken on April 3, 1871, the area and population of the several provinces are as under:—

	Area, square miles.	Population.
Ontario	121,260	1,620,842
Quebec	210,020	1,191,505
Nova Scotia	18,660	387,800
New Brunswick	27,105	285,777
Manitoba	2,891,734	111,963
British Columbia	213,000	50,000
	3,481,779	3,647,887
Newfoundland (1869)	40,200	146,536
Prince Edward Island (May 1871)	2,173	94,021

In 1871 the Dominion had 2854 miles of railway open, 1173 miles in preparation, and 3000 miles for which concessions had been granted by the government. A line has been projected to extend from Lake Superior to the Pacific Ocean.

Brazil. Brazil is the largest state in South America, and enjoys the greatest combination of natural advantages. It is bounded on the south, west, and north, by La Plata, Paraguay, Uruguay, Bolivia, Peru, Ecuador, Colombia, Venezuela, and Guiana. Embracing an area of 3,100,000 English miles, it is nearly as large as Europe, and is capable of supporting a much greater population. Its climate is probably cooler and more salubrious than that of any other extensive tropical country; and every part of its soil is rich and fruitful, as its magnificent forests and the exuberance and boundless variety of its vegetable productions attest. Its commerical advantages are admirable. No country in the new world has the same facilities for carrying on intercourse with Europe and with all its neighbours. The Amazon, with its numerous branches, the Parana, the Tocantins, the St Francisco, and other streams, supply the most remote parts of the interior with easy means of communication with the sea. Brazil possesses iron, copper, and probably all the other metals; but her mines of gold and diamonds are remarkably rich. Her most valuable productions for exportation are cotton, sugar, coffee, hides, tobacco, vanilla, dyewoods, aromatic plants, timber, &c. Her commerce is much greater than that of all the Spanish colonies put together. The Brazilians are lively, irritable, hospitable, but ignorant, superstitious, and rather inclined to indolence. Their acquisition of independence in 1822, however, worked like a charm, and produced an extraordinary change in their industry, opinions, and modes of thinking. There are numerous schools, but although the education is gratuitous, they are not well attended. The advance literature has made will be allowed to be great when it is remembered that printing was unknown in the country in 1807. According to the constitution introduced by Dom Pedro, the legislature consists of a Senate of 52 members, who hold their places for life, and a House of Congress of 107, elected by the people for four years; upon the acts of both of which bodies the emperor has a negative. The members of the lower house are chosen by elections of two stages. The householders of a parish meet and appoint one elector for every thirty of their number, and the electors thus chosen meet in districts and choose the deputies. The members of both houses receive salaries. The executive power is invested in the emperor assisted by a ministry and a council of state.

The population of Brazil amounted to 3,671,558, according to returns published in 1818, and procured probably for the purpose of taxation. This was exclusive of the wandering Indians. In 1823 it was estimated at 4,000,000 by Humboldt. M. Schœffer carries it to 5,700,000, and an estimate for 1867 makes it 9,858,000, comprising 8,148,000 free persons, and 1,674,000 slaves. The census taken in 1872 gives a population of 10,095,978, including 1,683,864 slaves.

Brazil, unlike the Spanish American provinces, has remained, subject to its ancient sovereign; and its government, from being colonial, has become imperial and independent, without any violent revolution. The result has been greatly in favour of the peace and prosperity of the country. See BRAZIL.

The portion of South America next to the isthmus includes the states of Venezuela, Colombia, and Ecuador. From 1820 till 1831, when a separation took place, it formed one state under the name of Colombia; which name has recently been assumed by the republic long known as New Granada. The territories of these three states are bounded on the south by Peru, on the south-east and east by Brazil and Guiana, on the other sides by the sea, and embrace an area of 1,020,000 square English miles. The soil is fruitful and the climate salubrious, except along the coast and in a few other low situations. The eastern part consists chiefly of the llanos or steppes of the Orinoco, which are very hot; the western, of the mountain ridges of the Andes, which support tracts of table-land where the blessings of a temperate climate are enjoyed, and the cerealia of Europe can be successfully cultivated. The tropical vegetation extends to the height of 4000 feet; from 4000 to 9000 is the region where wheat, barley, and leguminous plants thrive. Above the level of 9000 feet the climate becomes severe; and at 15,700 feet vegetation ceases. The situation of Colombia is highly favourable for commerce. It has excellent ports on both seas; and being mistress of the isthmus of Panama, it has superior facilities for establishing a communication from the one to the other. The Orinoco and the Amazon afford the inmost districts of Venezuela and Ecuador the advantages of water carriage to the ocean. The Cassiquiari, an intermediate channel, by which the Orinoco bifurcates or connects with the Amazon (a remarkable hydrographical phenomenon), is within the limits of Venezuela. The territory contains much gold and silver—the former in alluvial deposits: it has mines of copper and mercury also, with platinum, iron, and coal. Its tropical productions are similar to those of Brazil; but it has as yet cultivated few articles for foreign markets, and its exports are inconsiderable. The civilised population of this country is chiefly located in the districts near the coast, and in the high valleys or table-land of the Andes. Its amount, according to the *Statesman's Year-Book*, is— Columbia, Venezuela, and Ecuador.

Venezuela	1,564,433
Colombia	2,794,473
Ecuador	1,300,000
	5,658,906

It is always of importance to know in what proportions the different races are blended, but on this subject we have only approximate data. In Colombia the whites form about half of the population, the Indians about one-third, and the negroes about one-tenth, the remainder being of mixed blood. In Venezuela the whites form about one-third, the Indians about one-thirtieth, and Zamboes (from Indians and negroes) about one-half. In Ecuador the proportions are, roughly—whites one-sixth, Indians nearly one-half, negroes one-thirteenth.

All the three states are republican. See VENEZUELA, COLOMBIA, and ECUADOR.

The Argentine Republic, or La Plata, is, in point of natural advantages, the second state of importance in South

ENCYCLOPÆDIA BRITANNICA NINTH EDITION

Argentine Republic, or La Plata. America. It is bounded on the west by Chili; on the north by Bolivia; on the east by Paraguay, Brazil, Uruguay, and the sea; and on the south by Patagonia. It embraces an area of 515,000 square miles if we include Tucuman, Salta, Santiago del Estero, and Jujuy, which scarcely acknowledge its authority. Nearly the whole territory of this republic consists of open plains destitute of timber, called *pampas*, extending from the Atlantic and the river Paraguay to the Andes. The eastern part of these plains exhibits a vigorous growth of herbage, intermixed with a forest of gigantic plants, 9 or 10 feet high, which have been called thistles, but are now known to be artichokes; in the middle they are covered with grass; and the western division, which extends to the foot of the Andes, consists of barren sandy plains, thinly sprinkled with shrubs and thorny trees. The openness and dryness of the country, however, render it healthy; and by the Parana, the Paraguay, and their branches, it possesses a great extent of natural inland navigation. It has mines of gold, silver, copper, lead, and probably iron; but its mineral riches have been greatly diminished by the separation of Potosi, Cochabamba, La Paz, and other provinces now forming part of Bolivia. The force of this republic lies almost entirely in the wealth, intelligence, and commercial spirit of its capital, Buenos Ayres, which contains 150,000 souls, including a large proportion of foreigners. A small number of *estancias*, or grazing farms, are sparingly diffused over its boundless plains, the proprietors of which keep multitudes of horses and mules, flocks of sheep, and vast herds of cattle; the latter being chiefly valued for their skins. These people are a bold, frank, hardy, half-civilised race, who live isolated in the wilderness, and scarcely acknowledge any government. The census of 1869 gives a total population of 1,736,922. See Argentine Republic; and for the two small states formed out of the north-eastern portion of its territory, see Paraguay and Uruguay. Entre Rios, formerly a separate state, is now a province of La Plata.

Chili. Chili extends along the coast of the Pacific from 24° to 56° of south latitude: its length is 2270 miles; its breadth varies from 40 to 200; and its surface, exclusive of Araucania, which has an area of 88,000 sq. miles, is estimated at 130,977 English square miles. The country consists properly of the western slope or declivity of the Andes, for the branches of the mountains running out in tortuous directions from the main trunk reach to the sea-shore. It enjoys an excellent and healthful climate; severe cold is unknown in the inhabited parts, and the heat is seldom excessive. The useful soil bears a small proportion to the entire surface of the country, consisting merely of the bottom of the valleys. It has rich mines of gold, silver, and copper in the northern provinces; but very few of them can be worked in consequence of the absolute sterility of the adjacent country. Its two northern provinces, occupying 450 miles of the coast, are nearly perfect deserts. The soil continues extremely dry, and yields nothing without irrigation, till we reach the latitude of 35°; and it is believed that not one-fiftieth part of the country is fit for cultivation. But south of the river Maule the land is covered with fine timber, and bears crops of wheat and other grain without the aid of any other moisture than what is supplied by the atmosphere. This is in truth the fine and fruitful part of Chili; and the project was once entertained of selecting its chief town, Conception, for the seat of the government. Chili has no manufactures, and is unfavourably situated for commerce. It has no navigable rivers, while its mountainous surface is an obstacle to the formation of roads; but nevertheless it has now upwards of 500 miles of railway opened. A representative constitution was established in Chili in 1833. An enumeration dated 1869 makes the population, exclusive of Araucania (with 70,000 aborigines), 1,938,861. See Chili.

Peru. Peru may be regarded as a continuation of Chili, consisting of the western declivities of the Andes, from the 4th to the 22d degree of south latitude, with the addition of a considerable tract on the east side of the mountains, between the 4th and 15th parallels. There are few countries in the world which have a more singular physical character than the western part of Peru. It is a belt or zone of sands, 1240 miles in length and from 70 to 600 in breadth, with inequalities of surface which might be called mountains if they were not seen in connection with the stupendous background of the Andes. This long line of desert is intersected by rivers and streams, which are seldom less than 20 or more than 80 miles apart, and on the sides of which narrow strips of productive soil are created by means of irrigation. These isolated valleys form the whole habitable country. Some of the large rivers reach the sea; the smaller are either consumed in irrigating the patches of cultivated land or absorbed by the encompassing desert, where it never rains, where neither beast nor bird lives, and a blade of vegetation never grew. No stranger can travel from one of these valleys to another without a guide, for the desert is trackless; and the only indications of a route are an occasional cluster of bones, the remains of beasts of burden that have perished. Even experienced guides, who regulate their course by the stars, the sun, or the direction of the wind, sometimes lose their path, and they almost inevitably perish. Of a party of 300 soldiers thrown ashore by a shipwreck in 1823 on one of these desert spaces, nearly a hundred expired before they reached the nearest valley. Ignorance and wonder have been busy with this singular region: legends are current, which tell that descendants of the ancient Peruvians have lived in some of these mysterious valleys, hid from the knowledge of their merciless invaders, since the days of the Incas. We have no reason to believe that more than one acre in a hundred of maritime Peru will ever be available for the sustenance of mankind. The country has two advantages—its mines of the precious metals, and a temperate and delightful climate, in consequence of the absence of rain and the fogs which intercept the solar heat. It can never be rich in the proper sense of the term, or make much progress in the improvements which depend upon a dense population. Like Chili, it has no navigable rivers—and nature has deprived it of the means of forming good roads. There are indeed few countries in the world whose natural advantages have been so much overrated as Peru; and it requires little sagacity to discover that its future career cannot correspond with its past celebrity. The districts east of the Andes, which have a hot climate accompanied with a rich soil, will ultimately be the most valuable part of the country; but their secluded situation and want of communication with other countries must keep them long in a backward state. The government is republican. Peru comprehends a surface of 502,760 square miles; the capital, Lima, contained in 1862 a population of 121,370. In that year a rough calculation was made which gave 3,199,000 as the entire population of the republic. It was also estimated that the proportions of races were :—

Indians	57 per cent.
Mixed races	23 ,,
Spaniards, Negroes, Chinese, &c.	20 ,,

Bolivia. Bolivia, or Upper Peru, lies eastward of Lower Peru, and is bounded on the south by the Argentine Republic, and on the north and east by Brazil. It is of an irregular form, and comprehends a space of 473,300 square miles. The climate is pleasant and healthful, the soil is generally dry, and in the eastern parts, as well as the elevated table-land, its aridity produces barrenness. Nature, however, as a compensation for its other disadvantages, has bestowed upon it some of the richest mines in the world. The country was erected

into an independent state only in 1826, and named Bolivia in honour of its liberator Bolivar. It has a small strip of barren territory on the shores of the Pacific Ocean, between the 22d and 25th parallel; but it is, properly speaking, entirely an inland country, and more deficient in the means of communicating with foreign nations than any other state in America. See BOLIVIA.

Guatemala. Guatemala or "Central America" originally occupied all the narrow part of the continent from the 83d to the 94th degree of west longitude, extending 800 miles in length, and covering a space of 130,000 square miles. The surface of the country is hilly, and in most parts mountainous; the climate warm and very moist. The mineral wealth of the country is not great; but this is compensated by the richness of its soil and its excellent commercial position. It was a federal republic, but its five provinces have now become independent states. Humboldt estimated the population of the five states at 1,600,000. According to a statement furnished to Mr Thomson, a former British envoy by the government, it was 2,000,000; while the most recent of the estimates made by the resident officials give a total of 2,335,019, viz.:—

Guatemala (1865)	1,180,000
St Salvador (1870)	434,520
Honduras	250,000
Nicaragua	350,000
Costa Rica	120,499
	2,335,019

The proportions of the different races have been estimated as follows:—

	Humboldt.	Thomson.
Whites and Creoles	20 per cent.	20 per cent.
Mixed classes	28 ,,	40 ,,
Indians	52 ,,	40 ,,

Mexico. Mexico is the most populous and powerful of all the new states erected in America since the commencement of the present century. Previous to the war with the United States it embraced an area of 1,600,000 square miles, which was reduced to 1,030,442 by the cession of the northern provinces in 1848. About three-fourths of the surface consists either of mountains or table-land, raised from 5000 to 10,000 feet above the sea. Owing to this extraordinary elevation, even those parts of the country which lie within the torrid zone (the low ground on the coast excepted) enjoy a dry, cool, and salubrious atmosphere; but this advantage is counterbalanced by the insufficient supply of moisture and the rapid evaporation resulting from the same cause, which render the soil generally rather arid, and in many parts absolutely barren; by the smallness of the rivers and the almost entire absence of inland navigation; and by the obstacles which the steep and rugged ascents from the coast present to land-carriage. The republic is, besides, almost destitute of ports on the Atlantic side. Mexico is extremely rich in the precious metals; and there are few regions upon which nature has lavished so great a variety of vegetable productions, or where plants fitted to the coldest and the hottest climates may be seen so nearly in juxtaposition. The low ground on the east coast is admirably adapted for raising sugar; and no country is more favourably situated for growing the other great articles of West India produce—coffee, cotton, cocoa, indigo, and tobacco. The raising of *bread-stuffs*—as they are termed by the Anglo-Americans—wheat, maize, and barley, with potatoes, the cassava root, beans, pumpkins, fruit, &c.—for domestic consumption, will necessarily be the chief branch of industry on the table-lands. The mines have never employed above 30,000 labourers; and their superior productiveness depends chiefly on two circumstances—the great abundance of the ore, which is only of poor quality, and the comparative facility with which they can be worked owing to their being generally situated in fertile districts, where provisions, wood, and all materials can be easily procured.

Mexico has had her full share of the ignorance and superstition which belonged to Spain; and these evils, with her internal dissensions and her rapacious, immoral, and intolerant clergy, are great obstacles to her improvement. That excessive inequality of fortune which corrupts both extremes of society has been nowhere in the world more prevalent than in Mexico. Individual proprietors possessed immense tracts of land and boundless wealth, while all the great towns swarmed with beggars, and thousands fell a sacrifice to famine from time to time. The Mexican constitution, which is federal and almost a literal copy of that of the United States, was established in 1824. The distinction of *castes*, which was maintained in the greatest rigour under the colonial system, has now disappeared, and power and office are open, not only legally but practically, to men of all colours. The African blacks formed an extremely small proportion of the Mexican population at all times; and since the revolution slavery has ceased. The number of inhabitants was estimated at 6,800,000 by Humboldt in 1823, and classed as follows:—

	Numbers.	Proportions.
Whites	1,230,000	19 per cent.
Mixed races	1,860,000	27 ,,
Indians	3,710,000	54 ,,

Mr Ward states that very few of the whites, so called, are free from a mixture of Indian blood; and now when the odious distinctions founded on complexion are abolished, they readily acknowledge it. Mr Ward estimated the population at 8,000,000 in 1827. In 1869 that of Mexico with its present boundaries was stated to be 9,176,082. See MEXICO.

Hayti, called formely Hispaniola and St Domingo, was a colony belonging partly to France and partly to Spain till 1791, when the blacks rose in arms, killed a number of whites, and expelled the rest. The attempts of England in 1793, and of France in 1801, to conquer the island, both failed, and Hayti has at length been acknowledged as an independent state by all the great powers, including France. The island, which contains about 28,000 square miles, is remarkably fertile; but its climate, like that of the West Indies generally, is rather unhealthy. The population, which before the revolution was estimated at 600,000, is now said to amount to 900,000 or 1,000,000, and it is almost entirely composed of blacks and mulattoes. The island formed one state till 1844, when the eastern or Spanish portion revolted, and established its independence. It is now the republic of "Dominica," ruled by a president, while the western portion, retaining the name of Hayti, was formed into an empire under Faustin I.; but in 1867 a republican constitution was proclaimed. After long negotiations, the French government agreed in 1838 to acknowledge the independence of Hayti on condition of the latter paying 60,000,000 of francs by small annual instalments continued for 30 years. The money was destined chiefly to indemnify the French proprietors who were chased from the island in 1791. Nothing has been paid of late years. Hayti.

The multifarious nature of the subject prevents us from attempting any description of the West India colonies, insular and continental. The islands have been variously denominated, but the most convenient division seems to us the following:—1. The Great Antilles, comprehending Cuba, Hayti, Jamaica, and Porto Rico; 2. The Small Antilles, extending in a semicircle from Porto Rico to the coast of Guiana; 3. The Bahama Isles, about 500 in number, of which, however, only a small number are inhabited. West Indies.

The British colonies are 18 in number, viz., 16 *insular*—Jamaica, Antigua, Barbadoes, Dominica, Grenada, Montserrat, Nevis, St Kitts, St Lucia, St Vincent, Tobago,

Tortola, Trinidad, Bahamas, Bermuda, Falkland Island; and 2 *continental*—British Guiana and Honduras. The colonies contained a population of 1,228,967 in 1871, of whom probably four-fifths were persons of colour.

The Spanish colonies are Cuba and Porto Rico. Cuba has an area of 45,883 square miles, and in 1867 the population was 1,414,508. Porto Rico has an area of 3530 square miles, and in 1866 a population of 646,362 persons. In 1867 there were upwards of 700,000 slaves in these two colonies.

In August 1872 the Spanish government issued a decree ordering that arrangements should be made for the gradual emancipation of the slaves; and in December 1872 a bill was laid before the Spanish Cortes for the abolition of slavery in Porto Rico in 1873; so that probably slavery will soon be extinct throughout the whole of America.

The French colonies in the West Indies include Martinique, Guadaloupe, and some smaller isles; and on the continent, Guiana. According to a recent authority the population of these colonies was 318,934.

The Dutch have Surinam on the continent, with the islands of Curaçoa, St Eustatius, and St Martin.

In 1870 the population of the islands was 35,482, and of Surinam 59,885, occupying an area of 2812 geographical square miles. Slavery has ceased since July 1863, when the Dutch government compensated the owners for 44,645 slaves.

The Danes have the small islands of Santa Cruz and St John, containing a population of 24,698 in 1860, of whom most are freed slaves, and St Thomas, which had in the same year a population of 13,463. St Bartholomew, another of the Lesser Antilles, belongs to Sweden.

Transit from the Atlantic to the Pacific.

The problem of making a grand highway for travel and traffic from the Atlantic to the Pacific, either across the breadth of the American continent or by taking advantage of the narrow isthmus that joins its northern to its southern portion, has been the subject of many schemes since its western as well as its eastern shores have been inhabited by enterprising nations, skilled in commerce and in mechanical arts. It is interesting to remark that, whereas the hope of sailing to India by a westward route was the motive which guided the navigators of the 15th century to the discovery of America, the means of internal communication for this part of the earth, and the geographical exploration of its remote extremities, have been more recently advanced by the desire of finding a path in this direction to the Asiatic resorts of mercantile activity. Arctic voyagers were at first invited to the icy seas of high latitudes by the dream of a north-west passage to China and the East Indies. It was a passage by sea from the Atlantic to the Pacific which Sir John Franklin went to seek in his last expedition in 1845, but which Captain Maclure effected in 1856, though by an opposite course from Behring's Strait to Baffin's Bay. But it is scarcely possible that this route along the north coasts of America should ever be habitually frequented by mariners going to and fro between the two oceans. At the opposite extremity of the continent arrangements have lately been made to substitute a shorter way to the Pacific for that round Cape Horn by improving the navigation of the Strait of Magalhaens, which separates Tierra del Fuego from the south portion of the mainland. The project of cutting a canal through the central American isthmus has often been discussed. There can be no doubt of the practicability of a system of inland navigation from the Atlantic coast by the river San Juan to Lake Nicaragua, and thence by a canal to the neighbouring Lake Managua or Leon, with a short artificial channel of exit to the Pacific. A different route, of combined river and canal navigation, has more recently been proposed, which would cut off the whole of the isthmus from the body of South America—entering the uppermost part of that mainland by the river Atrato from the Gulf of Darien, ascending this river 150 miles, then following up the course of the Napipi or the Bajaya, tributaries of the Atrato—crossing the coast range of hills by a canal with several locks, and descending to the Pacific either in Limon Bay or in the Gulf of Cupica. But these projects could be adapted only to the admission of vessels of smaller size than such as in the present day are commonly employed for commercial traffic between distant regions of the world. In spite of the grand example of the Suez Canal, it seems likely that, in a country tolerably productive of wealth and capable of supporting population, the more profitable means of providing for a through traffic will be found in railroads, which serve also for the accommodation of intermediate districts. In this class of undertakings North America has of late years displayed a wonderful degree of active enterprise. The line of 60 miles from Aspinwall, near Chagres, across the neck of land, which is there so narrow, to Panama, on the Pacific side, though situated in the territory of a Spanish republic, was constructed by citizens of the United States, expressly for the traffic between New York and San Francisco. But since that first opening of a gateway of communication with California, Australia, or China, for the travellers and merchandise of the Atlantic states or of Europe, the whole breadth of the continent where it widens, in latitudes between 35° and 45° N., all belonging to the United States, has been traversed by a continuous railroad system. The middle link of this system is the Union Pacific Railway, 1600 miles long, from Omaha, on the Missouri, in the state of Nebraska, through that state, up the course of the Platte river, and through Wyoming, Idaho, Utah, and Nevada, crossing the summits of three great mountain ranges from 7000 feet to 8250 feet high, and meeting the Central Pacific Railway of California. This line was through a barren desert for several hundred miles, in the arid uplands of Idaho and the salt plains of Utah; but its construction has served to bring the commercial cities of the Atlantic and of the Pacific within six or seven days' journey of each other. Three or four rival projects of railways across the width of the United States, or extensions of the existing railway system westward from the Mississippi and Missouri, have been taken up with some promise of their realisation. The one which offers the greatest advantages is that designed to ascend the long and broad valley of the Arkansas river, and to cross the Rocky Mountains with a southerly inclination into New Mexico, opening up the Rio Grande and San Juan country, which is said to be very rich, and thence passing on to the Grand Cañon of the Colorado, and to the Nevada mining district. Near the northern frontier of the United States territory, where it borders on the British Dominion of Canada, another continental line from east to west is now in progress—that is, from the western extremity of Lake Superior, through Minnesota, Dakotah, and Washington, to Puget Sound, just below Vancouver Island. But the work of this kind that will be most interesting to many of our readers is that undertaken in 1871 by the government of the Canadian Dominion. By the extension of the Dominion beyond the Rocky Mountains to include British Columbia, and the incorporation of the vast territories of the Hudson's Bay Company, nearly the whole of North America above the 49th parallel is united in one grand British colonial province, and the Canadian Pacific Railway will do much to promote a compact union between the widely-scattered communities of Her Majesty's subjects on this great continent. The line will proceed from a port on the northern shore of Lake Superior, westward to the Red River settlement, near Lake Winnipeg, now forming the province of Manitoba; and will thence be conducted up the valley of the river Saskatchewan to the foot of the Rocky

Mountains, which it will cross by the Yellowhead Pass, to descend along the Thomson and Fraser rivers, in British Columbia, till it finally reaches the coast of the Pacific Ocean, possibly connecting Vancouver Island with the mainland by a bridge over the narrowest part of the straits. In connection with the Grand Trunk and other railways of Canada, supplemented by the Intercolonial Railway between Lower Canada, New Brunswick, and Nova Scotia, this new western line will afford the most direct and expeditious means of transit across North America, and will probably become the favourite route for mails and passengers and light traffic from Europe to China. It will open a country which abounds in mineral wealth, especially of iron, coal, and copper; while the Saskatchewan valley, and the belt of fertile soil lying at the base of the Rocky Mountains (where the climate, as far north as Fort Dunvegan on the Peace river, is not more severe than that of Toronto, though in latitudes beyond 56° N., nearly thirteen degrees above that place), are capable of sustaining an agricultural population. The progress of railroad construction in North America, stimulating and assisting the development of industrial resources with amazing rapidity, is a feature of high importance in the most recent phases of the world's civilisation. Its average rate of advance in the United States alone, during the five years preceding January 1873, was nearly 6000 miles annually of new railway; and the aggregate length of railway lines in the Union, all completed and in actual working, was then computed at 71,000 miles. British America, as we have seen, will not be left deficient of similar appliances for its internal improvement.

Gold Mines.

A great auriferous deposit was discovered in Upper California in the end of 1847, just before its formal cession to the United States. It is situated in the valley of the Sacramento river, and its principal branch the Joaquin, and is believed to extend over a range of country 200 miles in length, or more. The gold is found in its virgin state in small grains in three different situations—*first*, in sand and gravel beds; *secondly*, among decomposed or disintegrated granite; and *thirdly*, intermixed with a friable talcose slate standing in vertical strata, and containing white quartz, interlaminated or in veins. The largest pieces of gold are found in and near the talcose slate rocks, over which the streams flow; but the finer particles and scales have been carried down by the water to the lowest part of the valleys. It was known before that gold existed in the country; but the wonderful richness of the deposit was only discovered in 1847, in making a mill-race on American Fork, a small branch of the Sacramento. It soon became widely known, and attracted multitudes of persons, first from the neighbouring districts, and by and by from all parts of the world. The population, which was estimated at 15,000 in 1848, had increased to 92,000 in 1850, and in 1870 was found to be 560,247.

Population.

Humboldt gave the following estimate of the entire population of America in 1823:—

	Number.	Proportion.
Whites	13,471,000	38 per cent.
Indians	8,610,000	25 "
Negroes { Slaves, 5,000,000; Free, 1,433,000 }	6,433,000	19 "
Mixed races	6,428,000	18 "
	34,942,000	

Bollaert made the following estimate for 1863:—

	Number.	Proportion.
Whites	38,074,423	52 per cent.
Indians	11,014,710	15 "
Negroes	12,122,030	17 "
Mestizoes	6,031,000	} 16 "
Mulattoes	4,037,440	
Zamboes	1,563,230	
	72,842,833	

What will be the number of the inhabitants of the new continent two or three centuries hence, and of what races will it consist? Setting aside the negroes, to simplify the question, and the Indians, who will gradually disappear, it is evident that the soil of America is destined to be occupied by two races, who may be designated as the Anglo-Saxon and the Spanish-Indian. In the latter the Indian blood greatly predominates, for the Creoles or pure progeny of the Spaniards probably do not constitute more than 20 per cent. of the population, while the civilised Indians may amount to 50, and the Mestizoes to 30.

The whites in the United States were in 1850	19,500,000
The population of British America	2,500,000
	22,000,000
The population of Spanish and Portuguese America, exclusive of slaves, was in round numbers	20,000,000

The Anglo-Saxon population in America increases at 3 per cent. annually, and doubles its numbers in 25 years.

Its amount in 1850 was	22,000,000
In 1875 it will be	44,000,000
In 1900	88,000,000
In 1925	176,000,000

A population of 176,000,000 spread over the territories of the United States and Canada would only afford an average of 40 persons to each square mile, about 1-7th part of the density which England now exhibits, and could occasion no pressure. But let us suppose the rate of increase after 1925 to fall to 2 per cent., the period of doubling will then be 35 years.

In 1960 the number will be	352,000,000
In 1995 do. do.	704,000,000

Suppose the rate again to decline to 1½ per cent., which scarcely exceeds that of England and Prussia, the period of doubling will then be 50 years.

In 2045 the number will be	1,408,000,000
In 2095 do. do.	2,816,000,000

Let us now compare with this the growth of the Spanish-Indian population, doubling its numbers in 75 years.

Its amount in 1850 was	20,000,000
In 1925 it will be	40,000,000
In 2000 do.	80,000,000
In 2075 do.	160,000,000
In 2095 (interval of 20 years)	200,000,000

Prospects of America.

It hence appears that, supposing both races to have free space for expansion, the Anglo-Saxon population in 220 years from the present time will amount to 2816 millions, while the Spanish-Indian population will only have multiplied to 200 millions, or *one-fourteenth part* of the other. It will be shown by and by, on probable grounds, that the new continent, if fully peopled, could support 3600 millions, and there would consequently be room enough for both; but long before this density is attained the two races will inevitably come into collision. In new settlements, where the best lands are invariably first occupied and the inferior neglected, the population is always thinly diffused. The Anglo-Saxons will therefore crowd to the richer fields of the south, while millions of acres of their own poorer lands are still untenanted; for we may rest assured that before cultivation is extended to the third-rate soils on the north side of the boundary, means will be found to appropriate the first-rate soils on the south side. These may be acquired by purchase like the lands of Louisiana, or by conquest like those of New Mexico and California, but in one way or another they will be acquired. Nearly forty years ago M. de Tocqueville calculated that along the great space from the Gulf of Mexico to the Canadian lakes the whites were advancing over the wilderness at an average rate of 17 miles per annum, and that enlightened observer was powerfully impressed by the grandeur and solemnity of this deluge of men, for ever swelling and flowing onward,

to the west, the south, and the north, as "driven by the hand of God." Since he wrote the rate of progress has perhaps doubled, and every year will quicken its pace. If, then, we take a glance at the state of America at any future period, say 220 years hence (A.D. 2095), we must take the ratio of increase of the two civilised races as the prime element of our calculation. We may assume that the whole continent, from Behring's Straits and Hudson's Bay to Cape Horn, will be divided between the two races in some such proportion as their rate of growth indicates—it may be 10, 15, or 20 to 1. Supposing them to maintain a separate existence, the weaker race will probably be driven, like the Welsh before the English, into the mountainous and inhospitable regions. On the other hand, it is possible, and not improbable, that the smaller population may be absorbed into the mass of the greater, be incorporated with it, and adopt its language. The result, like other things in the womb of time, may be modified by causes yet unseen; but in whatever shape it may present itself, there is little risk in predicting that the Anglo-Saxon race is destined by its superior intelligence and energy to rule the New World from end to end. American statesmen now speak of the whole continent as the heritage of their people.

Useful soil in New and Old Continents.

Paradoxical as the fact may appear, we are satisfied that the new continent, though less than half the size of the old, contains at least an equal quantity of useful soil and much more than an equal amount of productive power. America is indebted for this advantage to its comparatively small breadth, which brings nearly all its interior within reach of the fertilising exhalations of the ocean. In the old continent, owing to its great extent from east to west, the central parts, deprived of moisture, are almost everywhere deserts; and a belt round the western, southern, and eastern shores, comprises nearly all that contributes to the support of man. How much fruitful land, for instance, is there in continental Asia? If we draw a line from the Gulf of Cutch (near the Indus) to the head of the Yellow Sea, we cut off India and China, with the intervening Birman empire and the southern valleys of Thibet; and this space, which comprises only about one-fifth of the surface of Asia, embraces five-sixths of its productive power. Arabia, Persia, Central Thibet, Western India, Chinese and Independent Tartary are deserts, with scattered patches of useful soil not amounting to the twentieth part of their extent. Siberia, or Northern Asia, is little better, owing to aridity and cold together. Anatolia, Armenia, the Punjab, and a narrow strip along the western shores of the Pacific Ocean, north as far as the 60th parallel, compose the only valuable agricultural territory beyond India and China. Europe, which is merely the western margin of Asia, is all fruitful in the south; but on the north its fruitfulness terminates at the 60th or 62d parallel. Africa has simply a border of useful soil round three-fourths of its sea-coast, with some detached portions of tolerably good land in its interior. Of the 31,000,000 of square miles which these three continents occupy, we cannot find, after some calculation, that the productive soil constitutes so much as one-third, and of that third a part is but poor.

Now, in estimating the useful soil in America we reject—1. Most of the region north of the latitude of 53°, amounting to 2,600,000 square miles; 2. A belt of barren land about 300 miles broad by 1000 in length, or 300,000 square miles, lying on the east side of the Rocky Mountains; 3. A belt of arid land of similar extent situated on the east side of the Andes, between 24° and 40° of south latitude; 4. The desert shore of Peru, equal to 100,000 square miles; 5. An extent of 100,000 square miles for the arid country of Lower California and Sonora; and 6. An extent of 500,000 square miles for the summits of the Andes and the south extremity of Patagonia. These make an aggregate of 3,900,000 square miles; and this, deducted from 13,900,000, leaves 10,000,000 square miles as the quantity of useful soil in the New World.

Ratio of fertility to latitude.

The productive powers of the soil depend on two circumstances, heat and moisture; and these increase as we approach the equator. Now, it appears that the productive or rather nutritive powers of the soil will be pretty correctly indicated by combining the ratios of the heat and the moisture, expressing the former of these in degrees of the centigrade scale. Something, we know, depends on the distribution of the heat through the different seasons; but as we do not aim at minute accuracy, this may be overlooked.

Latitude.	Inches of Rain.	Mean Heat.	Product.	Ratio.
60	16	7	112	4
45	29	14	406	15
0	96	28	2688	100

Thus, if the description of food were a matter of indifference, the same extent of ground which supports four persons at the latitude of 60°, would support 15 at the latitude of 45°, and 100 at the equator. But the food preferred will not always be that which the land yields in greatest abundance; and another most important qualifying circumstance must be considered—it is labour which renders the ground fruitful, and the power of the human frame to sustain labour is greatly diminished in hot climates. We shall therefore consider the capacity of the land to support population as proportional to the third power of the cosine (or radius of gyration) of the latitude. It will therefore stand thus in round numbers:—

Latitude,	0°	15°	30°	45°	60°
Productiveness,	100	90	65	35	12½

Increase of population.

In England the density of population is about 389 persons per square mile; but England is in some measure the workshop of the world, and supports, by her foreign trade, a greater population than her soil can nourish. In France the density of population is about 177; in Germany it varies from 100 to 200. On these grounds, we may assume that the number of persons which a square mile can properly sustain without generating the pressure of a redundant population is 150 at the latitude of 50°, and 26 is the sum which expresses the productiveness of this parallel. Then taking, for the sake of simplicity, 35 as the index of the productiveness of the useful soil beyond 30° in America, and 85 as that of the country within the parallel of 30° on each side of the equator, we have about 4,000,000 square miles, each capable of supporting 200 persons, and 5,700,000 square miles, each capable of supporting 490 person. It follows that if the natural resources of America were fully developed it would afford sustenance to 3,600,000,000 of inhabitants, a number nearly five times as great as the entire mass of human beings now existing upon the globe!

Alphabetical Contents.

AMERICAN LITERATURE

I.—Introductory.

The literature of the United States, while still half our own, is pervaded, to a degree not easily estimated, by a foreign element. The relationship between Englishmen and Americans, making them ignorant of their mutual ignorance, operates against the soundness of their judgment on each other's work. Community of speech, which ought to be a bond of union, is often a medium of offence; for it dispenses with a study of the language, and in studying a language we learn something also of the habits and social histories which are reflected in, and serve to interpret, distinctly alien literatures. Facility of travel, making it easy to acquire first impressions, is a temptation to such hasty estimates as many of the most accomplished Americans have formed of England, and many of the most accomplished Englishmen have formed of America. The least satisfactory works of some of their foremost writers, as Mr Hawthorne's *Old Home* and Mr Emerson's *English Traits*, are those associated with their transatlantic experiences. But of the mistakes on both sides, ludicrous and grave, we have had perhaps the larger share. Few Americans have ever so misconceived a British statesman as we misconceived Mr Lincoln, or gone so far astray in regard to any crisis of our history as we did in reference to the moving springs and results of their Civil War. The source of this greater ignorance lies not so much in greater indifference as in greater difficulty. England is one, compact and stable. The United States are many, vast, various, and in perpetual motion. An old country is a study, but a new country is a problem. Antiquity is brought to our firesides in the classics, till Athens and Rome

"To us are nothing novel, nothing strange."

We are more familiar with the Acropolis than with the Western Capitol—with Mt. Soracte than with the Catskills. Our scholars know more about Babylon than about Chicago. Dante immortalises for us the Middle Age; Plantagenet England is revived in Chaucer; the inner life of modern England has a voice in Tennyson and the Brownings. Where is the poet who will reveal to us "the secrets of a land," in some respects indeed like our own, but separated in other respects by differences which the distance of 3000 miles of ocean only half represents; which, starting on another basis, has developed itself with energies hitherto unknown in directions hitherto unimagined? Who will become the interpreter of a race which has in two centuries diffused itself over a continent, the resources of which are not more than half discovered, and which has to absorb within itself and harmonise the discordant elements of other races for whom the resources of the Old World are well-nigh exhausted? *Caret vate sacro;* but it does not want poetical aspirations as well as practical daring:

"This land o' ourn I tell ye's gut to be
A better country than man ever see;
I feel my sperit swellin' with a cry
That seems to say, 'Break forth and prophesy.'
O strange New World, thet yet wast never young,
Whose youth from thee by gripin' want was wrung,
Brown foundlin o' the woods, whose baby bed
Was prowled round by the Injun's cracklin' tread,
An' who grew'st strong thru' shifts an' wants an' pains,
Nursed by stern men with empires in their brains."

II.—Conditions and Characteristics of American Literature.

The number of writers who have acquired some amount of well-founded reputation in the United States is startling. The mere roll of their names would absorb a great part of the space here available for an estimate of the works which best represent them. Mr Griswold informs us that he has in his own library more than 700 volumes of native novels and tales; his list of "remarkable men" is like Homer's catalogue of ships. Almost every Yankee town has indeed its local representatives of literature, reflecting in prose or verse the impulses and tendencies of the time. But while America has given birth to more than a fair proportion of eminent theologians, jurists, economists, and naturalists, hardly any great modern country, excepting Russia, has in the same number of years produced fewer works of general interest likely to become classical; and Bishop Berkeley's prophecy of another golden age of arts in the Empire of the West still awaits fulfilment. This fact, mainly attributable to obvious historic causes, is frankly recognised by her own best authors, one of whom has confessed—"From Washington, proverbially the city of magnificent distances, through all its cities, states, and territories, ours is a country of beginnings, of projects, of designs, of expectations." The conditions under which the communities of the New World were established, and the terms on which they have hitherto existed, have been unfavourable to Art. The religious and commercial enthusiasms of the first adventurers to her shores, supplying themes for the romancers of a later age, were themselves antagonistic to romance. The spirit which tore down the aisles of St Regulus, and was revived in England in a reaction against music, painting, and poetry, the Pilgrim Fathers bore with them in the "Mayflower," and planted across the seas. The life of the early colonists left no leisure for refinement. They had to conquer nature before admiring it, to feed and clothe before analysing themselves. The ordinary cares of existence beset them to the exclusion of its embellishments. While Dryden, Pope, and Addison were polishing stanzas and adding grace to English prose, they were felling trees, navigating rivers, and fertilising valleys. We had time, amid our wars, to form new measures, to balance canons of criticism, to discuss systems of philosophy; with them

"The need that pressed sorest
Was to vanquish the seasons, the ocean, the forest."

The struggle for independence, absorbing the whole energies of the nation, developed military genius, statesmanship, and oratory, but was hostile to what is called polite literature. The people of the United States have had to act their Iliad, and they have not had time to sing it. They have had to piece together the *disjecta membra* of various races, sects, and parties, in a παντοπώλιον πολιτειῶν. Their genius is an unwedded Vulcan, melting down all the elements of civilisation in a gigantic furnace. An enlightened people in a new land, "where almost every one has facilities elsewhere unknown for making his fortune," it is not to be wondered that the pursuit of wealth has been their leading impulse; nor is it perhaps to be regretted that much of their originality has been expended upon inventing machines instead of manufacturing verses, or that their religion itself has taken a practical turn. One of their own authors confesses that the "common New England life is still a lean impoverished life, in distinction from a rich and suggestive one;" but it is there alone that the speculative and artistic tendencies of recent years have found room and occasion for development. Our travellers find a peculiar charm in the manly force and rough adventurous spirit of the Far West, but

the poetry of the pioneer is unconscious. The attractive culture of the South has been limited in extent and degree. The hothouse fruit of wealth and leisure, it has never struck its roots deeply into native soil. Since the Revolution days, when Virginia was the nurse of statesmen, the few thinkers of America born south of Mason and Dixon's line—outnumbered by those belonging to the single State of Massachusetts—have commonly migrated to New York or Boston in search of a university training. In the world of letters at least, the Southern States have shone by reflected light; nor is it too much to say, that mainly by their connection with the North the Carolinas have been saved from sinking to the level of Mexico or the Antilles. Whether we look to India or Louisiana, it would seem that the tropical sun takes the poetic fire out of Anglo-Saxon veins, and the indolence which is the concomitant of despotism has the same benumbing effect. Like the Spartan marshalling his helots, the planter lounging among his slaves was made dead to Art by a paralysing sense of his own superiority. All the best transatlantic literature is inspired by the spirit of confidence—often of over-confidence—in labour. It has only flourished freely in a free soil; and for almost all its vitality and aspirations, its comparatively scant performance and large promise, we must turn to New England. Its defects and merits are those of the national character as developed in the Northern States, and we must seek for an explanation of its peculiarities in the physical and moral circumstances which surround them.

When we remember that the Romans lived under the sky of Italy, that the character of the modern Swiss is like that of the modern Dutch, we shall be on our guard against attributing too much to the influence of external nature. Another race than the Anglo-Saxon would doubtless have made another America; but we cannot avoid the belief that the climate and soil of America have had something to do in moulding the Anglo-Saxon race, in making its features approximate to those of the Red Indian, and stamping it with a new character. An electric atmosphere, and a temperature ranging at some seasons from 50° to 100° in twenty-four hours, have contributed largely to engender that restlessness which is so conspicuous "a note" of the people. A territory which seems boundless as the ocean has been a material agent in fostering an ambition unbridled by traditionary restraints. When European poets and essayists write of nature, it is to contrast her permanence with the mutability of human life. We talk of the everlasting hills, the perennial fountains, the ever-recurring seasons. "Damna tamen celeres reparant cœlestia lunæ—nos ubi decidimus"— In the same spirit Byron contemplates the sea and Tennyson a running stream. In America, on the other hand, it is the extent of nature that is dwelt upon—the infinity of space, rather than the infinity of time, is opposed to the limited rather than to the transient existence of man. Nothing strikes a traveller in that country so much as this feature of magnitude. The rivers like rolling lakes, the lakes which are inland seas, the forests, the plains, Niagara itself, with its world of waters, owe their magnificence to their immensity; and by a transference, not unnatural although fallacious, the Americans generally have modelled their ideas of art after the same standard of size. Their wars, their hotels, their language, are pitched on the huge scale of their distances. "Orphaned of the solemn inspiration of antiquity," they gain in surface what they have lost in age; in hope, what they have lost in memory.

> "——That untravelled world whose margin fades
> For ever and for ever when they move,"

is all their own; and they have the arena and the expectations of a continent to set against the culture and the ancestral voices of a thousand years. Where Englishmen remember, Americans anticipate. In thought and action they are ever rushing into empty spaces. Except in a few of the older States, a family mansion is rarely rooted to the same town or district; and the tie which unites one generation with another being easily broken, the want of continuity in life breeds a want of continuity in ideas. The American mind delights in speculative and practical, social and political experiments, as Shakerism, Mormonism, Pantagamy; and a host of authors, from Emerson to Walt Whitman, have tried to glorify every mode of human life from the transcendental to the brutish. The habit of instability, fostered by the rapid vicissitudes of their commercial life and the melting of one class into another, drifts away all landmarks but that of a temporary public opinion; and where there is little time for verification and the study of details, men satisfy their curiosity with crude generalisations. The great literary fault of the Americans thus comes to be *impatience*. The majority of them have never learnt that "raw haste is half-sister to delay;" that "works done least rapidly, art most cherishes." The makeshifts which were at first a necessity with the Northern settlers have grown into a custom. They adopt ten half measures instead of one whole one; and, beginning bravely, like the grandiloquent preambles to their Constitutions, end sometimes in the sublime, sometimes in the ridiculous.

Many of the artistic as well as many of the social peculiarities of the United States may doubtless be traced to their form of government. After the most obvious wants of life are provided for, Democracy stimulates the production of literature. When the hereditary privileges of rank have ceased to be recognised, the utility, if not the beauty, of knowledge becomes conspicuous. The intellectual world is spurred into activity: there is a race in which the prize is to the swift. Everyone tries to draw the eyes of others by innumerable imperfect efforts with a large insignificant sum total. Art is abundant and inferior: whitewashed wood and brick pass for marble, and rhythmical spasms for poetry. It is acknowledged that the prevailing defect of Aristocratic literatures is formality; they are apt to be precise and restricted. A Democratic literature runs the risk of lawlessness, inaccuracy, and irreverence. From both these extremes the Athenian, the Florentine, and the Elizabethan classics were preserved by the artistic inspirations of a flexible tradition. The one is exemplified in the so-called Augustan ages of letters, in the France of Louis XIV. and the England of Queen Anne, when men of genius, caring more to perfect their style than to establish truth, more to captivate the taste than to stir the passions, moved with clipt wings in a charmed circle of thought. The other has its best illustration in the leaders of our own romantic schools, but its most conspicuous development in America; a country which is not only democratic but youthful without the modesty of youth, unmellowed by the past and untrammelled by authority, where the spirit of adventure is unrestrained by feelings of personal loyalty—where order and regularity of all kinds are apt to be misnamed subservience—where vehemence, vigour, and wit are common, good taste, profundity, and imagination rare;—a country whose untamed material infects the people, and diverts them from the task of civilisation to the desire of conquest.

American literature is cramped on another side by the spirit of imitation. It has been in great measure an offshoot or prolongation of our own. As English sculptors study at Rome and Naples, the most prominent Western artists in every department have almost invariably inaugurated their careers by travelling in Europe, and writing descriptions of the foreign lands where they have found their richest intel-

lectual culture. They have sought the sources, the themes, the rules, and the sanctions of their art in the Old World, and their highest ambition, like that of all colonists, has hitherto been to receive a favourable verdict, not from the country of their birth, but from that of their ancestors. Even Franklin—in some respects an American of the Americans—was in philosophy a practical disciple of Locke, as Jefferson was of the French Revolution. "The literary genius of Great Britain," says De Tocqueville, "still darts its rays into the recesses of the West. . . . The small number of men who write are English in substance, and still more in form." Of the great number of men who have written in America since the date of this criticism, only a few have written much to confute it. Washington Irving, who, in the course of four distinct visits, spent much of his life in Europe, only escapes from the influence of Addison in his *Knickerbocker* and Dutch sketches. On land at least, Cooper—though in many respects an original writer—everywhere remembers Scott. As in the works of the Scotch novelist, the semi-barbarous feudal spirit is represented in conflict with modern law, in those of the American the enterprise of New England is struggling against the ruggedness of nature and a savage life. The writers of the last thirty years have been making strenuous, sometimes spasmodic, efforts after originality, but they are still affected by transatlantic associations. In the style of Mr Motley we cannot help observing the stamp of Carlyle. The Transcendental movement begun by Emerson is admitted to have derived its first impulse from *Sartor Resartus*; and among the eccentricities that mark its followers none is more remarkable than their mania for German and Oriental quotations. The tyranny which five centuries' load of classics, in the same tongue, exercises over the mind of a nation not yet a century old is very much strengthened by the non-existence of an international copyright, which leads to the intellectual market being glutted with stolen goods. As long as a publisher in Boston or New York can republish a good book written in Edinburgh or London without paying for it, he is likely to prefer an undertaking which involves no risk and comparatively no outlay, to another which involves both; that is, the republication of the English to the first publication of an American book; for the English book has already attained its reputation, and its popularity in America is secured, while the American book, for the copyright of which he has to pay, has, except in the case of a few authors, still to win its spurs. If the people of the United States had spoken a language of their own, it is probable they would have gained in originality; as it is, they are only now beginning to sign their intellectual declaration of independence,—a fact confessed among the latest words of their own greatest prose artist:—"Bred in English habits of thought as most of us are, we have not yet modified our instincts to the necessities of our new modes of life. Our philosophers have not yet taught us what is best, nor have our poets sung to us what is most beautiful in the kind of life that we must lead, and therefore we still read the old English wisdom, and harp upon the ancient strings."

III.—Earlier American Literature.

We may trace the influence of the foregoing controlling facts or tendencies, subject to various phases of personal power, through the three great periods under which Anglo-American history obviously falls:—The Colonial, the Revolutionary, and that of the 19th Century.

1. *The Colonial Period.*—Little of interest in the world of letters has come down to us from the 17th century in the West. Sandys's *Ovid*, translated on the banks of the James River, dedicated to Charles I., and published 1626, is worthy of note as the first contribution to English literature from America. About the same date the Welsh Puritan Vaughan sent home his *Golden Fleece* from Newfoundland, and Captain Smith gave to the world his descriptions of Virginia. But the earliest verse that has a real claim to be regarded as American is a doggerel list, by an anonymous author, of New England's annoyances, which, if we remember the date—a generation after Spenser had celebrated "the Indian Peru" in his *Faery Queen*—will confirm our view of the backwoodsman's want of leisure for "polishing his stanza:"—

> "The place where we live is a wilderness wood,
> Where grass is much wanting that's fruitful and good.
> * * * *
> If fresh meat be wanting to fill up our dish,
> We have carrots and pumpkins, and turnips and fish;
> We have pumpkins at morning and pumpkins at noon,
> If it was not for pumpkins we should be undone."

A little later we have a Puritan version of the Psalms, the worst of many bad; and about 1650 the poems of Anne Bradstreet and Benjamin Thomson, worthy of mention, but scarcely readable. In prose are relics of the sermons and controversies of Roger Williams and John Cotton and Eliot, the apostle of the Indians, with the ponderous *Magnalia* and witch denunciations of Cotton Mather. The main literary event of the century was the foundation (1636) of Harvard University. Yale College followed at a long interval, and subsequently Princeton College, and Brown University (Rhode Island). In all new countries industrial and commercial interests are at first the strongest. The febrile activity produced by fear of a sterile future leaves little room for speculative imagination. But in the New World, colonised in part by adventurers, in part by religious refugees and enthusiasts, another influence was from the first at work. When her solitudes began to give place to cities, the brains of her people were expended on the farm or the exchange with a zeal materially modified by the spirit and formulæ of the faith which led the founders of the Northern States across the sea, and continued to infuse a religious element into their enterprises. This element, which elevated the settlers of New England above ordinary emigrants, adding to their strength and giving a faster dye to their morality, was yet, in its original form, no more favourable to freedom or variety of thought than the industrialism by which it was surrounded. But it begat and fostered the Puritan theological literature which was concentrated in the massive yet incisive treatises and discussions of Jonathan Edwards of Connecticut—(1703– Edwards.
1758)—who, if not, as asserted by American panegyrists, "the first man of the world during the second quarter of the 18th century," was yet, by the clear vigour of his thought and the force of its expression, one of the foremost figures of that era. An estimate of his rank as a theologian belongs to a distinct branch of the history of American literature. It is enough here to refer to the testimony of all competent judges as to the singular lucidity of his style, and to that of his contemporaries as to the fervour of his eloquence and the modest simplicity of his life. Passages of his occasional writings, as the description of his future wife, evince a grace and sweetness of temper not always associated with the views of which he was and remains the most salient English advocate. A slightly junior contemporary of Edwards, the exponent κατ' ἐξοχήν of the other—that is, the secular side of early American life—was destined to see the end of one and play a prominent part in opening another era of his country's history. Benjamin Franklin, as long as Utili- Franklin.
tarian philosophy endures, will be a name to conjure with. It is *clarum et venerabile*, though its owner was endowed with as little as possible for a great man of the "faculty divine." Franklin's autobiography, the details of which

need not find place here, is as romantic as the life of an unromantic person can be. The incidents of the young candle-moulder — the printer's apprentice — the ballad-monger wisely discouraged by the wise paternal criticism, "Versemakers are generally beggars"—the runaway, eating rolls on the Philadelphia street—his struggling life in London with Ralph of the *Dunciad*—his return, "correcting the erratum" of his infidelities by marriage with his old Pennsylvanian friend—his success as a printer, economist, statesman, and diplomatist—his triumphs in natural and political philosophy, clenched in Turgot's line, adapted from Manilius—

"Eripuit cælo fulmen, sceptrumque tyrannis"—

his examination before the House of Commons, resulting in the repeal of the Stamp Act, when Lord Chatham spoke of him as one who was "an honour not to England only, but to human nature"—his signature of the Declaration of Independence—his ministry in France and popular triumph with Voltaire, who said, "Je n'ai pu résister au désir de parler un moment la langue de Franklin"—the acclamations of shouting multitudes on his return home—Mirabeau's announcement of his death (in 1790, in his eighty-fourth year) to the Assembly—"the genius which has freed America, and poured a flood of light over Europe, has returned to the bosom of the divinity"—are elementary facts of schoolboy history. They are the records of the successive stages of the greatest success achieved in modern times by the genius of common-sense, integrity, and industry indomitable. Franklin's experiments and physical discoveries form a chapter in the history of science; but half of his fame even in this field is due to the precision and clearness of the manner in which they are announced. "The most profound observations," says Lord Jeffrey, "are suggested by him as if they were the most obvious and natural way of accounting for phenomena." The same literary merit characterises the financial pamphlets and treatises which first brought him into celebrity. Both are marked by the same spirit,—the love of the Useful, which was his passion through life. Franklin follows Bacon, to an extreme opposed to that of the Platonists, in decrying abstractions. Archytas is said to have apologised for inventing the arch. Franklin is ashamed to have wasted time over pure mathematics in his "magical squares." His aim is everywhere to bring down philosophy, like the lightning, from heaven to earth, "*illustrans commoda vitæ.*" His ethics—those of Confucius or the Seven Sages, modified by the experience and the circumstances of a later age—are embodied in the most famous of popular annuals, *Poor Richard's Almanack*, in which for twenty-six years he taught his readers (rising to the number of 10,000) "the way to be healthy and wealthy and wise," by following simple utilitarian rules, set forth in plain incisive prose and rhyme, rendered attractive by a vein of quaint humour and the homely illustrations always acceptable to his countrymen. The same train of thought appears in the "Whistle," among the letters from Passy, where his persistent deification of thrift appears side by side with graceful compliments to Mesdames Helvetius and Brillon, records of the aftermath of sentiment that often marks a green old age. Franklin remains the most practical of philosophers in perhaps the most practical of nations.

2. *The Revolution Period.*—It has been often remarked that periods of political national crisis are more favourable to the preparation than to the actual production of literature. Wordsworth's assertion, that poetry is the outcome of emotion recollected in tranquillity, applies with slight modification also to artistic prose. The demands of instant action cast the reflective powers into abeyance, but a stormy era is the seed-time of a later harvest. There is only one exercise of the imagination that it directly stimulates—that of the orator; and the conditions of his success, save in a few instances, make a drain on his posthumous reputation. In reading even the greatest speeches of the past, divested of the living presence which gave them colour and force, we find it difficult to account for the effect which they are known to have produced. They are the ashes or the fossils of genius. Little that is of permanent literary value is left us of the harangues that were the trumpet-calls of patriotism during the American Revolutionary War. The triumphs of Patrick Henry, who "wielded at will that young democraty," are commemorated in the judicious biography of Wirt, but few of his orations are accurately preserved; and of the speeches of James Otis, which were compared to "flames of fire," we have mainly a tradition. His pamphlet (1762), entitled *A Vindication of the conduct of the House of Representatives*, is considered to contain the germ of the Declaration of Independence. Among other considerable efforts of eloquence, those of Fisher Ames are worthy of note as being directed in great measure against the excesses of democracy. The master-minds of the era were the statesmen and jurists, who fought for the free soil, sunk the deep foundations, and reared the superstructure of the new Commonwealth. The history of American law is a distinct theme. It must suffice here to mention, as claiming recognition in the field of letters, Washington himself, in his clear and incisive though seldom highly-polished correspondence; his biographer John Marshall, chief justice of the supreme court from 1801 to 1835, one of the early pilots of the state, who left behind him a noble and stainless name, and laid down the first principles of that international code afterwards elaborated by Wheaton; Madison, John Jay, the elder Adams, and Alexander Hamilton, during the war Washington's "most confidential aid," afterwards the presiding genius of the movement represented by the *Federalist*, the organ of the anti-democratic party. To this he contributed three-fourths of the material, marked, as are all his papers and speeches, by originality of thought, breadth of view, and purity of style. As secretary of the treasury, he became perhaps the greatest of financiers. The general judgment of his countrymen acquiesces in the terms of the tribute paid to his memory by Guizot. "He must be classed among the men who have best known the vital principles and fundamental conditions of a government worthy of its name and mission." Of Hamilton's numerous historical sketches, the most celebrated is his letter to Colonel Laurens giving an account of the fate of Major André, in which refinement of feeling and inflexible impartiality of view are alike conspicuous. The great and unhappily the bitter antagonist of the Federalists is one of the most conspicuous figures in the history of American thought. Thomas Jefferson (1743–1826), President from 1801 to 1809, is the representative in chief of the revolutionary spirit of his age and country. While his rival compeers stood firmly on the defensive against the encroachments of an arbitrary government, his desire was, in politics as in speculation generally, to break with the past. Inspired with patriotic zeal by Patrick Henry's denunciations of the Stamp Act, he came forward prominently in 1769 as a member of the Colonial Assembly of Virginia. In 1776 the main part of the responsibility of drawing up the Declaration of Independence fell upon him. In 1784 he was appointed minister of the congress in Paris, where he spent the greater part of six years, and brought back an admiration for those phases of the French Revolution from which the more temperate judgments of Hamilton and Fisher Ames had recoiled. He threw himself heart and soul into

Orators.

Statesmen.

Washington.

Marshall.

Hamilton.

Jefferson.

the arms of the Democratic party, and in the constitutional struggle that ensued his keener sense of the direction in which popular sympathies were tending, with the weight of his half physical energies, gave him the ascendancy over the wider knowledge and more far-seeing intellects of his adversaries. Jefferson might be termed the Danton of the West, but his forte lay not so much in oratory as in political management and incisive vivacity. More perhaps than any other great statesman of his age, he aspired to be an author, to which title the best passages in his *Notes on Virginia*, his *Autobiography*, and *Correspondence*, give him a fair claim. His descriptions of scenery in the first are always pleasing and generally graphic. His sketches of Continental society are lively, and his occasional flights of fancy, as the dialogue between the head and heart, at least ingenious. His religion and ethics were those of his friend Tom Paine and the *Encyclopédie*.

Minor writers. The age of the Titans in transatlantic history abounds in minor literati, whose light effusions, mainly satirical or descriptive sketches in prose and verse, throw a somewhat dim and ragged lustre over its graver page. The bulk of these obvious reflections of the manner and thought of Butler, Pope, and Swift, or of Gay, Prior, and Shenstone, are a penance to wade through, and scarce claim remembrance for their authors. A few stand out conspicuously by the celebrity of the names with which they are associated, or a certain raciness and approach to originality in their style. Of these the chief are:—The social caricatures of Judge Brackenridge (who, though born in Scotland, lived in America from infancy), and his doggerel but vigorous lines on Bunker's Hill; the once popular humorous lyric entitled *M'Fingal*, by J. Trumbull, also the author of *The Progress of Dulness*, in the Hudibrastic metre which seems to have been used by imitators to show how intolerable it is in any but the original hands; the more flowing but on the whole commonplace odes of Philip Freneau, including his patriotic hymns to Washington, with the more musical lyrics the "Wild Honeysuckle" and the "Indian Death Song," and his prose entitled *Advice to Authors;* the political satires of Mercy Warren, authoress of *Things necessary to a Woman* (the obvious model of the more modern squib, *Nothing to Wear*), and of a *History of the Revolution*, remembered only as being the first in date; the patriotic rhapsodies of Phillis Wheatley, interesting as the production of a young negress brought from Africa in 1761, and soon afterwards sold in Boston to the mistress from whom she took her name; Francis Hopkinson's *Battle of the Kegs* and his *Pretty Story*—a burlesque closely fashioned after Arbuthnot's *John Bull*—his *New Roof*, meaning the American constitution, and his satire on the pedantry of the sciences entitled the *Salt Box;* Joel Barlow's *Hasty Pudding;* the humorous *Wants of Man*, by Quincy Adams, more prominent as a statesman than as a poet; and on a similar but higher platform the best of too large a volume of verses, in which the "Triumph of Infidelity" (after the manner of Cowper), the "Conquest of Canaan," and "Columbia," are the leading pieces, by the amiable theologian Dr Timothy Dwight. Dwight's prose descriptions, as that of the Notch of the White Mountains and the evening on Lake George, are superior in grace to his efforts in rhyme.

Ballad literature. The ballad literature of the revolution days is said to have attracted the attention of Lord Chatham, less probably from its intrinsic merit than from its faithful though rough embodiment of the sentiment that not only moved over the surface, but penetrated the depths of the national life. The anonymous popular literature of a country is the best "abstract and brief chronicle of the time" in which it is produced. The songs current in America during this era, inspired by the same spirit and pitched in the same key, are historically interesting and artistically monotonous. They celebrate in rude verse the achievements of native heroes, like "Bold Hawthorne;" or ridicule, like "Jack Brag," the British Lion, or, like the "Fate of Burgoyne," the overthrow of vaulting ambition; or, as in "Wyoming Massacre," bewail the fate of the fallen; or, as in "Free America," celebrate with schoolboy huzzahs the triumph of the good cause. Among the very rude national anthems of the West, "Yankee Doodle" is remarkable as having been an old Dutch catch adapted into an English satirical chant, and adopted, with conscious or unconscious irony, by the American troops. "Hail Columbia," which as a poetical production takes even a lower rank than "Rule Britannia," was a somewhat later production by Joseph Hopkinson (1798); and the "Star-Spangled Banner" of Francis S. Key is associated with the traditions of the second British war. As inspired with the spirit of the 18th, though belonging in date to the early years of the 19th century, we may mention in advance the "Pilgrim Fathers" of J. Pierpont, Woodworth's "Old Oaken Bucket," "Home, Sweet Home," by J. H. Payne; the humorous burlesque of J. G. Saxe, "Miss MacBride:" and the verses of the great painter and creditable romancer Washington Allston, with the refrain "We are one."

English philology and literature were during this period represented by the famous Lindley Murray, and Noah Webster (1758–1843), the author of the best dictionary of our language that has appeared since Johnson's. In natural science, the two Bertrams; Alexander Wilson the ornithologist; and Audubon, the literary glory of Louisiana, whose descriptions of animate nature rival those of Buffon, are illustrious names.

IV.—The Literature of the Nineteenth Century.

Prose Writings.

1. In a rapid estimate of the literature of this prolific age we can only signalise its contributions to the several branches of physical and mental science. The United States have during the last two generations been justly proud of the names of Morton and Schoolcraft in ethnology, of Bowditch in mathematics, of Sullivan and Dana in chemistry and mineralogy. Their classical scholarship, which hardly competes with that of England, has yet been fairly maintained by Everett, Felton, Woolsey, Anthon, and Robinson. Dr Marsh is an accomplished English scholar, while Professor Whitney is a learned and accurate philologist, whose researches in Sanscrit are well known and appreciated by European Orientalists. The metaphysical schools of Locke and Reid are nowhere better represented than in America by Dr Bowen and Dr N. Porter. The place of Marshall as a jurist has been worthily filled by Chief-Justice Kent and Judge Story; the latter of whom ranks, by virtue of his essay on classical studies and his graceful descriptions of natural scenery, among the most accomplished of the numerous professional men who have in the New World devoted their leisure hours to lighter literature.

The inhabitants of the United States have always been noted for remarkable fluency, sometimes a super-fluency of speech. The early years of the century were illustrated by the fiery zeal of Randolph and the practical force and occasional impassioned eloquence of Henry Clay. The great political controversies inherited from the preceding age found their most conspicuous popular exponents in two leading minds laying claim to diverse kinds of greatness, and destined to be in almost incessant antagonism. John C. Calhoun, the most illustrious representative of the Southern States, of whose rights, real or imaginary, he was during his life the foremost champion, was by education and choice a professional statesman. Secretary of War in 1817, and Vice-President of the United States in 1825, he resigned the latter office on occasion of the dispute about the tariff law in 1832, to become the leader of the Opposition; and in vindicating the attitude of South Carolina was the first to lay the strands of the future Secession war. The most accomplished modern apologist for slavery, it is probable that he only hastened the conflict between opposing principles which was sooner or later inevitable. Calhoun's eloquence, as attested by his auditors and the numerous speeches and papers preserved in the six volumes of his published works, was notable for its earnestness and gravity, the terse polish of its manner, for philosophic generalisations and analytical dialectic. His prevailing sincerity and candour have made his memory respected by those farthest removed from him in sentiment and opinion. Daniel Webster, on the whole the grandest orator of the New World, was during the greater part of his career the champion of Massachusetts and the assertor of her policy. His defence of that State in the Senate (1830) against General Hayne of Carolina, and his oratorical duel with Calhoun (1838), resulting in the temporary overthrow of the doctrine of nullification, are among the most

Orators. Calhoun. Webster.

remarkable triumphs of debate in history. Some of his pleadings on criminal trials have an almost terrible power. But his literary genius and richness of illustration found freer scope in his famous appeal for the Greeks in 1824, his great speech (1820) on the second centennial anniversary of the landing of the Pilgrims, or his address (1825) on laying the corner-stone of Bunker Hill monument. Webster's eloquence, everywhere solid, massive, and on great occasions glowing with a lurid light, is not the mere record of half-forgotten strifes; it is "vital in every part," and belongs to the permanent literature of his country, in whose political arena he was during his life perhaps the most powerful actor. The art of making commemorative speeches, technically called "orations," has been cultivated in North America to excess. The great master in this species of composition was Edward Everett, distinguished by his early association with Lord Byron in Greece, the high dignities—governor of Massachusetts, minister to the court of St James's, and president of Harvard—to which he attained, and by the variety of his accomplishments. Mr Everett was for ten years a useful member of Congress. In his literary work he displayed an almost fatal fluency, having contributed to the "North American Review," of which he was for some time editor, upwards of a hundred articles in the space of a few years. These articles are inevitably of unequal merit, but they everywhere evince the ripe scholarship of a highly cultivated mind. The volume by which he is best remembered—twenty-seven Orations—published in 1836, is marked by the same characteristics. Discoursing on a wide range of subjects—among which the refrains are America and Greece, the "Mayflower," the Progress of Discovery, Patriotism, Reform, the Republic, Concord, Lexington, and the inevitable Bunker Hill—these speeches are always able, but seldom inspiring: carefully elaborated and richly adorned, they are the production of the first of rhetoricians rather than a genuine orator.

Everett.

Among the remaining lawyers and statesmen, remarkably numerous in the States, who have in the course of their professional careers made highly creditable contributions to literature, it may suffice to mention H. Swinton Legaré of Charleston, at one time a student of law at Edinburgh, a prominent speaker in the House of Representatives, afterwards President Tyler's attorney-general, who published in the *Southern Quarterly* and *New York Reviews* a series of masterly criticisms mainly relating to Greek and Roman literature; J. P. Kennedy of Baltimore, a successful barrister and Congressman, also a vigorous essayist and author of some remarkably lively sketches of country life and manners in the Old Dominion; Richard H. Wilde, of Georgia, in which State, after surmounting unusual difficulties with remarkable perseverance, he rose at the bar to be attorney-general, author of the song entitled the "Lament of the Captive," and of a Life of Tasso, displaying great research and occasionally subtle criticism, written after two years' residence in Europe; and, taking higher rank as an author, Richard Dana, a barrister of the early years of the century, and adherent in politics of the old Federalist party in the state. Dana became known in the world of letters as the author of a Fourth of July Oration in 1814, and somewhat later as the contributor to the *North American Review* of appreciative and discriminating criticisms of the English lake poets. In 1827 he published his fantastic ghost story of the "Buccaneer" and other poems, to which he continued to add at intervals. Many of his minor verses are characterised by remarkable grace, but they want original force. Among contemporary politicians, Mr Wendell Phillips is the only one who can be called a great orator; the ease and energy of his style at its best being rarely surpassed. But the speeches of Mr Sumner are eloquent, and his arrangement of facts converging to clench his argument is often masterly.

Dana.

Phillips.

Historical and biographical writers.

2. HISTORY, as the reflection of philosophy on the statesmanship and the struggles of the past, seldom comes very early in national literature. The 18th century in America supplied, in letters, journals, and contemporary chronicles, material for more elaborate and comprehensive treatment in the 19th at the hands of George Bancroft, a leading Democrat, who held the post of representative of his country in Great Britain from 1846 to 1849. His great work—three volumes of which are devoted to the Colonisation and seven to the Revolutionary period—published at intervals between 1834 and 1874, has been generally accepted as the standard history of the United States up to this time. The book is written for the most part in a sufficiently vigorous style; somewhat defective, however, in elegance, and characterised by a certain monotony and want of ease, which detracts from the pleasure of the reader. Bancroft's statements of matters of fact are generally reliable; but his comments are moulded even more than is usual by the foregone theories of a political partisan. The rival history of Richard Hildreth, which appeared in six volumes, issued in rapid succession (1849–53), while marked by the same Puritan tone, is even more severe in its judgments. The style is more animated, but more prone to the *torva voluptas* of false rhetoric. The key-note of the sentiment which pervades Mr Hildreth's book is to be found in his keen abolitionist views, previously expressed in a juvenile work of the author, *The White Slave.* One of its merits is its appreciation of the Federalists, and especially of the genius and character of their leader, Hamilton. Of the host of national biographies in which the West abounds, Sanderson's *Lives of the Signers*, the historical sketches of G. C. Verplanck, Wirt's *Patrick Henry*, and the stupendous series edited and largely written by Jared Sparks, may be signalised. Nearly one-half of the works of the most classic American prose writers of the generations previous to our own are historical or biographical. Washington Irving's *Conquest of Granada*, and his lives of *Columbus*, the *Followers of Mahomet*, *Goldsmith*, and *Washington*, if not the most original, are among the most interesting of his works—accurate in their leading estimates, and marked by the usual smoothness and even flow of his style. Irving contemplated a continuation of the record of the early relations of Spain to the New World, but, with his wonted generosity, abandoned the theme on hearing that the task had been assumed by worthy hands. The works of William H. Prescott, the most artistic historian to whom the United States have hitherto given birth, are remarkable from the difficulties under which they were produced, and for the well-deserved success which they have achieved. This success is due in part to the genius and indomitable industry of the writer, in part to the steady concentration of his powers on the arduous undertaking of which he had at an early age formed a just estimate. In a diary of 1819 (that is, in his twenty-third year) he allows ten years for preliminary studies and ten more for the execution of his task—a notable example to his countrymen, nine-tenths of whose literary performances will prove ephemeral, less from lack of ability in the writers than from an utterly inadequate sense of the time and toil that every true Muse demands of her votaries. *Ferdinand and Isabella*, given to the world in 1838, was written while Mr Prescott was, owing to an accident at college, almost wholly deprived of his sight. His authorities, in a foreign tongue, were read to him by an assistant, and by aid of a writing-case for the blind he scrawled the pages of his great work. It soon attained a European as well as an American fame, and superseded all other records of the period of which it treats. No such comprehensive view of Spain at the zenith of her greatness has ever appeared in English. The proportion of its parts and the justice of its estimates are universally acknowledged; while hypercriticism of the style—graceful, correct, and sufficiently varied—can only point to the occasional possibility of greater condensation. Among the most notable of the descriptions, which can seldom be detached from the whole into which they are woven, we may refer to the return of Columbus and the contrasted characters of Queen Isabella and Elizabeth. The *Conquest of Mexico*,

Bancroft.

Hildreth.

Irving.

Prescott.

written with somewhat improved sight, followed in 1843; that of *Peru* in 1847. These have attained an even wider popularity than their precursor, owing to the more condensed romance and greater novelty of their themes. They are "open sesames" to an old world of wonders, real, and yet from its strangeness invested with half the charms of fairyland. Few passages of fiction are so enthralling to the youthful reader as the story of Nezahualcoyotl, king of Tezcuco, the life and exploits of Montezuma, the night retreat from the Aztec capital, or the account of the sun-worshippers in the Golden City. Both works are dramas in which our sympathy is divided between the chivalry of Spain in her hey-day and the poetical traditions and innocent patriotism of a vanished race. But their author has never, in the midst of his "Claude-like descriptions" and charmingly vivid narratives, allowed himself to forget that he is writing history. Boys read his Mexico and Peru as they read the Arabian Nights; critics can point to few flaws in the accuracy of the author's judgment. *Philip II.*, Mr Prescott's latest work, has similar excellencies in dealing with a less attractive theme. John Lothrop Motley, a distinguished ambassador in foreign courts, and author of the best existing history of Holland, is Mr Prescott's only more recent rival. Less faultless, he is more strikingly original; and the greater complexity of the theme, which he has made his own, calls for the exercise of even higher powers. The *Dutch Republic*, which appeared in 1856, at once arrested attention by its evidence of careful and long research, comprehensive grasp, rich pictorial power, and the enthusiasm which, only here and there interfering with the impartial judgment of the author, gives colour and life to the work. Mr Motley's style, even to minute turns in his sentences, bears the impress of the influence of Carlyle. The very titles of his chapters, especially in the first volume, seem transferred from the *French Revolution*. Such are "Sowing the Wind," "The Harvest Ripening," "The First Whirlwind," "The Taciturn against King, Cardinal, and Elector," &c. From the same source he may have caught some of his hero-worship, which, however, by the choice of a worthy object, he has done much to vindicate. The *Dutch Republic*, preluded by the overture of a masterly and vivid historical survey, is a drama, which facts have made highly sensational, of the most terrific struggle against temporal and spiritual despotism that, within the same space of years, modern times have seen. It is divided, not inappropriately, though perhaps with some regard for effect, into a prologue and five acts, to each of which in succession the name of the Spanish governor for the time is attached. The portraits of those emissaries, particularly those of Granvelle of Arras and Duchess Margaret of Alva, Don John of Lepanto, and Alexander of Parma, are drawn with bold strokes and in lasting colours. Behind the scenes, director of the assailing forces, is the evil genius Philip himself, to whose ghastly figure, writing letters in the Escurial, our attention is called with a wearisome, if not affected, iteration of phrase; while the presence of the great champion, like that of Achilles in the *Iliad*, is felt at every crisis retrieving the retreat and urging on the victory. The most horrible chapter of modern history—that of the Inquisition—is unfolded with a power that brands its records into the memory of the reader; and amid a throng of scenes of pageantry and pathos we may refer to those of the resignation of Charles V., Egmont's triumph at St Quentin and his death, the misery of Mook Heath, the siege of Leyden, and the hero's death. The *United Netherlands* (1867-69) is a continuation of the same history in the same spirit; but, as regards style, a somewhat calmer and more matured composition. The most thrilling chapters in those four later volumes are the siege of Antwerp—which compares with that of Syracuse in Thucydides—and that on the wreck of the Armada, unsurpassed in vividness and vigour by either Froude or Kingsley; to which we should add the episodes of the battle of Ivry and the skirmish at Zutphen, with one of the most eloquent tributes ever paid to the genius and character of Sir Philip Sidney. Of the other full-length pictures, which, with the campaigns of Parma, Spinola, and Maurice, and the intrigues of England and France, divide the interest of the book, are those of Queen Elizabeth (whose habitual treachery, real meanness, and shallow pretences to magnanimity are exposed, as afterwards by Mr Froude), Henry of Navarre, St Aldegonde, the Earl of Leicester, and the great Barneveld, who, with the Prince of Nassau, divides our sympathy at the close of the book. Since the death of Lord Macaulay no equally solid and valuable contribution has been made to historical literature. As supplementary in some measure to the volumes of Mr Prescott, we may mention here the *History of Spanish Literature* by his coadjutor Geo. Ticknor, incomparably the best, the most comprehensive, most critical, and most interesting work which exists on the subject.

Motley.

Ticknor.

Of other contributions to literary criticism, from which, owing to their superabundance, it is hard to select, those of George S. Hillard, one of the most highly cultured writers in New England; of Henry T. Tuckermann, author of *Thoughts on the Poets*, an elegant but sentimental essayist; of E. P. Whipple, a critic who, according to Mr Griswold, combines "the strength of the *Areopagitica* with the liveliness of the *Spectator*" (!); of Margaret Fuller D'Ossoli, a precocious linguist, translator of Eckermann's *Conversations with Goethe*, herself a brilliant conversationalist and somewhat cloudy transcendentalist and advocate of the superiority of women to men; the always lively reviews of Mr Lowell, with numerous papers in the *North American* and *Atlantic Reviews*,—may be referred to. To these we should add the discriminating "Essays on recent English Poets" contributed to *Scribner's Monthly* by E. C. Stedman.

3. Polite Literature, of any excellence, in the lighter branches is, in the West, almost wholly a growth of the present century. The most widely and justly celebrated of transatlantic authors in this field, during its earlier half, was the amiable and versatile Washington Irving. Of his numerous writings, we have referred in last section to those which are directly historical. The rest fall under two heads, according as they are concerned mainly with American or with European themes. On the same principle on which Agassiz, and Follen, and Paine, even Berkeley and Priestley, have been claimed by the United States, Irving is associated with the progress of English literature; for in virtue of his Scotch parentage, and in the course of four distinct and extended visits to Europe—1803-6, 1815-20, 1827-32, and 1841-46—he may be said to have become half an Englishman. His style is in the main that of the essayists of Queen Anne, modified by the humour of Charles Lamb; and many of his most effective sketches of life, manners, and society relate to the eastern hemisphere. Such are his Histories, the *Tales of a Traveller*, *Bracebridge Hall*, *Newstead and Abbotsford*, the *Alhambra*, and half of the *Sketch Book*. In reference to those works—the best passages of which are classical—a French critic has said that Irving describes all countries but his own in the style of Addison. In others, however, and these the earliest and latest of his works, he treats of national legend and scenery in a manner peculiar to himself. His first literary efforts, which resulted in the series of papers entitled *Salmagundi*, were gently satirical descriptions of the features of society in American cities. The *History of New York*, by "Diedrich Knickerbocker," in point of pure originality his masterpiece, is one of the richest farragoes of fact, fancy, and irony that have ever issued from the press. In later life, his *Tour of the Prairies*—*The Adventures of Bonneville*, and *Astoria*, are instinct with the spirit of western discovery and adventure.

Irving.

In this, as in other points of view, versatility and grace are his prevailing characteristics. He belonged historically to both worlds, and was equally at home in each; he reflected the quiet philosophy of the *Tatler* and *Spectator*, adding to it the pathos which dims the eye of the reader over his "Wife," and "Widow and Son," and "Broken Heart," and "Pride of the Village." He started the vein of burlesque that has run through his country's literature, but under the restraints of taste and temperance that have unfortunately been often discarded. The even grace of his manner often leads hasty critics to do scant justice to the range of his sympathy. His manly but gentle style is at home in Spanish history, English essay, and American legend; in the *Alhambra* and among the slopes of "Sleepy Hollow," where, as in the famous "Rip Van Winkle," we have some of the earliest models of amusement with grave faces and the melancholy parties of pleasure that are, under various forms of buffoonery, still typical of American humour. Associated with Irving in his

Paulding. *Salmagundi*, the name of J. K. Paulding deserves a distinct place for the humorous vigour of his character sketches, and his vivid pictures of early colonial life, in the *Dutchman's Fireside* and *Westward Ho!* where the features of the contest between the new settlers and the aborigines are brought before us in clear relief. His apologue of "Bull and Jonathan," and the thirteen good farms over which they squabbled—founded on Swift's *Tale of a Tub*—presents us, in a satire which lies on the border of irony and a rougher form of wit, with an early American view of the relations between his own and the mother country. Some of the same themes have been handled with superior richness of illustration and force by the greatest, with one

Cooper. exception, of transatlantic novelists—J. Fenimore Cooper (1789–1851)—a man remarkable no less for the somewhat defiant independence of his character, which led him to defend his countrymen in Europe, where he travelled from 1827–33, and to assail their foibles in America, than by the marked originality of his genius. His first considerable work, *The Spy*, appeared in 1821, and from its fresh treatment of a patriotic theme obtained a European reputation. His second, *The Pioneers* (1823), with a vivid representation of the scenery of the author's early life, introducing for the first time his ever-recurring hero the famous Natty Bumpo, or Leather-Stocking, established his place as a new actor on a crowded stage. Then followed *The Pilot*, in which he first asserted his claim to an empire since indisputably made his own among novelists—that of the sea; and somewhat later *The Last of the Mohicans* and *The Prairie*, in which he asserted a similar sway over the "gardens of the desert" and the hills of the remoter West. While abroad he wrote his *Red Rover* and *The Bravo*—a graphic tale of Venice, and flung on the aspersors of his country the *American in Europe*. Shortly after his return he issued his satirical assault on newspaper editors and other delinquents — his *Homeward Bound*, which led him into several actions for libel, in which he claims to have been almost invariably successful—*The Pathfinder*, and *The Deerslayer* (1840–41). The latter, perhaps the best of the Leather-Stocking series, completes the list of his great novels; to which must be added another important work—*The History of the American Navy*—published in 1839. There is a certain severity about Cooper's genius, showing itself in a hardness in his style, which restricts the range of his readers. He wastes perhaps too many words on descriptions, is exhaustive where he might have been suggestive, and his plots are apt to be deficient in interest —*The Red Rover* conspicuously excepted. But, deducting the echoes of Scott, to which we have referred, he is American to the core; he needs no slang or affectation to establish his originality, but moves on his own way with something like disdain of comment. His best descriptions —as, for example, those of the prairie on fire, of the "Ariel" among the shoals, of the capture of the whale and the panther in *The Pioneers*, of the last sea-fight in *The Rover*, of the regatta in *The Bravo*—are unsurpassed. His ships move over the seas like things of life. His hunters traverse the prairies with a sense of possession. His best characters are few; but Natty Bumpo, Bob Yarn, Nightingale, Long Tom Coffin, Hetty Hunter, and Brand Merideth are undying creations. The earliest American romancer of note, Charles Brockden Brown (1771–1810), Brockden who came before the world (1797) in *Alcuin, a Dialogue* Brown. *on the Rights of Women* (first of a mob of tracts on the same theme), set the example on his side of the Atlantic of that love of the anomalous, fantastic, and horrible, represented on our own by Beckford, Walpole, and Godwin, and later by Mrs Radcliffe and Mrs Shelley. His main works—*Wieland*, *Ormond*, *Arthur Mervyn*, and *Edgar Huntly*—are unmistakably the productions of a man of genius. None are wanting in passages of thrilling interest, striking situations, and subtle analysis of character. But they dwell too prevailingly on the night-side of nature—on such themes as insanity and somnambulism, and all the repulsive anatomy of mental disease. Brown's account of the yellow fever in *Arthur Mervyn* may be compared with the corresponding narratives in Thucydides, Lucretius, and Defoe; and Wieland's confession of the murder of his wife (a favourite subject of Western fiction) is hideously vivid; but the author's plots as a whole are wanting in method, his bursts of passion are dulled by intervening tediousness, and his style deformed by pedantic circumlocutions. Brown must be credited with considerable originality of conception, and blamed for introducing a morbid vein of thought. His influence is apparent in two novels of Richard Dana—to whom we have before referred—*Tom Thornton* and *Paul Felton*, in which a more graceful style is employed with almost equal vigour to illustrate similar monstrosities of character on the basis of incidents almost equally unnatural. Of the same school are many of the sketches of Charles F. Hoffmann, as "Ben Blower's Story" Hoffmann. of being immured in a steam-boiler, and the "Flying Head;" but alongside of these are others, as his "Winter in the West," "Romance of the Mohawks," and "Adirondacks," that are steeped in the fresh atmosphere of the green fields and hills. Hoffmann is also the author of three deservedly popular songs, "Myrtle and Steel," "Sparkling and Bright," and "Rosalie Clare." The influence of those writers, along with that of a profounder analyst, the French Balzac, is apparent in the works of Poe. the most morbid genius the modern world of letters has known. In the regions of the strangely terrible, remotely phantastic, and ghastly, Edgar Allan Poe reigns supreme. For clearness of style, aptness of illustration, and subtilty of thought, he distances in this field all his predecessors except Balzac, who in the mental dissecting-room is his only master. But while the Frenchman deals with anomalous realities, the power of the American consists in making unrealities appear natural. One of his great charms is his perpetual interest. Confining his imagination within limited bounds of space, he is never dull, save in his acridly jealous criticisms and miserable attempts at humour. Criticism would hardly strike a line from the longest and perhaps the most thrilling of his narratives, that of "Arthur Gordon Pym." In fictitious verisimilitude it is only equalled by De Quincey's "Flight of the Kalmuck Tartars." With the "Adventure of Hans Pfaall" in his balloon, and the "Descent into the Maelstrom," it is the obvious source of the ingenious pseudo-scientific romances of Jules Verne, which have lately attained so wide a popularity. Poe's most hideous tales, as "Thou art the

Man," "The Black Cat," "The Premature Burial," "The Pit and the Pendulum," "The Cask of Amontillado," "The Tell-Tale Heart," are redeemed by their literary merits and their reference, under the form of grotesque circumstances, to dominant fears and passions of mankind. In the "Fall of the House of Usher," "The Domain of Arnheim," "William Wilson," and "Ligeia," a more purely poetic or deeply psychological element is added to the horror. In the "Murders of the Rue Morgue," "The Mystery of Marie Roget," "The Purloined Letter," and "The Gold Bug," he is on the border-land between romance and reality, and seems to prove himself in potentiality the prince of all detectives. We shall have to refer to him again as a poet. The super-subtilty of Balzac and Poe appears with higher qualities in the works of the greatest of New England romancers, on the whole the most artistic of American prose writers, Nathaniel Hawthorne. Of his style it is impossible to speak too highly; for without any of the defects often found in the writings of his countrymen, it has a healthy flavour of nationality. It is accurate and strong, terse and yet full, rich and yet simple, harmonious, varied, and suggestive. These excellencies of form give a fascination to his most ordinary themes as to his descriptions of scenery and works of art. The only modern pictures of Italy comparable to those of Rome and her sculptures in *Transformation* are Ruskin's *Venice* and the finest stanzas in the fourth canto of *Childe Harold*. But Hawthorne's scenery can seldom be disentangled from the mood of mind in which he views it, and which constantly associates it with some remoter purpose or underlying allegory. Amid the din of voices in the Custom-house or half-buried in the mosses of his Manse, walking along the Appian Way or gliding down the Assabeth, he dwells among strange visions. The sea-shore tells him secrets of the past, and the prattling village is full of a present sympathy. But the features of nature, and life, and character which he loves to draw are peculiar. They are for the most part sombre and mysterious; not with the sort of mystery that attends unprecedented events and unnatural marvels, but with the mystery which he finds underneath the current of common lives. One of his prevailing thoughts is, things are not what they seem—he is so fond of peering beneath the surface of existence, that in his pages it almost loses its ordinary reality; he tries so constantly to look through life that he scarcely takes time to look at it. The highest art of all is that which comprehends both aspects, and, seeing the face of nature as it is, also penetrates to its hidden meanings. Hawthorne, on the other hand, weaves his fictions, to borrow a phrase from himself, in "the moonlight of romance;" and while he admits that materials for a better book than he has written "lie scattered on the page of life open before him, he has seldom stooped to gather them."

Hawthorne.

"Moonlight," he repeats in his preface to the *Scarlet Letter*, "moonlight in a familiar room, falling so white upon the carpet and showing all its figures so distinctly, making every object so distinctly visible, yet so unlike a morning or noontide visibility, is a medium the most suitable for a romance writer to get acquainted with his illusive guests. The room becomes a neutral territory, somewhere between the real world and fairyland, where the actual and imaginary may meet, and each imbue itself with the nature of the other."

Hawthorne has sometimes abandoned this neutral territory, and given us a few short sketches which show that he is eminently capable, when he chooses, of illustrating and characterising common things; such, among his minor tales, are "The Old Apple Dealer," "Little Annie's Ramble," "A Rill from the Town Pump," "Sights from a Steeple," "The Village Uncle," that well-named "Buds and Bird Voices," and "The Seven Vagabonds," the most humorous and genial of his lighter pieces. His prevailing themes are drawn on a border-land or twilight between two worlds, half real and half ideal; fairy tales, in which human beings are the fairies, and are made to point morals of their own histories. He haunts us, as he himself was haunted, by problems. Of the five volumes of his minor sketches, three at least are filled with allegories—riddles, some of them hard to read, and open to doubtful because double interpretations. "The Great Stone Face" is a noble piece of writing, apart from the lesson it is intended to convey. "Drowne's Wooden Image" and "The Artist of the Beautiful" are in themselves "beautiful exceedingly." The exquisite pathos of "Lily's Quest" and "Edward Fane's Rosebud" lies on the surface. "Lady Eleanor's Mantle" tells its own story in a parable of the Nemesis of pride; but in "Roger Malvin's Burial," "The Wedding Knell," "Young Goodman Brown," and others, the meaning is either more intricate or more remote. Hawthorne's longer works are all conceived in the same spirit. Their incidents are comparatively few, and might have easily been condensed into one of his shorter tales; which in their turn might easily have been expanded into elaborate romances—what a consummate story, for instance, might have been reared on the basis of "Rappacini's Daughter!" His forte lies in the analysis of character and situations, rather than the dramatic arrangement of events. "To live in other lives, and to endeavour to learn the secret which was hidden even from themselves," is the purpose set before himself by a character which in one of those romances nearly represents the author. Everywhere he seems to be carrying out this purpose, operating upon some three or four characters, and removing them—as he tells us in the introduction to *Blithedale*—a little from the highway of ordinary travel to a theatre where these creatures of his brain may play their phantasmagorical antics without exposing them to too close a comparison with the actual events of real lives. A small group of figures is thus made to work out some problem of life, or at least to throw by their ideal actions a light on some puzzle in the author's mind. The great question over which, in one form or other, he perpetually broods, is the nature of evil—the effect of sin and error on the soul—and their relation to virtue and human progress. In the *Blithedale Romance*, for instance, his theme is that the exaggeration of good may turn to evil. This almost painfully minute anatomy of four lives, relieved by passages of delicate description and a few scenes of thrilling power, is designed to show the blighting effects of a one-sided idea, even though it assumes the guise of a benevolent impulse, when it overrides private and personal claims. In *Transformation, or the Romance of Monte Beni*, a conception in some respects the converse of this, is wrought out of richer materials; and we are taught to appreciate the possibilities of good that there may be in evil, by the effect which an impulsive crime has in inspiring a simple instinctive nature with a stronger life. The *Scarlet Letter*, which is at once the most solid and the subtlest of the author's works, illustrates the fatal influence which a single sin exerts on all the persons whom it involves; but unlike the *Blithedale Romance*, which is a dismal tragedy, it ends with a magnificent triumph of expiation. The *Scarlet Letter* appears to us to be the best analytical novel of this century, the nearest approach to it in artistic finish and pyschological penetration being Goethe's *Elective Affinities*. The *House of the Seven Gables* has more variety, and mixes humour with its pathos; but the web of this last romance, which has for its moral the malign influences which may be transmitted from one generation to another, is woven of thinner threads. Hawthorne's Protean genius is a power in American thought. His influence as a teacher and an artist is still crescent among the contemporaries from

whom he has lately passed. His symbolic yet real characters—Hester and Pearl by the forest brook; Dimmesdale by the scaffold, with the red morning upon his brow; the dead Judge sitting with his watch; the Cleopatra of Brook Farm plunging in the pool; Miriam and Hilda, and Donatello the Faun—are stamped in letters of fine gold on the pages of his country's literature, and the music of his quiet sentences yet lingers on the ear of strangers as of friends. But his name remains as a warning as well as an example. In one sense he was a patriot, glorying in the great deeds of his country's past. Of this feeling the "Gray Champion" and "Howe's Masquerade" give sufficient evidence. At the close of the last he writes, as we may fancy with a grim Puritan smile: "On the anniversary night of Britain's discomfiture the ghosts of the ancient governors of Massachusetts still glide through the portals of the Province House." But as a politician he wrecked himself with the democratic party. He looked upon slavery as "one of those evils which Providence does not leave to be remedied by human contrivances." He had no sympathy with the abolitionists, and at least a half sympathy with the planters. "As regards human progress," he wrote, "let them believe it who can;" and in the preface to his last completed work, as his excuse for laying the scene in Italy,—"There is in our country no shadow, no ambiguity, no mystery, no picturesque and gloomy wrong." "Romance and poetry, ivy, lichens, and wallflowers, need ruin to make them grow." Hawthorne lived to see the beginning of what he could only regard as ruin: he did not live to see his country rising stronger after a great struggle with a gloomy wrong.

Holmes. Oliver Wendell Holmes, the accomplished physician of Harvard, better known as a humourist and author of occasional verses, has contributed to psychological romance two remarkable volumes: *Elsie Venner* and *The Guardian Angel*. The former, and more striking of the two, is a weird tale of destiny, dwelling upon the idea of transmitted qualities in a manner which suggests comparison with *The House of the Seven Gables;* but Holmes's story has a more incredible plot, the chief character being a sort of sprite, having mysterious relations to the animal world, a snake-charmer, herself half a snake (as Donatello in *Transformation* is half a faun), like the Lamia of tradition and Keats, but endowed with the graces of Undine. The vigorous sketch of the hero Langdon, with which the book opens, is impaired by the somewhat obtrusive manner in which he is vaunted as a type of the blue-blooded or Brahmin caste of New England. The same pathological treatment of human nature pervades *The Guardian Angel*, which turns partly on mysterious physical and psychical affinities. The *Margaret* of Sylvester Judd, a Unitarian clergyman of Maine, belongs, by virtue of some of the problems with which it deals, to the category of metaphysical novels. This work of decided genius, to which a just tribute is paid by Mr Lowell in his *Fable for Critics*, has hardly attained the popularity it merits, owing to the slender character of the plot, and the frequency of the dissertations by which the author endeavours to impress his own views of society, art, and religion. But it is a powerful picture of the more ideal sides of New England life; the character of Margaret and Chilion are permanent types, and the whole book is extremely fresh and original. The most genuine successor of Hawthorne is Theodore Winthrop, who left a counting-house in New York for an adventurous life, and fell at Great Bethel in 1861 in his thirty-third year. His best novel, *Cecil Dreeme*, teems with life-like characterisation, bathed in a poetic element of mystery; and *John Brent*, the next in merit, is a graphic sketch of romantic incidents in the Far West, drawn from his own experience.

Judd.

Winthrop.

Minor novelists. Of tales evincing talent there is a plethora; they lie on the shelves of the libraries "thick as the leaves on Vallombrosa." Among those worthy of note are the pictures of Southern society by W. G. Simms, whose fertile brain is said to have produced fifty volumes in twenty years; *The Bee Hunter*, and other narratives of the south-west, by T. B. Thorpe of Baton Rouge; John Neal's *Rachel Dyer* and *Ruth Elder;* the classical romances of Ware, *Zenobia* and *Probus and Julian;* Mrs E. O. Smith's *Indian Reminiscences; The Linwoods, Hope Leslie*, and other philanthrophic tales of New England, by Miss Sedgwick; Mrs Lydia Child's *Hobomok*, and her *Philothea*, a romance of Pericles and Aspasia, somewhat too sentimental in its style, and not free from anachronisms; with the anti-slavery pictures represented by Mrs Stowe's *Uncle Tom*, a book which, inspired by ordinary talent and written in an earnest spirit, owed its success to the air of simple narration which pervades it, and its having the aggressive strength of a political pamphlet appearing at the right time in harmony with the passion on one side of an impending struggle. The light but graceful and often incisive sketches of N. P. Willis take a somewhat higher rank. A rapid writer, but at his best a brilliant colourist, his fertile fancy has been employed in almost all the countries of Europe, and in his own, in prose and verse, with more than average success. His *Pencillings by the Way* and *People I have Met* are among the most agreeable of books for a leisure hour; his descriptions are always interesting as well as accurate, and his characters, grave and gay, are generally life-like. His picture of the Indian girl, Nunu, in the *Inklings of Adventure*, is fascinating and vivacious enough to be worthy of a higher artist.

Willis.

Travels. Books of TRAVEL, among which those of Mr Willis hold a respectable place, superabound in the literature of the West. Nine-tenths of the literary men of America have crossed the Atlantic, and nine-tenths of those who have done so have published their impressions of the Old World, with every variety of good and bad taste, from the *Old Home* to the *Innocents Abroad*. After that of his birth, an American author's travels are the first essential of his being. We may next predict his praise of Italy, his half satirical half curious view of England, and his wonder at the Pyramids. Of the multifarious descriptions of Europe to which this habit has given birth, the worthiest of note are those of Hawthorne and Emerson, of Story and Cheever, and Curtis's *Nile Notes*. In the "Lotus Eating" of the last named we have pleasing reminiscences of the watering-places of his own country. But the most interesting records of western scenery are those of Fremont; Winthrop's *Canoe and Saddle*, and *Life in the Open Air;* and the numerous remarkable "Excursions" of Emerson's leading pupil, H. D. Thoreau—his "Maine Woods," "Cape Cod," and "Merrimack;" with the vacation voyage to Cuba of the younger Dana.

Humorous writers. 4. A leading feature of transatlantic literature is its HUMOUR. Humour is a word of many meanings: it begins on the low level of any laughter-provoking absurdity, and rises, as in the speeches of Lear's Fool, to a tragic height. In the Greek classics it shows itself in the Rabelaisian exuberance of Aristophanes or in the Socratic irony: in the English we have an even more subtle appreciation of the curiosities of character, and a deeper sense of the contradiction or conflict between the higher and lower phases of human nature. In Sterne and Fielding, as in Ben Jonson, we have every man in his humour. As developed in America, this quality of the mind seldom penetrates to the under-currents of life; its insight is clear but not profound; it relies mainly on exaggeration, and a blending of jest and earnest which has the effect of singing comic words to a sad tune, or telling a preposterous story with a grave face. Mr Lowell makes us laugh by his description of a negro "so black that charcoal made a chalk mark upon him," and of a wooden shingle "painted so like marble that it sank in the water." Mr Browne (Artemus Ward) excited the same sort of laughter by his remark in pointing to a hill daubed on his canvas, "the highest part of this mountain is the top." In both cases there is a surprise, excited in the one by a falsehood plausibly pretending to be the truth, in the other by a truism asserting

itself as a novelty. Similarly, when the latter writer, among his anecdotes of the conscription, tells us that "one young man who was drawn claimed to be exempt because he was the only son of a widowed mother—who supported him," the amusement is all in the unexpected turn of the last three words. In contradistinction to this, the humour of Don Quixote, of Falstaff, of Uncle Toby, of Major Bath, of the Vicar of Wakefield and Sir Roger de Coverley, of Major Pendennis and Bishop Blougram, consists in its truth. What these people do or say never surprises us. It is absurd as a great part of human life is absurd, and, laughing at them, we feel we are laughing at something in ourselves. The best recent instances of this higher kind of humour which American literature affords are to be found in Washington Irving, in Mr Lowell's *Biglow Papers* (to which, as a considerable national poem, we shall have to revert), in passages of Mr Longfellow's *Kavanagh*, in Mr Hawthorne's *Seven Gables* and *Seven Vagabonds*, and in the prose and verse of Dr Holmes. In his three pleasant volumes, *The Autocrat*, *The Professor*, and *The Poet at the Breakfast Table*, there is much that might have been omitted, more that should have been compressed. They contain too many jokes, good, bad, and indifferent, and are tainted here and there with what we must be excused for regarding as New England slang. But they are pervaded by a genial glow of kindly sympathy, and they exhibit, with a quaint mannerism—not without its attractions—personages, and situations, and sentiments which we recognise as at once odd and real. Dr Holmes's works have frequent reflections of Montaigne and Burton, and the *Noctes Ambrosianæ;* he mixes pathos and whimsicality after the manner of Lamb and Sterne. His humorous verses, the best known of which, "Daily Trials," "Evening, by a Tailor," and the "Music-grinders," inevitably recall the drolleries of Hood. His genius has, nevertheless, an original vein, less mellow, but at its best as genuine as that of his older masters. Several of the miscellaneous papers, essays, and periodicals belonging to the earlier years of the century, as *Salmagundi*, *The Talisman* of Bryant and Verplanck, *The Olipodiana* of W. G. Clarke, and the *Sparrow Grass Papers*, are frequently enlivened by sparkles of wit and evidences of keen discrimination. In others we trace the germs of a vicious style which threatens to degrade the lighter literature of the States. The *Charcoal Sketches* of Joseph Neal—which might be entitled Comicalities of the Mississippi—are among the earliest examples of the habit of playing with slang terms characteristic of his successors. An author who relies for effect on giving his imaginary personages such nicknames as "Dawson Dawdle," "Peter Ploddy," "Tippleton Tipps," and "Shiverton Shanks," is more likely to be the cause of wit in others than the source of humour himself. During the last generation in America the anxiety to be national has led many of her minor authors to make themselves ridiculous. To avoid walking like Englishmen, they have gone on all-fours; to escape the imputation of Anglo-Saxon features, they have painted their faces with ochre and put ear-rings through their nostrils; forsaking the speech of Addison and Steele, they have expressed themselves in an unseemly jargon of strange tongues. Of this mocking-bird humour the most legitimate form is that of the *Biglow Papers*, where the New England dialect is employed with effect to give voice to the sentiments of that district of the country during the national struggle, on one side of which it took the lead. A similar justification may be put forward in behalf of the Californian peculiarities, which are perhaps not too prominent in the often really humorous pieces of Bret Harte. The mixture of two dialects in the *Breitmann Ballads* is a bolder licence, though for the best of these Mr Leland may plead the wide-spread use of the mongrel speech, and the original success of a drollery which has only become tiresome from his not knowing when his readers have had more than enough of it. The parodies of Mr Browne (Artemus Ward) are open to the same criticism. The writer was a man of wit and talent, and therefore his writings are amusing. They are good specimens of the worst style of satire: for the wit that relies on bad spelling is almost as false as that which consists in bad language. In vindication of the "Showman," it must, however, be observed that his sarcasm is generally directed against mean or ridiculous things. But his example has paved, for those who have caught the trick of his phrase and who are unrestrained by his good feeling and good sense, an easy descent to the lowest form of light literature—that which panders to the vice of moral scepticism and thrives on the buffoonery of making great and noble things appear mean or ridiculous. The names of those who habitually feed on mental garbage should be left to sink into the oblivion from which they have unfortunately emerged. It is painful but necessary to observe that some of the more considerable writers and thinkers of the New World are apt to condescend on occasion to this burlesque way of writing. American light literature bristles in puns which are at best the "a-b abs" of wit. Of these, Mr Lowell (a severe critic of everything English) has made the worst—"Milton is the only man who has got much poetry out of a cataract—and that was a cataract in his eye." Mr Leland, the next worst, in his book of travels—"If a thing of beauty be a *jaw* for ever, as the American said of his handsome, scolding wife, then the donkey boys of Cairo are the most jaw-ous and beautiful creatures; for the sound of their voices drieth not up." Eccentricities of this sort, with the graver irreverences which intrude themselves even into the pulpits of the West, should be universally discredited as blasphemies against the first principles of taste. They are as "flat, stale, and unprofitable" as the contortions of a wearied clown. True humour—as ever in our classics—must go hand-in-hand with seriousness; it must never forget that behind the comic there is a tragic element in human life. The mere "farce" is contemptible, because it is as unnatural as the expression of a countenance distorted by a continual grin. In forgetfulness of this lies the greatest danger of the recent literature of America, and we can only trust to the higher intellectual instincts and tendencies of the age to detect and resist it.

5. New England Transcendentalism.—Religion, the first motive power of thought in America, has continued to flow, both in its old channel—that of the orthodox Puritanism which came down from Eliot and Edwards through Dwight to Hodge and the Princeton Essays—and in another, that of the new forms of faith advocated by W. E. Channing, and with gravely heterodox modifications by Theodore Parker. Criticism of Channing's theological position is apart from our purpose here. He claims notice in a review of literature by the vigour of his conceptions and his graceful and correct expression of them. His earliest considerable essay, the *Moral Argument against Calvinism*, one of the best known of his numerous controversial works, indicates by its title his prevailing attitude. He relied through life on *a priori* moral arguments, and employed them as his engines of attack against all persons, institutions, or practices that offended his rigid sense of justice or his enthusiastic benevolence—*e.g.*, Napoleon I., War, and Slavery. A generous indignation against wrong, and keen practical sense of the duties of life, are more conspicuous in his writings than speculative power; but his insight into the political position of parties and the probability of future

Theology.

Channing.

conflicts is remarkable. Though at variance with the older creeds of Christendom, Channing's writings are everywhere marked by a reverential spirit, and not unfrequently by a touch of asceticism inherited from the Puritan days, whose abstract doctrines alone he proposed to modify. On the other hand, he admired the higher forms of Art, and in his eloquent essays on *Self-culture* anticipated much that has been said more recently by Emerson. He loved beauty as well as virtue for itself, and his style, except on rare occasions, is free from the defects of taste so frequent in the writings of his contemporaries. His reviews of Milton and Fenelon abound in passages—as the picture of religious peace in the latter—which exhibit the delicacy and the breadth of his sympathies. Parker. Theodore Parker—unlike Channing—assails the whole basis of the old theology, and frequently errs from arrogance and impetuosity. He had, perhaps, a more powerful but a less highly cultivated mind. He was a pupil of the transcendental movement of New England, to which, because of its influence on literature and its association with the most original thinker of the New World, we must accord some space.

Transcendentalism. In the early years of this century the mental philosophy of the West, beyond that which was a handmaid to the Calvinistic theology, was limited to commentaries on Locke and Brown and the eclecticism of Cousin, when the republication of *Sartor Resartus*, and the works of the German idealists which it introduced, gave life and voice to a new intellectual world. Ideas which filter slowly into English soil and abide there for a generation, flash like comets through the electric atmosphere of America. Coleridge and Carlyle were hailed as prophets in Boston while their own countrymen were still examining their credentials. The rate of this transformation was surpassed by its thoroughness. The converts put their teachers to the blush; and in recoil from solid Scotch psychology and practical materialism, rushed to the outer verges of idealism, mysticism, and pantheism. Their quarterly magazine, the *Dial*, during the space of four years represented their views throughout four volumes of miscellaneous merit. The *Dial* is a pantheon from which only Calvinists and Utilitarians are excluded, where the worshippers, Parker, Fuller, Alcott, and a host, meet and sing hymns to Confucius, Zoroaster, Socrates, Goethe, Tieck, and Richter, set to German music; and pass from antiquated laudations of Homer and Shakespeare to friendly recognitions of new heresies; from thoughts on labour to puffs of poetasters; from Hindoo mythology and Chinese ethics to 19th century truisms about progress and union, prudence and humanity; from soaring among the heights of a modern religion of beauty to raking among the tangled roots and dead leaves of a second-hand Orientalism. But those vapours of idealism might have soon faded into the light of common day, had not all their best aspirations been concentrated and Emerson. vitalised by Mr R. W. Emerson. His first oration, delivered at Cambridge thirty-five years ago—the refrain of which is the independence of American literature—is referred to by recent critics as a landmark in the annals of their country. In this discourse—as in the six volumes through which the author enforces the same conceptions—there is scarce anything of which, taken separately, we need fail to trace the pedigree. Fichte had many years before spoken in the same strain of the vocation and nature of the scholar; the view of science comes from Swedenborg and Schelling; and the dignity of labour from Carlyle. The originality, as is the case with the author's whole system of thought, is in the combination—which, it may be, is the only kind of originality now possible. His position, as far as it is tenable, illustrates the fact that the divisions of philosophy are being continually altered as old systems form affinities with new beliefs and historical conditions. Mysticism in the New World has been combined with the opposite extravagances of Mount Lebanon and Oneida Creek, but it has been distinguished from idealism proper by its exaltation of emotion above reasoning. Mr Emerson, defining transcendentalism as "the saturnalia of faith," differs from the older mystics in his absolute rejection of all external authority, his almost arrogant confidence in the sufficiency of the inner light, and his new American preference for the active to the passive sides of life. He has an historical sympathy with the unsatisfied aspirations of all ages, with the day-dreams of restlessness in search of rest that inspired the quest of the Sangreal, and led the monks to Christianise the eastern Nirvana; that laid out Brook Farm in Massachusetts, and gave Novalis and Newman back to the fold of Rome: but he will not be drawn by them into any church with walls. All religions are to him "the same wine poured into different glasses." He drinks the wine, and tries to shatter the glasses. His unflinching scepticism pierces the armour of all definite dogmas, while he entrenches himself behind an optimism like that of Spinoza. Mysticism has in the main been fatalistic. As a developed system, its natural home is in the East; where the influence of great uniformities of soil and climate have only in recent years been partially counteracted by the conquering activities of an energetic race. Beneath her burning sun and surrounded by her tropic vegetation, the mass of men were overwhelmed by a sense of their insignificance, and this feeling of subjugation was intensified by absolute forms of government. The same listlessness which permitted a secular and priestly despotism, led its victims to welcome the idea of a final absorption of their individuality. Their philosophical ambition was to pass into the framework of a gigantic nature, to be "rolled round the earth's diurnal course with rocks and stones and trees." There is a relic of this spirit in the ἀταραξία, ἀπάθεια, and ἠρεμία, which are the aims at once of the Epicurean and Stoic systems; but the doctrines of passive obedience had been banished from Greece as early as the overthrow of the Pythagorean institute. They revived in the dark and middle ages, when the church took upon itself the task of legislating for the intellect; and even the precursors of the Reformation were possessed with an almost oppressive sentiment of resignation. The reproduction of the Oriental spirit in America, in so far as it is genuine and not the mere expression of a love of far-fetched quotations, may be attributed to external influences in some respects comparable to those which weighed on the inhabitants of ancient India. In the Western, as formerly in the Eastern World, nature still struggles to assert her old supremacy, and threatens to domineer over men's minds by the vastness of her empire. But in other respects the conditions are reversed. In place of stagnation and uniform although magnificent decay, we have to deal with the manifold progress of 19th century civilisation in a land where every one is more or less inspired by the resolve of the modern mariner with an ancient name to "sail beyond the sunset" in pursuit of fresh adventures; where the energies of the individual are in constant, and in the long run triumphant, struggle with all that tends to restrict the full sweep of his arm or to retard the freest activities of his mind. Where every moon sees new forests felled, new rivers crossed, new fleets built, new tribes amalgamated, new discussions raised, and new problems solved, mysticism, if it exist at all, must take on a form very different from that handed down from the East of 3000 years ago to the Alexandrians, and transmitted to the European ages of implicit faith by the pseudo Dionysius. Mr Emerson strikes the key-note of the difference when he writes, "Feudalism and orientalism had long enough thought it majestic to do nothing; the modern

majesty consists in work." Retaining from the mystics his belief in the supremacy of the higher emotions, he substitutes for a religious creed an idealised view of modern physical science. His combination of stern practical rectitude with an ideal standard is his point of contact with Puritanism. A chivalric nobility, in which beauty and goodness are blended, is at once the goal, the sanction, and the motive of his ethical system. Praise of the virtue which, transcending all prudence and disdaining all consequences, is its own reward, is the refrain of his moral monologue. His severe censure of Goethe's artistic indifferentism recalls the age when the Bible and theological commentaries were regarded as the sum of honest literature. He writes of our great dramatist in the spirit of the men who closed the theatres: "He was the master of the revels to mankind"—a sentence far removed from the spirit of modern art-worship. But those which follow, protesting against the opposite extremes of austerity, indicate his divergence on the other side from the old faith of New England.

Mr Emerson is, we believe, most widely known in this country by his *Representative Men:* by no means the most satisfactory of his works. A series of generally acute criticisms, pervaded by no well-marked ethical idea, it leaves on the mind a somewhat indefinite impression. Its categories are not exhaustive, and it is difficult to determine on what principle they are chosen: but it serves as an interesting point of comparison with the corresponding lectures of the great English advocate of hero-worship, to the suggestions of which it probably owes its existence. Mr Carlyle, whose whole faith is centred in strong individualities, adopts the view of history which practically resolves it into a series of biographies. Mr Buckle, caring little for persons, and confiding rather in general laws, resolves biography into history. Mr Emerson on this question steers a middle course. He believes in great men, "to educate whom the state exists, with the appearance of whom the state expires;" but he regards them as inspired mouthpieces of universal or national ideas rather than as controlling forces. Their mission is not so much to regulate our action as to "fortify our hopes." Possessed of a larger share of the Over Soul which "makes the whole world kin," they apprehend and explain phenomena which have hitherto passed unheeded; but their indirect services are the best. Their examples, more weighty than their acts or discoveries, are perpetual encouragements. The great man is an encyclopædia of fact and thought; the belief born in his brain spreads like a current over humanity, and he becomes for a time the golden key to the ill-defined ideal of the multitude. But his career should rouse us to a like assertion of our liberties. We ought not to obey, but to follow sometimes by not obeying him. Our author accepts the position upheld by Aristotle and popularised by Macaulay, that different forms of government are adapted to different social conditions; but maintains that the tendency of modern times, attaching more weight to the equality of persons and less to the inequalities of property, is towards Democracy, with which and the industrialism of his age he has in the main a cordial sympathy. He believes in collective wisdom as the best check on collective folly, and, allowing that the state exists for its members, he thinks they can act best in union when all are subject to the fewest external restraints. He differs from Thoreau and others of his disciples in having no share in their selfish isolation. His best essays, woven of two curiously intersecting threads, present us with a unique conjunction of shrewdness and idealism. There never was a mystic with so much of the spirit of the good farmer, the inventor, or the enterprising merchant.

As regards form, Mr Emerson is the most unsystematic of writers. The concentration of his style resembles that of a classic, but, as with others who have adopted the aphoristic mode of conveying their thoughts, he everywhere sacrifices unity to riches of detail. His essays are bundles of loose ideas tacked together by a common title, handfuls of scraps tossed down before his audience like the contents of a conjuror's hat. He delights in proverbs and apt quotations; he exaggerates like an American, loves a contradiction for itself, and prefers a surprise to an argument His epigrams are electric shocks. He sacrifices everything to directness. His terse refinement of phrase and trenchant illustrations are his charm. His ideas are on the scale of a continent; his sentences are adapted for a cabinet of curiosities—bits of mosaic work, sweeping generalisations given in essences. His style, armed with points like the bristles of a hedgehog, wants repose. This feature is conspicuous in the *English Traits*, where his estimates of men and things, frequently felicitous and generally racy, are often marred by an unpruned violence. His eye is keen, but its range is narrow, and he is ignorant of the fact. Unconsciously infected by the haste which he condemns, he looks at other nations through the folding telescope of a tourist. His representations of our leading writers and statesmen seldom rise above the level of Mr Willis's *Pencillings by the Way.* His taste is constantly at fault, and an incessant straining after *mots* often leads him into caricature. His judgments of those whose lives and writings do not square with his theories are valueless; and in dealing with foreign languages he betrays the weakness of his scholarship.

One qualification for a good critic is a well-defined artistic standard, another is the dramatic capacity of placing himself for the time in the position of the person who is being criticised. Mr Emerson has neither of these. With the spirit of a fearless inquirer, he unfortunately blends so much presumption as to feel an absolute indifference regarding the opinions of others; and this in excess constitutes a moral as well as an artistic defect. Thought is free, and the expression of it ought to be so; but when our thought wanders very far from that of the majority of the wise and good, we are bound to watch it, to sift its conclusions, and to state them moderately. Mr Emerson's thought does wander far, and it runs fast; he does not know what moderation in expression means, and his almost childish love of contradiction perpetually, and often justly, provokes offence. He rides rough-shod over the most cherished convictions, or waves them aside with a complacent smile and a sort of divine impudence. Every claim of authority he receives as a challenge to his personal rights, and he stabs the bull Apis, in utter disregard of the historian's warning. His impatient *anticipationes naturæ* detract from his reliability in matters of detail, while by a similar carelessness he repeats and contradicts himself with equal frequency. His soundest judgments relate to the men around him, of whom he is at once the panegyrist and the censor. All that is weak and foolish in their mode of life he condemns, all that is noblest and most hopeful he applauds.

Mr Emerson has left his mark on the century; to use a favourite phrase of his own, "he cannot be skipped." Even where his results are least satisfactory, his intense suggestiveness is the cause of thought in others; and as one of the "genetic" powers of modern literature, his fertilising influence will survive his inconclusive speculations. His faults are manifest: a petulant irreverence, frequent superficiality, a rash bravery, an inadequate solution of difficulties deeming itself adequate, are among the chief. But he is original, natural, attractive, and direct—limpid in phrase and pure in fancy. His best eloquence flows as easily as a stream. In an era of excessive reticence and cautious hypocrisy he lives within a case of crystal where

there are no concealments. We never suspect him of withholding half of what he knows, or of formularising for our satisfaction a belief which he does not sincerely hold. He is transparently honest and honourable. His courage has no limits. Isolated by force of character, there is no weakness in his solitude. He leads us into a region where we escape at once from deserts and from noisy cities; for he rises above without depreciating ordinary philanthropy, and his philosophy at least endeavours to meet our daily wants. In every social and political controversy he has thrown his weight into the scale of justice, on the side of a rational and progressive liberty; and his lack of sympathy with merely personal emotions is recompensed by a veneration for the ideal of the race which recalls the beautiful sentiment of Malebranche: "When I touch a human hand I touch heaven."

Poetry.

Half the literary men and all the literary women of this century in America have written verses; most of them are respectable and many are excellent. But a brief review of the poetry of the West must dwell on the works of four or five authors who most clearly and saliently express the main tendencies of their nation. It must suffice here to name as familiar, or worthy to be so, the graceful *vers de société* of Holmes, especially his "Punch Bowl" and "Old Ironsides;" the patriotic chants of James Percival; the sparkling fancies of J. R. Drake's "Culprit Fay;" the fashionable satires of Halleck; the lyrics and romances of the great traveller and prolific author, J. Bayard Taylor; the well-balanced stanzas of Hillhouse; the plays of Conrad and Bird; "Woodman, spare that Tree" and the "Whip-poor-Will," by G. P. Morris; A. B. Street's "Settler," and "Forest Walk;" and, pre-eminent among female minstrels, Mrs Sigourney, whose blank verse descriptions of nature approach those of Bryant; the youthful prodigies, Lucretia and Maria Davidson; and Maria Brooks, authoress of the richly imaginative southern romance of *Zophiel*, whom Southey, her friend and admirer, pronounced to be "the most impassioned of poetesses." We proceed to review the position of the really great poets of the United States, as representing somewhat different manners and modes of thought.

Longfellow.

1. THE EUROPEAN SCHOOL.—Of these, in our judgment, Mr Longfellow is still the first. His works are free from the defects that stamp the national literature of his country. He has none of the uncouth power and spasmodic exaggeration of his contemporaries. He is all grace, polish, and sweetness. His prose masterpiece, "Hyperion," is the key-note of his minor poems. The source of their inspiration is "Outre Mer" among feudal towers, Flemish towns, and Alpine passes. Like Irving in the variety of his culture and superior in genius, his imagination is Teutonic rather than American. He lingers in Nuremberg, Bruges, and Prague; and chooses for his emblem of life's river, not the Ohio, nor the Hudson, nor the Assabeth, but the "Moldau's rushing stream." His "New England Tragedies" are perhaps his least successful efforts, partly because dramatic literature has seldom yet flourished in American soil, and partly because his sympathy with the ruder age is not keen enough to enable him to vitalise it. Mr Longfellow has given us the best translations in the world from Swedish, German, Spanish, and Italian authors, and many of his best verses are avowedly suggested by proverbs or sentences, or bits of old romance. A few words from an old French author give him the burden of the "Old Clock on the Stairs;" a leaf out of Mather's *Magnalia Christi* is rhymed into the "Phantom Ship;" the ballad of the Count Arnaldos sets him dreaming over the secret of the sea; a verse of Euripides is the key-note to his "Voices of the Night;" a few lines from Goethe gather up the essence of the "Psalm of Life." In the New World, but not of it, he dwells with almost wearisome fondness on the word "old." Volumes of old days, old associations that we cannot buy with gold, quaint old cities, old poets and painters, sweet old songs, old haunted houses, dear old friends, the grey old manse, Nature the dear old nurse, dear old England,—on phrases and thoughts like these his fancy broods. American verse is frequently rough-hewn and audacious, sometimes obscure and pedantic; its novelty is often more striking than its truth. Every sentence that Longfellow has penned is as clear as crystal and as pure as snow. He wears his weight of learning lightly as a flower; and though he cannot create, he cannot touch without adorning. He seldom gives us thoughts absolutely new, but he puts our best thoughts in the best language. Critics react against his popularity, and complain of his want of concentration and the conventionality of his epithets (a fault more rare in his later volumes); but his place as the laureate of women and children and gentle men is unassailable; and there are seasons when we prefer his company to that of the grand old masters, when we seek an anodyne rather than a stimulant—

> "His songs have power to quiet
> The restless pulse of care."

Longfellow's command of verse alone proves him to be a genuine poet. There are passages in the "Arsenal," the "Occultation of Orion," the "Building of the Ship," and the "Household Poems" unsurpassed in melody by any in contemporary English verse. The introduction to "Hiawatha," the closing lines of "Evangeline," and some of the character sketches which preface the "Tales of the Wayside Inn," have a music equally attractive and more decidedly original. The highest flights of Longfellow's imagination are in the strangely-confused old-world story of the "Golden Legend;" but the work on which his fame most securely rests is "Hiawatha." This poem, in which a series of idylls are strung together on the thread of an idea common to Indian and Scandinavian legend, has that exhilarating flavour of nationality wanting in many of the author's works, and it yields to none of them in artistic finish. The monotony of the verse is like that of a bird's song which has only two or three notes, and yet from its everlasting freshness never palls upon the ear. Most modern attempts to reproduce old ballads put new wine into old bottles; but the American poet has thrown himself as completely into the spirit of aboriginal western life as he has into that of Gothic paganism in the "Challenge of Thor." Like Chibiabos the musician he is at home among the pine-groves and the prairies and "the great lakes of the Northland;" and

> "All the many sounds of Nature
> Borrow sweetness from his singing."

Longfellow's descriptions charm us more than they astonish. Inferior in luxuriance to those of "Enoch Arden," in intensity to those of "Locksley Hall," in subtilty to Browning's Italian pictures, they are superior in simplicity. If they do not adorn Nature as a mistress with the subjective fancies of a lover, they bring her before us as a faithful nurse, careful for her children. In "Evangeline" the poet follows the wheels of the emigrant's waggon over

> "Billowy bays of grass, ever rolling in sunshine and shadow;"

and

> "Over them wander the buffalo herds and the elk and the roebuck."

Hiawatha speaks of Nature with the familiarity of an inhabitant; there is no trace of the grandiose style of the tourist. In the best episodes of the volume—as the account of the hero's childhood and his friends—of the wooing of Minnehaha—of the son of the evening star—of

the ghosts and the famine—the parable of human life, with its incidents of birth, love, and death—of civilisation and decay—is told in a narrative of child-like tenderness as well as masculine grasp. He who runs may read it, and yet the whole is lit up by an imagination like an aurora borealis. A recent New York critic ridicules the European view of "Hiawatha" as an American poem. It is true that the feverish ardour of Wall Street has no place in its pages; but it is none the less manifestly transatlantic and *sui generis.* In celebrating Red Indian life, it inevitably discloses some of the features of the race which has come into close contact with that life. The New Zealand myth about the strength of the dead enemy passing into his conqueror applies here. Mr Dixon has dwelt very justly on the extent to which the aborigines of America have communicated their spirit to the pioneers before whom they have given way. Hiawatha sings of the decadence of a primitive people in strains that recall by their pathos the old British legends of the death of Arthur, but has also a prophetic side; from the meeting-point of two races it looks before as well as after.

Poe. More devoid of national sentiment and local colouring are the remarkable verses of Edgar Allan Poe, to whom we have before referred as a romancer. If the aim of poetry be to astonish or to fascinate, Poe takes a high rank among poets. According to Wordsworth's definition of the art, he has hardly a place among them at all. He teaches nothing, and living in one world writes in another. All we know of the personality of most of the authors we have named adds to the charm of their works. Regarding Poe's career it is otherwise. The vain and captious jealousy of his criticism is as repulsive as his graver defects. It has been said that he is the greatest of American writers in verse. This is an exaggeration of his powers only surpassed by his own exaggeration of them. It is true, however, that by pure intensity of delirium he now and then takes a flight beyond that of any other Western poet. His "Politian" is perhaps the stupidest fragment of a play that exists. But in his lyrics the fervour of his sympathy with himself makes artistic recompense for his want of sympathy for others. The passion of "Annabel Lee" is at a white heat, and is pervaded by a true pathos. The class finish of the best of his verses is unsurpassed, and his musical cadences give a charm even to those which are comparatively meaningless. The "Raven" is at the worst a marvellous piece of mechanism; and the same delicacy of touch is everywhere visible in the rushing lines of "Annie," "Eulalie," "Ulalume," "Lenore," and the "City in the Sea." The purity of those poems is one of their most remarkable features. By the side of the author's life, they are like nuns in the convent of a disorderly city; but they are at the same disadvantage—their isolation gives them an air of unreality. The "banners, yellow, glorious, golden," of his fancy "float and flow" on the roof of an imaginary palace.

2. School of American Scenery and Adventure.—The French critic M. De Tocqueville remarks that, in democratic communities, where men are all socially insignificant, poetry will be less apt to celebrate individuals, but will incline to dwell on external nature or on the ideas which concern mankind in general. It will be either

Bryant. descriptive or abstract. The works of Mr Bryant, the earliest considerable American poet, help to vindicate the generalisation. His "Thanatopsis," written in his 19th year, is perhaps the masterpiece of his sombre contemplative imagination. The reason why the author has never surpassed this effort of his youth is be found partly in the cast of his mind, characterised by a narrow greatness, and partly in the fact that, during the major part of his life he has been constrained to "scrawl strange words with the barbarous pen" as the editor of a daily newspaper: a fact to which, at the close of his "Green River," he makes a touching reference. Mr Bryant has lived in thronging cities, an honest and energetic politician; but in his leisure hours his fancy has roamed to breezy hills and valleys and the undulating sea of the prairies. The perpetual autumn of his writings is peculiar. He has written smoothly in various measures, but he is never lively. An American Alastor, he loves "the air that cools the twilight of the sultry day" better than morning "clad in russet vest." In the beautiful verses on the "Death of the Flowers" his ear catches a dirge in the wind

> "The south wind searches for the flowers whose fragrance late he bore,
> And sighs to find them in the wood and by the stream no more."

The high rank grass of the meadow is to his eye the garniture of the graves of a race represented by his "Disinterred Warrior." His "Evening Wind," "Forest Hymn," "Monument Mountain," "The Burial Place," and "The Past," are set to the same slow music, and pervaded by the thought of life as the avenue of death. If we compare his "Address to a Waterfowl" with Wordsworth's or Shelley's "Skylark," we appreciate the monotony of his mind, which is like that of Cowper without Cowper's occasional vivacity. Mr Bryant stands on a high level, but the space he covers is limited; he has no touch of humour, and only the distant pathos of prevailing melancholy. Master of his position where he is at home in the woods, he loses his inspiration when he draws near his own cities. His nature-worship has a parallel in the feeling which animates some of the most graphic passages in New England prose; as when Emerson writes—

> "At the gates of the forest, the surprised man of the world is forced to leave his city estimates of great and small, wise and foolish. The knapsack of custom falls off his back with the first step he makes into these precincts. Here is sanctity which shames our religions, and reality which discredits our heroes. . . . We have crept out of our crowded houses into the night and morning. . . . . The incommunicable trees begin to persuade us to live with them, and quit our life of solemn trifles. Here no history or church or state is interpolated on the divine sky and the immortal year."

The whole life and writings of the morbidly eccentric Thoreau.
genius H. D. Thoreau are a comment on the results of this one-sided spirit. It pervades half the volumes of Theodore Winthrop, a manlier though less original mind. It has taken possession of the poetic advocate of Far Western and wild Indian life, Joaquin Miller, whose "Songs of the Sierras" in their best passages add to Bryant's descriptive power more of the fire of adventure, finding expression in the quicker pulse of the verse. But the lyrics of this writer, though the vehicle of national thought, bear the mark of foreign influence. Their cadences are echoes of Mr Swinburne. The impulse which made captive the "Scholar Gipsy," which the hero of "Locksley Hall" welcomes and then rejects, is a leading feature of Western literature. Imaginative and ardent minds, oppressed by what Mr Arnold calls "this strange disease of modern life," try to escape from the region of the real drama into that of the ideal lyric,—"arva, beata petamus arva, divites et insulas,"—and have now and then endeavoured to convert it into an actual idyll, as when Thoreau buried himself in a log hut by Walden lake, or Theodore Winthrop, leaving his ledgers in New York, scoured over the crags of Oregon; or Horne, with his "Orion" still unsold, was found mining in a quarry of New South Wales. But this *emigré* spirit, when put into practice, ultimately cures itself: a poet soon tires of working with his hands for a livelihood. The aspirations of Clough's "Bothie" are stifled by the *vitiosæ curæ* of a hard life, or terminate in the catastrophes of a fanaticism, such as Hawthorne has branded with his genius in the *Blithedale Romance.* The philosophical refugees

find that the solitude they desired charms only by its contrast with the civilisation they have left; as the beauty of the sea is its contrast with the shore. But this wandering impulse, strong in the ancient Greek and the modern English race, has colonised and civilised the world: it is especially strong in the Anglo-American. The very restlessness which makes his cities so noisy bid him long for a remoter rest, and this longing acts in conjunction with more material demands to drive him across the Mississippi, and pioneer the way to the Pacific.

Emerson. 3. Transcendental and Eccentric School. — The freshness which breathes through Mr Emerson's essays reappears in his poems: but they are seldom so successful as his prose. Apart from the obscurity of their matter, which is great—for he has chosen verse as the vehicle of his remoter mysticism—they are defaced by frequent mannerisms and incongruities most of them are wanting in melody, many in syntax. The writer seems to trust to providence for his rhymes, and changes his metres at will. Nevertheless, his genius has a lyric side, and the imaginative sympathy with nature which makes his prose poetical, prevents his verse, even when awkward, from becoming prosaic. The rippling of rivers, the sough of the pine, the murmur of the harvest, and the whirr of insects pervade and give life to his descriptions. A morning light is thrown over his happiest pages, and some of his quieter reflective pictures are not unworthy of the author of the "Excursion." Interleaved between the gold-dust of Alexandrian rhapsody there are pieces that speak of a love that is neither "initial," "dæmonic," nor "celestial," but human. Of these, "The Dirge," "In Memoriam," "The Farewell," the lines "To J. W.," "To Ellen," and the "Threnody," are the most conspicuous. The prevailing tone of the greater part of Emerson's poetry is cheerful. Unlike those of Bryant, his "woodnotes" are those of the spring.

> "Thousand minstrels wake within me,
> Our music's on the hills,"

is the perpetual refrain of the exulting worshipper of nature. His lines entitled "Good-bye, proud World," breathe the hermit-like spirit of Quarles or Andrew Marvell; but the Puritanism of older days has here assumed another shape. There are other pieces relating to the intercourse of men with each other showing a keen observation of common life and sound worldly wisdom, in neat quatrains and a few vigorous political songs. The "Hymn on Concord Monument" is strong and dignified, while the verses relating to the civil war address the nation in forcible terms both of warning and encouragement. Those practical manifestoes are the more striking from the fact that they are printed by the side of others proclaiming in transcendental enigmas the emptiness of transitory things, the fixity of fate, and the doctrine of the absorption of the individual in the infinite.

Whitman. Mr Emerson was one of the first to praise the extraordinary rhapsodies of Mr Walt Whitman, which have since attracted too much attention to be passed without notice. But although this author on various occasions displays an uncouth power, his success is in the main owing to the love of novelty, wildness, and even of absurdity, which has infected a considerable class of critics and readers on both sides of the Atlantic. Mr Whitman does not write in verse; he discards not only rhyme, but all ordinary rhythm. What there is of the latter seems to come by accident in lines of various length, and arranged either on no principle or on one which we have failed to discover. "The Leaves of Grass" is redeemed by a few grand descriptive passages from absolute barbarism both of manner and matter. It is a glorification of nature in her most unabashed forms, an audacious protest against all that civilisation has done to raise men above the savage state. The "Drum Taps," a set of generally vigorous pictures of the war, are less objectionable; the dirge on Lincoln in particular has many qualities of a noble elegy,—the imagery is rich though sometimes fantastic, and there is here and there a wild music in the composition,—but it is still defaced by pedantic words and unjustifiable, because unnecessary, novelties of phrase.

4. Patriotic and Political Poetry.—The assertion of Henri Beyle, that politics are like a stone tied round the neck of literature, must be accepted with a reservation; for if the songs make the laws, the battles often make the songs of a nation. The growth of a history on their own soil is, in the minds of most Americans, a requisite to the full development of national art. English history inadequately supplies the desired background, for they cannot associate it with what they see around them. Memories of the Revolution war have, during this century, been recalled in some stirring verses, as "Paul Revere's Ride," in Mr Longfellow's "Wayside Inn;" but the most effective national poetry has been suggested by more recent events. The "Biglow Papers," a series of metrical pamphlets, born Lowell. of the last great social and political struggle of the New World, are among the most original contributions to its literature. Mr James Russell Lowell is the author of several volumes of miscellaneous verse. His earlier efforts, buoyant and vigorous, but bearing the marks of haste, display more impetuosity than power. His genius everywhere appears in contrast to Bryant's. Far from shrinking into solitary places, he loves great cities and their cries, and sets them to rhyme with hearty good-will. When he goes into the country, it is on a "day in June," to have his blood sent faster through his veins by the spring morning, and not to dream among the autumn woods of "Thanatopsis." His "Allegra," "Fountain," and "Indian Summer Reverie," are marked by the same jubilant energy and the same apparent carelessness. Mr Lowell's diffuseness is only half redeemed by his fluency. He writes *currente calamo;* and, unchecked by any spirit of reverence, contemns what he is pleased to call "the blaspheming past" and the "dotard Orient." In dealing with the forms of nature around him, he shows a keen eye and a fine sense of analogies: his images drawn from history are less successful. Few Americans know how to use the classics with reticence, and Mr Lowell's pages are infected with schoolboy commonplaces. His "Ode to Freedom," "The Present Crisis," with other semi-political and social pieces, are noble and stirring platform verse, but they will not bear analysis. His "Irene," "Requiem," and "Beggar Bard" are marked by genuine sentiment and true pathos. But the prevailing flaw of his earlier and later serious poems—as "The Cathedral," and "Under the Willows," is the confusion of inspiration with aspiration. In the "Fable for Critics," which may be compared with Leigh Hunt's "Feast of the Poets," he breaks ground on the field in which he has found his harvest. The merit of this piece lies in its candour and the general fairness of its criticisms, in the course of which "the whole tuneful herd" of American authors are reviewed with good-humoured banter. In several instances, as in the following, he shows himself alive to the defects which he shares with the majority of his countrymen—

> "Neal wants balance; he throws his mind always too far,
> And whisks out flocks of comets and never a star;
> He has so much muscle, and longs so to show it,
> That he strips himself naked to prove he's a poet."

The author's style is rapid and sparkling; his points follow one another like the sparks from a Leyden jar; his love of freedom and truth and detestation of pretence are always admirable; but his earlier poems are constantly defaced by violences.

Mr Lowell informs us that the Mexican war, which he regarded as a crime perpetrated in behalf of slavery, led to the publication, in 1846, of the first of his series of "Biglow Papers." After an interval of thirteen years, the second began to appear in 1861, and closed with the war in 1865. In his preface to those remarkable productions the author makes a successful defence of the language in which they are written. The more homely standards of the present as compared with those of the last century give countenance to his mottoes—"Unser Sprach ist auch ein Sprach," and "Vim rebus aliquando ipsa verborum humilitas affert.' The essential to the use of a *patois* is that it be natural to the writer. Mr Lowell has taken pains to show that the peculiarities of the Yankee dialect are not indigenous; that the pronunciation and meanings given to familiar words, and the employment of words now unknown in England, are authorised by the example of our elder classics. We are more concerned to know that he has been happy in his use of the words and phrases in question. The popularity of his work is in this respect a voucher for his success. The rural dialect seems to suit his genius better than the English of his university. The quasi-dramatic form he has adopted confines within limits a too discursive fancy. The letters of Mr Sawin are excellent examples of the form of satire in which contemptible qualities are stripped of their varnish by the sheer effrontery of the wearer. The style of the book is more trenchant and better matured than that of Lowell's other works, and it is really humorous. The humour of the "Biglow Papers" is broad and obvious. They derive their force from the incisive expression given to the sentiments shared by the author with a large section of his countrymen; and the lines most frequently quoted owe everything to a startling directness, something bordering on irreverence. Mr Lowell's poetical powers are set on fire by political zeal, and his animosity sharpens the edge of his most effective verse. The satiric scorn of the lines put into the mouth of Calhoun, with the speeches of Garrison, Phillips, and Sumner, helped to hasten the irrepressible conflict of the contending forces in the Western Continent. The second series of the "Biglow Papers" are animated by the spirit of an uncompromising Unionist as well as that of an Abolitionist. In these the poet's patriotism glows with a deeper fervour, and his songs rise out of the battlefield "like rockets druv' by their own burnin'." The graver poetry of this volume reaches a higher standard than the author has elsewhere attained. The short rural romance entitled "The Courtin'" is one of the freshest bits of pastoral in the language. The stanzas beginning "Under the yallar pines I house," and ending "A nation saved, a race delivered," are his masterpieces.

Whittier. Mr John Greenleaf Whittier is the political lyrist *par excellence* of America; and the best of his lyrics have a verve, swing, and fire that impart to the reader a share of the writer's enthusiasm. His verse, rapid as a torrent, is perpetually overflowing its banks. No one stands more in need of the advice once given to Southey, "squeeze out the whey;" and to no works more than to his is the maxim πλεόν ἥμισυ παντός more applicable. There are few more graceful tales in verse than those of his "Tent on the Beach." They are remarkable for their smoothness and quiet beauty of sentiment. The music of "Rivermouth Rocks," "Revisited," and the "Grave by the Lake" recalls that of Longfellow's best ballads. The most striking is the "Brother of Mercy," Piero Luca, who, like Abu Ben Adhem, loves his fellow-men. The same trust in the divine love which is the sum of Whittier's ardent faith, appears in the beautiful verses entitled "The Eternal Goodness" and "Our Master." The strongest lines in the book, addressed to "Thomas Starr King," have the rare merit of condensation. Of Whittier's national lyrics, the most powerful is "Laus Deo," the burst of acclamation suggested by the passing of Lincoln's constitutional amendment. His narrative power is best illustrated in "Maud Muller," an original and more innocent version of Browning's "Statue and the Bust," springing up in an American meadow.

V.—Summary.

The critics of one nation must, to a certain extent, regard the works of another from an outside point of view. Few are able to divest themselves wholly of the influence of local standards; and this is pre-eminently the case when the early efforts of a young country are submitted to the judgment of an older country, strong in its prescriptive rights, and intolerant of changes the drift of which it is unable or unwilling to appreciate. English critics are apt to bear down on the writers and thinkers of the New World with a sort of aristocratic hauteur; they are perpetually reminding them of their immaturity and their disregard of the golden mean. Americans, on the other hand, are impossible to please. Ordinary men among them are as sensitive to foreign, and above all to British, censure, as the *irritabile genus* of other lands. Mr Emerson is permitted to impress home truths on his countrymen, as "Your American eagle is very well; but beware of the American peacock." Such remarks are not permitted to Englishmen: if they point to any flaws in transatlantic manners or ways of thinking with an effort after politeness, it is "the good-natured cynicism of well-to-do age;" if they commend transatlantic institutions or achievements, it is, according to Mr Lowell, "with that pleasant European air of self-compliment in condescending to be pleased by American merit which we find so conciliating." Now that the United States have reached their full majority, it is time that England should cease to assume the attitude of their guardian, and time that they should cease to be on the alert to resent the assumption. Foremost among the more attractive features of transatlantic literature is its *freshness*. The authority which is the guide of old nations constantly threatens to become tyrannical: they wear their traditions like a chain; and, in the canonisation of laws of taste, the creative powers are depressed. Even in England we write under fixed conditions; with the fear of critics before our eyes, we are all bound to cast our ideas into similar moulds, and the name of "free-thinker" has grown into a term of reproach. Bunyan's *Pilgrim's Progress* is perhaps the last English book written without a thought of being reviewed. There is a gain in the habit of self-restraint fostered by this state of things; but there is a loss in the consequent lack of spontaneity; and we may learn something from a literature which is ever ready for adventures. In America the love of uniformity gives place to impetuous impulses: the most extreme sentiments are made audible, the most noxious "have their day, and cease to be;" and truth being left to vindicate itself, the overthrow of error, though more gradual, may at last prove more complete. A New England poet can write with confidence of his country as the land

"Where no one suffers loss or bleeds
For thoughts that men call heresies."

Another feature of American literature is its *comprehensiveness:* what it has lost in depth it has gained in breadth. Addressing a vast audience, it appeals to universal sympathies. In the Northern States, where comparatively few have leisure to write well, almost every man, woman, and child can read and does read. Books are to be found in every log-hut, and public questions are discussed by

every scavenger. During the war, when the Lowell factory girls were writing verses, the "Biglow Papers" were being recited in every smithy. The consequence is, that (setting aside the newspapers) there is little that is sectional in the popular religion or literature; it exalts and despises no class, and almost wholly ignores the lines that in other countries divide the upper ten thousand and the lower ten million. Where manners make men the people are proud of their peerage, but they blush for their boors. In the New World there are no "Grand Seigniors," and no human vegetables; and if there are fewer giants, there are also fewer mannikins. American poets recognise no essential distinction between the "Village Blacksmith" and the "caste of Vere de Vere." Burns speaks for the one; Byron and Tennyson for the other; Longfellow, to the extent of his genius, for both. The same spirit which glorifies labour denounces every form of despotism but that of the multitude. American slavery, being an anachronism based on the antipathies of race, was worse than Athenian slavery. But there is no song of an Athenian slave. When the ancients were unjust to their inferiors, they were so without moral disquietude: the lie had got into the soul. Christianity, which substituted the word "brother" for "barbarian," first gave meaning to the word "humanity." But the feudalism of the Middle Ages long contended successfully against the higher precepts of the church: the teaching of Froissart held its ground against that of Langland. The hero-worship of our greatest living author is apt to degenerate into a reassertion of the feudal spirit. The aspirations of our descendants in the West point, on the other hand, to a freedom which is in danger of being corrupted by licence. But if the vulgarism of demagogic excess is restrained and overcome by the good taste and culture of her nobler minds, we may anticipate for the literature of America, under the mellowing influences of time, an illustrious future. (J. N.)

AMERIGO VESPUCCI. See Vespucci.

AMERSFOORT, a town of Holland, in the province of Utrecht, situated 12 miles E.N.E. of the city of that name, on the Eem, which here is navigable. It contains a town-house, several churches—Protestant and Roman Catholic—a court of primary jurisdiction, a Jansenist college, an industrial and several other schools. Woollen goods, cotton, silk, glass, and brandy are the chief manufactures, and there is a large trade in corn, tobacco, and dried herrings. Amersfoort received its municipal privileges in 1249. It was taken by the Archduke Maximilian in 1483, and by the French in 1672 and in 1795. Population, 13,200.

AMERSHAM, or Agmondesham, an old market town in Buckinghamshire, pleasantly situated in the valley of the Misbourn, a small tributary of the Colne, 32 miles from Buckingham, and 26 from London. It consists chiefly of a main street crossed by a smaller one, and possesses a handsome church, containing some beautiful monuments, several dissenting places of worship, a town-hall, built in 1642 by Sir William Drake, and a grammar school. It has manufactures of black lace, cotton, straw-plait, wooden chairs, flour, and beer. Edmund Waller, the poet, was born near Amersham, and sat for the borough, which sent two members to parliament until 1832. Population of parish in 1871, 3259.

AMES, Fisher, an eminent American statesman and political writer, son of Nathaniel Ames, a physician, was born at Dedham, in Massachusetts, on 9th April 1758. He studied at Harvard college, where he graduated in 1774. After practising the law for some little time, he abandoned that profession for the more congenial pursuit of politics, and in 1788 became a member of the Massachusetts convention for ratifying the constitution. In this assembly he bore a conspicuous part, and in the next year, having passed to the house of representatives in the state legislature, he distinguished himself greatly by his eloquence and sprightliness and readiness in debate. During the eight years of Washington's administration he took a prominent part in the national councils; and on Washington's retirement, he returned to his residence at Dedham to resume the practice of the law, which the state of his health after a few years obliged him to relinquish. He still continued his literary labours, and published numerous essays, chiefly in relation to the contest between Great Britain and revolutionary France, as it might affect the liberty and prosperity of America. Four years before his death he was chosen president of Harvard college, an honour which his broken state of health obliged him to decline. He died on the 4th July 1808, admired and respected by his countrymen from the brilliancy of his talents and his private virtues. His writings, which abound in sparkling passages, displaying great fertility of imagination, were collected and published, with a memoir of the author, in 1809, by the Rev. Dr Kirkland, in one large octavo volume. A more complete edition in two volumes was published by his son, Seth Ames, in 1854.

AMES, Joseph, author of a valuable work on the progress of printing in England, called *Typographical Antiquities* (1749), which is often quoted by bibliographers. He was born in 1689, and died in 1759. The best editions of his work are those published with the additions of Herbert (1785–90), and of Dibdin (1810–16). These both include a life of Ames written by Mr Gough.

AMES, William, D.D. In the Latinised form of Amesius this distinguished English theologian is now better known on the Continent than in our own country, through works that were a power in their day, and are not yet spent of their force. He was born at Ipswich, Suffolk, in 1576. He received an excellent education at the grammar school of Ipswich; and proceeded next to the university of Cambridge, where he was entered of Christ's college. From the outset, as to the latest, he was an omnivorous student. Entering half-carelessly into the church where the great Master William Perkins was the preacher, he was, under the sermon, roused and alarmed in such fashion as was not rare under so burning and intense an orator as Perkins. Like another Nicodemus he visited the venerable preacher, and was taught and comforted so as never through life to forget his interviews with the "old man eloquent." Perkins having died at a ripe old age, was succeeded by one of kindred intellect and fervour, Paul Bayne, and his friendship also was gained by Ames. He proceeded B.A. and M.A. in due course, and was chosen to a fellowship in Christ's college. He was universally beloved in the university. His own college (Christ's) would have chosen him for the mastership; but a party-opposition led to the election of a Dr Carey, who at once sought a quarrel by arraigning Ames for disapproving of the surplice and other outward symbols. Not succeeding by threats of expulsion, which were illegal and powerless, the master resorted to transparent flattery. Ames stood firm, was led to re-examine former opinions, and the result was that more absolutely than ever he decided against conformity. Nevertheless, he preached in season and out of season, and always with profound impression. One sermon became historical in the Puritan controversies. It was delivered on St Thomas' day, before the feast of Christ's

nativity, and in it he rebuked sharply Lusory Lotts and the "heathenish debauchery" of the students during the twelve days ensuing. His exposures and scathing denunciations won thunders of applause, but there were sheathed in them lightnings of wrath among the High Church party. He was summoned before the vice-chancellor and whole senate of the university. He appeared, and in presence of as brilliant an assembly as ever met in the congregation-house, defended himself triumphantly. Nonconformity, admittedly in lesser things, was regarded as excluding him from the Church of England. He left the university, and would have accepted the great church of Colchester in Essex, but the relentless bishop of London refused to grant institution and induction. Like furtive persecution awaited him elsewhere, and at last he passed over to Holland. To leave England was not so simple or easy a thing then, and Ames had to disguise himself for safety. His disguise was singularly timed, for it produced an incident that has long been worked into the very fabric of church history in England and Holland. Coincident with his arrival at Rotterdam a congress of theologians—Remonstrant and non-Remonstrant—was being held. Ames went into the meeting in his "habit of a fisherman, with his canvas slops about his body, and a red cap on his head." As the debate proceeded, the English visitor rose and craved permission to oppose Grevinchovius—a theologian long since in oblivion, but a tower of strength in heresy at that day—in Latin. The Remonstrant champion was rather taken aback at first; but jeered and flouted the plain countryman, "like another Goliath scorning David." The question was the old-new one of the "self-determining power of the human will to spiritual good, without any need of the previous efficacious operations of divine grace." Ames bore his opponent's gibes at his dress, and overwhelmed him with his logical reasoning from Phil. ii. 13, "It is God that worketh in us both to will and to do." The fisherman-controversialist made a great stir, and from that day became known and honoured in the Low Countries. Subsequently Ames entered into a controversy in print with Grevinchovius on universal redemption and election, and cognate problems. He brought together all he had maintained in his *Coronis ad Collationem Hagiensem*—his most masterful book, which figures largely in Dutch church history. At Leyden, Ames became intimate with the venerable Mr Goodyear, pastor of the English church there. While thus resident in comparative privacy he was sent for to the Hague by Sir Horatio Vere, who appointed him a minister in the army of the states-general, and of the English soldiers in their service, a post held by some of the greatest of England's exiled Puritans. He married at the Hague a daughter of Dr Burgess, who was domestic pastor of Vere. On his father-in-law's return to England, Ames succeeded to his place It was at this time he began his memorable controversy with Episcopius, who, in attacking the *Coronis*, railed against the author as having been "a disturber of the public peace in his native country, so that the English magistrates had banished him thence; and now, by his late printed *Coronis*, he was raising new disturbances in the peaceable Netherlands." It was a miserable libel. Mr Goodyear being present in the lecture-room when Episcopius vented his malice, there and then rebutted his charge against his absent friend None the less did the controversy proceed. Ultimately Ames reduced the Remonstrants to silence. The *Coronis* had been primarily prepared for the Synod of Dort, which sat from November 1618 until May 1619. At this celebrated synod the position of Dr Ames, if an extremely honourable, was a peculiar one. The High Church party in England had induced the king to interfere and bring about his removal from the Hague, on the ground of his nonconformity; but he was still held, deservedly, in such reverence that it was arranged he should attend the synod informally. Throughout its sittings Dr Ames appears to have been the most active and influential of the foreign divines. It is a sorrowful fact that, from 1611–12 onward, Ames was interfered with harassingly by the High Church party in England. Twice over, when chosen professor, the most envenomed opposition was led from England. He was kept from the university of Leyden; and when later invited by the state of Friesland to a professoriate at Franeker. the persecution was renewed, but this time abortively. He was installed at Franeker on 7th May 1622, and delivered a most learned discourse on the occasion on "Urim and Thummim." He soon brought renown to Franeker as professor, preacher, pastor, and theological writer. He prepared his *Medulla Theologica* for his students. His *Casus Conscientiæ* followed. Both these treatises left their mark on the thought of the century. His "Cases of Conscience" was a new thing in Protestantism. The work shows much insight into human nature, and may be favourably compared with the bulkier *Ductor Dubitantium*. Having continued twelve years at Franeker, his health gave way, and he contemplated removal to New England. But another door was opened for him. His English heart yearned for more frequent opportunities of preaching the gospel to his fellow-countrymen, and an invitation to Rotterdam gave him such opportunity. His friends at Franeker were passionately opposed to the transference, but ultimately acquiesced. At Rotterdam he drew all hearts to him by his eloquence and fervour in the pulpit, and his irrepressible activity as a pastor. Home-controversy engaged him again, and he prepared his *Fresh Suit against Ceremonies*—extrinsically having the distinction of being the book which made Richard Baxter a Nonconformist. It was posthumously published. He did not long survive his removal to Rotterdam. Having caught a cold from a flood which drenched his house, he died in November 1633, in his fifty-seventh year.

Few Englishmen have exercised so formative and controlling an influence on continental thought and opinion as Dr Ames. He was a master in theological controversy, shunning not to cross swords with the formidable Bellarmine. He was a scholar among scholars, being furnished with extraordinary resources of learning. His works, which even the *Biographia Britannica* (1778) testifies, were famous over Europe, were collected at Amsterdam in 5 vols. 4to. Only a very small proportion were translated into his mother tongue. His *Lectiones in omnes Psalmos Davidis* (1635) is exceedingly suggestive and terse in its style, reminding of Bengel's *Gnomon*, as does also his *Commentarius utriusque Epist. S. Petri.* His "Replies" to Bishop Morton and Dr Burgess on "Ceremonies" tell us that even kinship could not prevent him from "contending earnestly for the faith." (John Quick's MS. *Icones Sacræ Anglicanæ*, who gives the fisherman anecdote on the personal authority of one who was present; Brook's *Puritans*, vol. iii. pp. 405–8; Winwood's *Memorials*, vol. iii. pp. 346–7; Neal's *Puritans;* Fuller's *Cambridge* (*Christ's College*)*;* Sylvester's *Life of Baxter*, part i. pp. 13, 14; *Biogr. Brit.*, vol. i. pp. 172–3; Mather's *New England*, book iii.; Palmer's *Nonconf. Memorial.;* Mosheim's *Eccles. Hist.*, who mistakenly calls him a Scotsman; Hanburg, *s.v.*; *Collections of the Massachusetts Historical Society*, vol. vi., fourth series, 1863, pp. 576–7.) (A. B. G.)

AMESBURY, an old town in Wiltshire, on the Avon, 8 miles north of Salisbury, and 78 west of London. It is an ill-built place, with little trade. It contains an old parish church, which probably belonged to an abbey, a chapel for the Wesleyan Methodists, and a beautiful house erected by Inigo Jones for the Duke of Queensberry. Near Amesbury are Stonehenge, and Milston, where Addison was born. Population, 1169.

AMETHYST, properly, is only a variety of quartz or rock-crystal distinguished by its fine violet-blue or purple colour. This tint seems to be caused by a minute mixture of the peroxide either of iron or of manganese, and is lost when the stone is exposed to the action of the fire. It

then changes through yellow and green to colourless; and in this condition is often sold for the aquamarine or topaz. Amethyst is generally found in thick columnar masses, of short hexagonal prisms terminating in pyramids. The faces, especially in Brazilian specimens, are often marked by zig-zag or undulating lines, and the colour in many is similarly disposed, showing a peculiar internal structure in the stone. It has been proposed to name all varieties of quartz, whether coloured or uncoloured, showing this peculiarity, amethyst, but without sufficient reason. Amethyst, according to Pliny, got its name, ἀμέθυστος, from its supposed power of preventing drunkenness. Though not a true gem, it was formerly much valued as an ornamental stone, but has greatly declined in value in the present century, being obtained in great abundance from Brazil. There it is often white or yellow, and named topaz. The finest blue stones are found in Ceylon and Siberia; and less remarkable ones in many places in Europe, India, and Australia. Amethysts may be counterfeited by glasses, to which the proper colour or stain is given by mineral matter. There were fine ones made in France about the year 1690, which even imposed on connoisseurs, but with the decrease in price there is now less danger of such deceptions.

AMHERST, a district and city within the Tenasserim division of British Burmah, and within the jurisdiction of the chief commissioner of that province. The DISTRICT forms a narrow strip of land between the Indian Ocean and the mountains which separate it from the independent kingdom of Siam. It lies in 16° N. lat., 98° E. long., and consists partly of fertile valleys formed by spurs of the mountain system which divides it from Siam, and partly of a rich alluvial tract created by the great rivers which issue from them. The most important of these are the Salween river and the Houng-da-raw Khyoung. The river highways bring down inexhaustible supplies of rice to Maulmain, the chief town of the district, as also of the province of Tenasserim, and the second city in British Burmah. The district comprises an area of 15,144 square miles, of which 346 are cultivated, 4889 are capable of being brought under cultivation, and the remaining 9909 square miles are returned as uncultivable. The population in 1872 numbered 235,738 souls, occupying 38,945 houses, and consisting of 203,774 Buddhists, 15,598 Hindus, 12,279 Mahometans, and 4081 Christians. The town of Maulmain contains 53,653 inhabitants. The rainfall is very heavy, 245·85 inches being registered in 1871–72. The temperature is uniform, but not excessive, and averaged 83° at 2 P.M. throughout the month of May 1871, 80° at 2 P.M. throughout July, and the same at 2 P.M. throughout December 1871.

AMHERST TOWN, situated in the district of the same name, about 30 miles south of Maulmain. It was founded by the English in 1826 on the restoration of the town of Martaban to the Burmese, and named in compliment to the Governor-General of India who projected it. The proclamation inviting the natives to people the town was well adapted to the character and capacities of those whom it addressed. "The inhabitants of the towns and villages who wish to come shall be free from molestation, extortion, and oppression. They shall be free to worship as usual, temples, monasteries, priests, and holy men. The people shall go and come, buy and sell, do and live as they please, conforming to the laws. In regard to slavery, since all men, common people or chiefs, are by nature equal, there shall be under the English government no slaves. Whoever desires to come to the new town may come from all parts and live happy, and those who do not wish to remain may go where they please without hindrance." Shortly after its settlement the number of houses amounted to 230, and the population to 1200. Large teak forests abound in its neighbourhood, and the timber is exported in considerable quantities. The harbour, though large and capable of accommodating ships of any burden, is difficult of access, and dangerous during the south-west monsoon. Amherst town has been eclipsed by the rapidly rising city of Maulmain, which has absorbed to itself the trade and mercantile enterprise alike of Amherst district and of the Tenasserim province.

AMHERST, a post township of Hampshire county, Massachusetts, United States. It is a picturesque village intersected by two branches of the Connecticut river. Its water-power is utilised for manufactories of machinery, edge tools, cotton goods, paper, &c.; but it is principally known as the seat of Amherst college, a valuable institution founded in 1821, mainly for the purpose of educating poor and pious young men for the ministry. The charity fund is large, and pays the tuition fees of forty or fifty students. The faculty of the college consists of eighteen professors, beside the president. The number of students in 1873 was 261. The buildings of Amherst college are situated on a hill at the southern extremity of the village. An octagonal building in advance of the line of college halls is devoted to the purposes of a museum. Some of the collections are of great value, especially those in the palæontological department. The Massachusetts Agricultural school, founded in 1863, has also its seat at Amherst. Its handsome buildings are on the edge of a rich plain from which fine views are obtained of the mountains on the west and south. There is a large farm for experiment attached to the school, which is esteemed one of the best in America. The population of Amherst in 1870 was 4035.

AMHERST, EARL (WILLIAM PITT AMHERST), born in 1773, was the nephew of Jeffery Amherst, who, for his services in America, where he was commander-in-chief at the time of the conquest of Canada, was raised to the peerage as Baron Amherst in 1776. The patent of nobility was renewed in 1788 with remainder to the subject of this notice, who succeeded to the title in 1797. In 1816 he was sent as ambassador extraordinary to the court of China, with the view of establishing more satisfactory commercial relations between that country and Great Britain. On arriving in the Peiho, he was given to understand that he could only be admitted to the emperor's presence on condition of performing the *ko-tou*, a ceremony which Western nations have always considered degrading, and which is, indeed, a homage exacted by the Chinese sovereign from his tributaries. This Lord Amherst, following the advice of Sir George T. Staunton, who accompanied him as second commissioner, refused to consent to, as Lord Macartney had done in 1793, unless the admission was made that his sovereign was entitled to the same show of reverence from a mandarin of his rank. In consequence of this he was not allowed to enter Peking, and the object of his mission was frustrated. His ship, the "Alceste," after a cruise along the coast of Corea and to the Loo-Choo Islands, on proceeding homewards was totally wrecked on a sunken rock in Gaspar Strait. Lord Amherst and part of his shipwrecked companions escaped in the ship's boats to Batavia, whence relief was sent to the rest. The ship in which he returned to England in 1817 having touched at St Helena, he had several interviews with the Emperor Napoleon (Ellis's *Proceedings of the Late Embassy to China*, 1817; M'Leod's *Narrative of a Voyage in H.M.S. "Alceste,"* 1817). Lord Amherst held the office of governor-general of India from August 1823 to February 1828. The principal event of his government was the Burmese war, resulting in the cession of Aracan and Tenasserim to Great Britain. He was created Earl Amherst of Aracan in 1826. On his

return to England he lived in retirement till his death in March 1857.

AMHURST, Nicholas, an English poet and political writer of the 18th century, was born at Marden in Kent, and entered (1716) at St John's college, Oxford, from which he was expelled, ostensibly for libertinism and irregular conduct, but really, according to his own statement, on account of the liberality of his opinions. Retaining great resentment against the university on this account, he gave expression to his feeling in a poem published in 1724, called *Oculus Britanniæ*, and in a book entitled *Terræ Filius*. He published a Miscellany of Poems, sacred and profane; and *The Convocation*, a poem in five cantos, which was a satire on the bishop of Bangor's antagonists. But he is best known for the share he had in the political paper called *The Craftsman*, which he conducted for several years. It attained a circulation of 10,000 or 12,000 copies, and had very considerable influence in inflaming popular opinion against Sir Robert Walpole, and in bringing about the political change of 1742. Amhurst's party made no provision for him, however, on their accession to power, and their neglect is supposed to have hastened his death, which occurred at Twickenham on the 27th April 1742.

AMIANTHUS (*unstained*, from *a* privative, and μιαίνω, to stain), the best known and most beautiful of the asbestos class of substances. See Asbestos.

AMICI, Giovanni Battista, a celebrated designer and constructor of optical instruments, was born at Modena in 1784. While studying mathematics at Bologna, he acquired a taste for astronomical science, and devoted himself early in life to the improvement of astronomical instruments with great ingenuity and success. For the specula of his reflecting telescopes he prepared a very hard alloy, capable of receiving and retaining a fine polish, and to prevent spherical aberration he wrought the specula into an elliptical form. About 1812 he undertook the construction of a telescope with a five-foot speculum, and the gun-foundry at Pavia was put at his disposal for this purpose by the war minister of Italy, but the project was broken off, owing apparently to political complications. Amici is still better known from his microscopes. His reflecting microscopes, with ellipsoidal specula, were an improvement on all that had preceded them, and he attained still greater success in the construction of compound achromatic object-glasses. His compound microscope was the first that could be used either in a vertical or in a horizontal position. His prism, too, for the oblique illumination of objects of microscopical observation is much commended. Amici was a very diligent and skilful observer; and his intimate acquaintance with the principles of optical science enabled him to arrange his apparatus to the very best advantage. Various papers recording the results of his observations, which he read before learned societies, were published in scientific journals. They treat of the measurement of the diameters of the sun (by means of a micrometer he invented) and other astronomical subjects, the circulation of the sap in plants, the fructification of plants, infusoria, &c. After holding for some time a professorship of mathematics in Modena, he was in 1831 appointed inspector-general of studies in the duchy. A few years later he was entrusted with the charge of the observatory at Florence, where he also delivered lectures as professor of mathematics at the museum of natural history. He died in April 1863.

AMIENS, an ancient city of France, capital of the department of Somme, and formerly of the old province of Picardy, situated on the Somme, about 40 miles from its mouth, and 71 miles N. of Paris. It was once a place of great strength, and still possesses a citadel, but the ramparts which surrounded it have been replaced by beautiful boulevards. The new part of the town is well built, but the streets of the old quarter are narrow and irregular, and are so cut up by the eleven canals into which the Somme is here divided, that Louis XI. is said to have called the town "little Venice." The most interesting object in Amiens is its magnificent cathedral, one of the finest in Europe, commenced in the year 1220 and finished in 1288, although additions to it were afterwards made. Among the other important public buildings are the Hôtel de Ville, the Chateau d'Eau, the theatre, the museum, the hospital, and several churches. The town is the seat of a bishop, of a prefect, and of the departmental courts of justice; and possesses a library containing more than 50,000 volumes, besides manuscripts, an academy of sciences, various other learned societies, a theological seminary, a lyceum, and several ordinary schools. It has many important manufactures, the chief being cotton velvets, kerseymeres, woollen and linen cloths, flax, beetroot sugar, soap, leather, and paper. Amiens occupies the site of the ancient *Samarobriva*, capital of the *Ambiani*, from whom it probably derives its name. After the dissolution of the empire of the west it repeatedly changed owners, becoming for the first time a dependency of the French crown in 1185, when Philip of Alsace ceded it to Philip Augustus; and since that date it has more than once passed out of the power of the French kings. The famous treaty between Great Britain, France, Spain, and Holland, which took its name from this city, was signed in the Hôtel de Ville on March 25th, 1802. During the recent war between France and Germany Amiens fell into the hands of the Prussians on the 28th of November 1870. General Manteuffel was operating against the French army of the north, which had been formed with the view of helping the armies of Paris and of the Loire to effect a junction, and thus raise the siege of the capital. The French, however, were defeated in a battle in front of Amiens, which was fought on the 27th of November, along a line stretching from Saleux to Marceleane, and extending, it is said, more than four leagues. They retreated northward in the direction of Arras, and Amiens surrendered on the following day, after a very slight demonstration of force on the part of the Prussians. Peter the Hermit was born at Amiens about 1050. Population (1872), 63,747.

AMIOT, Pere Joseph, a learned Jesuit missionary to China, was born at Toulon in 1718. In 1750 he arrived, along with two others of his order, at Macao, from which, on a favourable answer to a petition being received from the emperor Kien-Lung, he removed to Peking in the autumn of the following year. He continued to reside in the capital until his death in 1794, devoting himself almost exclusively to the study of Chinese and Manchoo-Tatar literature. The results of his labours were communicated at frequent intervals to Europe in works which did more than had ever been done before to make known to the Western world the thought and life of the farthest East. Many of his statements, however, are not trustworthy, and his works are practically superseded by those of others who entered the field later. His *Dictionnaire Tatarmantchou-Français* (Paris, 1789) was a work of great value, the language having been previously quite unknown in Europe. His other writings are to be found chiefly in the *Mémoires concernant l'Histoire, les Sciences, et les Arts de Chinois* (15 vols. 4to, Paris, 1776–91). The *Vie de Confucius*, which occupies the twelfth volume of that collection, is very complete and accurate.

AMLWCH, a town of Anglesey, North Wales, situated on a rising ground on the north coast of the island, 15 miles from Beaumaris. It owes its importance almost entirely to the copper mines of the Parys Mountain; before

the discovery of the ore in 1768 it was a small hamlet of some six houses. At one time the mines produced 3000 tons of metal annually, but in recent years the quantity has greatly diminished. The harbour has been cut out of rock at considerable expense, and is protected by a breakwater. A branch of the Chester and Holyhead Railway terminates in the town. Amlwch, which is associated with Beaumaris, Holyhead, and Llangefni, in returning one member to parliament, had a population of 2968 in 1871.

AMMAN, Johann Conrad, a physician, and one of the earliest writers on the instruction of the deaf and dumb, was born at Schaffhausen, in Switzerland, in 1669. In 1687 he graduated at Basle, and commenced the practice of his profession at Amsterdam, to which he had to flee on account of his religious views. He first called the attention of the public to his method of training the deaf and dumb in a paper which was inserted in the *Philosophical Transactions*, and which appeared in a separate form in the year 1692, under the title *Surdus Loquens*. It was again issued, with much additional matter, in 1702 and 1728, under the title *Dissertatio de Loquela*. In this work, which Haller terms "*vere aureum*," he develops, with great ability, the mechanism of vocal utterance, and describes the process which he employed in teaching its use. This consisted principally in exciting the attention of his pupils to the motions of his lips and larynx while he spoke, and then inducing them by gentle means to imitate these movements, till he brought them to repeat distinctly letters, syllables, and words. As his method was excellent, we may readily give him credit for the all but universal success to which he laid claim. The edition of Cælius Aurelianus, which was undertaken by the Wetsteins in 1709, and still ranks as one of the best editions of that author, was superintended by Amman. He died about 1730.

AMMAN, Jost, an artist celebrated chiefly for his engravings on wood, was born at Zurich in June 1539. Of his personal history little is known beyond the fact that he removed in 1560 to Nuremberg, where he continued to reside until his death in March 1591. His productiveness was very remarkable, as may be gathered from the statement of one of his pupils, that the drawings he made during a period of four years would have filled a haywaggon. A large number of his original drawings are contained in the Berlin collection of engravings. The genuineness of not a few of the specimens to be seen elsewhere is at least questionable. A series of copperplate engravings by Amman of the kings of France, with short biographies, appeared at Frankfort in 1576. He also executed many of the woodcut illustrations for the Bible published at Frankfort by Feierabend. Another serial work, the *Panoplia Omnium Liberalium Mechanicarum et Sedentariarum Artium Genera Continens*, containing 115 plates, is of great value. Amman's drawing is correct and spirited, and his delineation of the details of costume, &c., is minute and accurate. He executed too much, however, to permit of his reaching the highest style of art. Paintings in oil and on glass are attributed to him, but no specimen of these is known to exist.

AMMAN, Paul, a physician and botanist, was born at Breslau on the 30th August 1634. In 1662 he received the degree of doctor of physic from the university of Leipsic, and in 1664 was admitted a member of the society *Naturæ Curiosorum*, under the name of *Dryander*. Shortly afterwards he was chosen extraordinary professor of medicine in the above-mentioned university; and in 1674 he was promoted to the botanical chair, which he again in 1682 exchanged for the physiological. He died on the 4th February 1691. Paul Amman seems to have been a man of acute mind and extensive learning; but a restless and irritable disposition led him to engage too much in controversy, and to indulge in raillery in his writings to a degree which the nature of the subjects hardly warranted.

Amman's principal works were—*Medicina Critica, seu Centuria Casuum in Facultate Lipsiensi resolutorum variis Discursibus aucta; Parænesis ad Docentes occupata circa Institutionum Medicarum Emendationem; Irenicum Numæ Pompilii cum Hippocrate; Supellex Botanica, et Manuductio ad Materiam Medicam;* and *Character Naturalis Plantarum.*

AMMANATI, Bartolomeo, a celebrated Florentine architect and sculptor, was born in 1511, and died in 1592. He studied under Bandinelli and Sansovius, and closely imitated the style of Michael Angelo. He was more distinguished in architecture than in sculpture. He designed many buildings in Rome, Lucca, and Florence, an addition to the Pitti palace in the last-named city being one of his most celebrated works. He also planned the beautiful bridge over the Arno, known as *Ponte della Trinita*—one of his celebrated works. The three arches are elliptic, and though very light and elegant, have resisted the fury of the river, which has swept away several other bridges at different times. Ammanati's wife, daughter of Giov. Antonio Battiferri, an elegant and accomplished woman, published a volume of poems of considerable merit.

AMMIANUS, Marcellinus, a Roman historian of the 4th century, was born in the city of Antioch, in Syria. In his youth he was enrolled among the *protectores domestici*, or household guards, which proves him to have been of noble birth. In the year 350 he entered the service of Constantius, the emperor of the East, and, under the command of Ursicinus, a general of the horse, he served during several expeditions. According to his own modest account, it appears that he acquired considerable military fame, and that he deserved well of his sovereign. He attended the Emperor Julian in his expedition into Persia, but it is not known that he obtained any higher military promotion than that which has already been mentioned. He was either in the city or in the vicinity of Antioch when the conspiracy of Theodorus was discovered, in the reign of Valens, and was an eye-witness of the severe tortures to which many persons were subjected by the emperor on that account. But his lasting reputation was not to be acquired from military service. He left the army and retired to Rome, where he employed himself in writing a history of the Roman empire, comprising a period of 282 years. Though a Greek by birth, he wrote in the Latin language; but, according to the remark of Vossius, his Latin shows that he was a Greek, and also a soldier. His history extended from the accession of Nerva to the death of Valens; and the work was originally divided into thirty-one books. Of these the first thirteen have perished, and the eighteen which remain commence with the seventeenth year of the reign of Constantius, and terminate at the year 378. But there are several facts mentioned in the history which prove that the author was alive in the year 380. Of this number are the accession of Theodosius to the Eastern empire, the character of Gratian, and the consulate of Neothorius. The style is harsh and redundant, as was to be expected from the author's education and military life; but the work is valuable as a source of information for the period of which it treats. Gibbon appears to give a correct estimate when he says that Ammianus is "an accurate and faithful guide, who composed the history of his own times without indulging the prejudices and passions which usually affect the mind of a contemporary." From the respectful manner in which he speaks of pagan deities, and of the advantage of heathen auguries in foretelling future events, it is evident that Ammianus was a

heathen. The favourable account which he gives of the religion, manners, and fortitude of Christians, is the result of his candour and impartiality as an historian. The work of Ammianus has passed through several editions, of which the best are the Leyden edition of 1693, by Gronovius, and those of Leipsic, published in 1773 and 1808. The latter was edited by Wagner and Erfurdt.

AMMIRATO, SCIPIO, an Italian historian, born at Lecce, in the kingdom of Naples, on the 27th September 1531. His father intending him for the profession of law, sent him to study at Naples, but his own decided preference for literature prevented him from fulfilling his father's wishes. Entering the church, he resided for a time at Venice, and afterwards engaged in the service of Pope Pius IV. In 1569 he went to Florence, where he was fortunate in securing the patronage and support of Duke Cosmo I. It was at the suggestion of this prince that he wrote the work by which he is best known, his *Istorie Fiorentine* (1600). In 1595 he was made a canon of the cathedral of Florence. He died in 1601. Among the other works of Ammirato, some of which were first published after his death, may be mentioned discourses on Tacitus and histories of the families of Naples and Florence.

AMMON, the name of an Egyptian deity, called by the ancient Egyptians *Amen* or *Amun*, and one of the chief gods of the country. His name meant the hidden or concealed god, and in this respect was analogous to *Hapi* or Apis, which conveyed the same idea. He was the local deity of Thebes or Diospolis, and supposed by the Greeks to be the same as Zeus or Jupiter. His type was that of a man wearing on his head the red crown *teshr*, emblem of dominion over the lower world or hemisphere, surmounted by the sun's disc to indicate his solar nature, flanked by two tail feathers of a hawk, also symbolical of his relation to the gods of light. Ammon was not one of the oldest deities of Egypt, for his form and name do not appear till the eleventh or Diospolitan dynasty, when the kings of that line assumed his name, and built a sanctuary to him at Medinat Habu. From this period the monarchs of Thebes introduced his name into their titles, and the worship of Amen became the predominant one of ancient Egypt; and the embellishment of his shrine and enrichment of his treasury were the chief object of the policy of the Pharaohs. Victory and conquest were the chief gifts he offered to his adorers; and he is often seen leading up the conquered nations of the north and south to the monarchs whom he endows with power and victory. In this character Amen is often represented holding the Egyptian scimitar *khepsh*. In his celestial character his flesh was coloured blue, that of the heaven. He is said to have been called on some monuments the son of Hapimaa (or the Nile); but in the hymns addressed to him the title of self-engendered is applied to him, and he was one of the self-existent deities. His principal titles are—lord of the heaven, king of the gods, substance of the world, and resident on the thrones of the world, eternal ruler,—appellatives of his celestial and terrestrial functions. He was also lord of heaven and earth, streams and hills, and as a demiurgos, the creator of beings. The hymns addressed to him designate him as the sole or only god, in terms applicable to one god who alone exists, who moulds and governs the world. At one time an attempt was made to identify him with the solar orb. Considered as the active, intelligent, and pervading spirit of the universe, he transfuses the breath of life into the nostrils of kings and other persons. In his solar characters, Ammon was allied with Ra, and called Amen Ra, or Amen Ra Harmachis, or "the sun in the horizon," Amen being considered one of the forms of the sun itself. The worship of the celestial Ammon prevailed chiefly at Thebes, where, with the Mut, or "mother" goddess, and his son Khonsu or Chons, he formed the Theban triad, and the sacred name of Thebes was "the abode of Amen." Besides Thebes, his worship has been found at Siuah in Lybia, at Beit Oually, and at Meroe in Ethiopia, marked respect being shown to his worship by the later Ethiopian monarchs. At Philæ and Debud his name also appears as one of the dominant deities. In the representations at Hermonthis he assists at the birth of Har-pa-Ra; and in the scenes of the passage of Ra, or the sun, through the hours of the night, the gigantic arm of Amen strangles the serpent Apophis, "the great dragon" of Egyptian mythology, the spirit of darkness, who warred against the gods of light. Another of the types of Amen represents him as the reproductive power of nature, still in the human form, but mummied, and holding—instead of the usual sceptre, *uasm*, or so-called *kukupha* sceptre—the whip *nekhekh*. In this type he was supposed to be Amen the father and Horus the child of the triad, which then consisted of Amen, Ament, or the female Ammon, and Harka. His titles in this character are *Amen-ka-mut-f*,—Amen, "the husband of his mother," considered as the final avatar of the god, the alpha and omega, the oldest and youngest of created beings. He is, considered in his youthful character, called *Harnekht*, or "the powerful Horus," and identified with *Khons*, the local god of Chemmo or Panopolis. As Horus he is called the "son of Isis," but this is clearly a later fusion of the two myths. In the inscriptions it is said "he has tall plumes," and in the esoterical explanations of the seventeenth chapter of the *Ritual*, these plumes are explained by "his two eyes," or Isis and Nephthys, who are seen accompanying Horus in certain scenes. This type of Amen was not usually exhibited, but brought out on the occasion of his festival, called the manifestation of Khem, one of the oldest fêtes of Egypt. This type of Amen is principally found at the Ruan, or valley of El Hammamat, on the way to Coptos; and at Wady Halfa, where a temple was erected to him by Amenophis III. As the god of the reproductive powers of nature, the kings of Egypt are seen hoeing the ground before him, or offering various coloured calves and gazelles to him. A great festival in his honour is represented at Medinat Habu, where his statue is carried by twenty priests, and Rameses III. cuts down before him the corn which has just ripened for the sickle. The negroes of Arabia, or else the *Regio Barbarica* of later geographers, appear as assistants at this festival. Another type of Amen connected him with the god Khnum or Chnoumis, the spirit of the waters. In this relation he has the head of a ram instead of the usual human one. Khnum was one of the demiurgi, and creator of mankind, whom he had made as a potter out of clay on the wheel, as also Osiris and Horus. Sometimes the type of Khnum bears the name of Amen; and with the ram's head he was worshipped in the Oasis of Ammon, as also up the Nile at the cataracts, Syene, Elephantine, Beghe, Beit Oually, and Meroe. It is this type of Amen with which the later Greek and Roman writers were most familiar; and Rameses II., as the son of Amen, assumes the ram's horn, which Alexander the Great adopted at a later date. The worship of Khnum was older than that of Amen, as it appears on the Pyramids and at the Wady Magaresh, but became less important, and finally fused into that of Amen. Although it has been supposed that the worship of Amen came from Meroe, it is now known that the Ethiopian civilisation was comparatively of much more recent date than the Egyptian, and that it was implanted in Ethiopia by the conquests of the Pharaohs, and subsequently adopted by the later rulers of Meroe; and that the statements of Herodotus, that it was brought from thence to the Oasis of Ammon are incorrect, the existing temple at the Oasis

not being older than the Persian rulers of Egypt, while the worship of the god at Thebes dates from a much older epoch. The later chapters of the *Ritual*, added at the time of the twentieth dynasty, which contain the mystic names and appellatives of the god in the language of the negroes of Punt, are also of too late a date to throw any light on the origin of Amen, which appears prior to the Hykshos, when the Egyptian princes were driven to the south. The sheep was sacred to the god, and the inhabitants of Thebes in consequence abstained from it; but it is said they annually sacrificed a ram to Amen, and dressed the figure of the god in the hide of the animal. The reasons assigned by classical authorities for this action, as well as for the astronomical meaning of his horns, are not confirmed by monumental evidence. On the conquest of Egypt Alexander the Great called himself the son of Ammon, and his portraits wear the ram's horn. In this he had only imitated the Pharaohs of the nineteenth dynasty. Amen is only mentioned by the Hebrew prophets in speaking of Diospolis as the city of No or No Amon.

Jablonski, *Panth. Ægypt.*, i. 160–184; Birch, *Gallery of Antiq.*, pt. i. 1; Wilkinson, *Manners and Customs*, iii. 313, iv. 246, *ff.*; Goodwin, *Trans. Soc. Bibl. Arch.*, ii. pp. 353–9; Herodotus, ii. 42, 54; Diodorus, iii. 72; Jer. xlvi. 25; Nah. iii. 8. (S. B.)

AMMON, CHRISTOPH FRIEDRICH VON, a distinguished theological writer and preacher, was born at Baireuth in January 1766, studied at Erlangen, held various professorships in the philosophical and theological faculties of Erlangen and Göttingen, succeeded Reinhard in 1813 as court preacher and counsellor at Dresden, retired from these offices in 1849, and died May 21, 1850. He sought to establish for himself a middle position between rationalism and supernaturalism, inclining, however, decidedly to the former. He declared for a "rational supernaturalism," and contended that there must be a gradual development of Christian doctrine corresponding to the advance of knowledge and science. He was a man of great versatility and extensive learning, and a very voluminous author, his principal work being the *Fortbildung des Christenthums zur Weltreligion*, in 4 vols. (Leipsic, 1833–40). *Entwurf einer rein biblischen Theologie* appeared in 1792 (second edition, 1801), and *Summa Theologica* in 1803 (other editions, 1808, 1816, 1830). Von Ammon's style in preaching was terse and lively, and some of his discourses are regarded as models of pulpit treatment of political questions.

AMMONIA (NH_3), sometimes called the *Volatile alkali*, or *Alkaline air*, was known to the alchemists in aqueous solution. Priestley first separated it in the gaseous state in 1774. Scheele in 1777 discovered that it contained nitrogen, and its true composition was ascertained by Berthollet about 1785. Ammonia occurs in the atmosphere as carbonate and nitrate, in sea-water, and in many mineral springs. Iron ores and many clayey soils contain it in small quantity, and sal-ammoniac and ammonia alum are found as minerals in volcanic districts. Carbonate of ammonia is obtained in large quantity by the putrefaction of the urine of animals, or the dry distillation of animal matter. Ammonia is obtained from its salts by the acting of slaked lime or solutions of potash or soda, and is freed from water by passing over quicklime or solid potash, and finally collected over mercury. It is a colourless gas, of a pungent smell, and alkaline taste and reaction. It does not support combustion or respiration, and is feebly combustible. It is remarkably soluble in water, 1 volume dissolving nearly 700 of the gas. It may by the action of a low temperature and great pressure be changed into the liquid or solid state. The gas is easily decomposed into its elements by a succession of electric sparks, or by passing it over red-hot iron or platinum wire. The aqueous solution in presence of finely divided platinum and atmospheric air is converted into nitrite of ammonia; and conversely, the oxides of nitrogen, mixed with excess of hydrogen and passed over platinised asbestos, are changed into ammonia. Nitrogen and hydrogen have not by any process been induced to combine so as to yield this compound directly, unless in very small quantity. For theoretical relations of ammonia, salts, &c., see CHEMISTRY.

AMMONIAC, SAL (NH_4Cl), the earliest known salt of ammonia, now named *chloride of ammonium*, formerly much used in dyeing and metallurgic operations.

The name *Hammoniacus sal* occurs in Pliny (*Nat. Hist.* xxxi. 39), who relates that it was applied to a kind of fossil salt found below the sand, in a district of Cyrenaica. It was similar in appearance to the *alumen scissile*, and had a disagreeable taste, but was useful in medicine. The general opinion is, that the sal-ammoniac of the ancients was the same as that of the moderns; but the imperfect description of Pliny is far from being sufficient to decide the point. The native sal-ammoniac of Bucharia, described by Model and Karsten, and analysed by Klaproth, has no resemblance to the salt described by Pliny. The same remark applies to the sal-ammoniac of volcanoes. Dioscorides (v. 126), in mentioning sal-ammoniac, makes use of a phrase quite irreconcilable with the description of Pliny, and rather applicable to rock-salt than to our sal-ammoniac. Sal-ammoniac, he says, is peculiarly prized if it can be easily split into rectangular fragments. Finally, we have no proof whatever that sal-ammoniac occurs at present, either near the temple of Jupiter Ammon, or in any part of Cyrenaica. These circumstances induce us to conclude that the term *sal-ammoniac* was applied as indefinitely by the ancients as most of their other chemical terms. It may have been given to the same salt which is known to the moderns by that appellation, but was not confined to it.

Some derive the name *sal-ammoniac* from Jupiter Ammon, near whose temple it is alleged to have been found; others, from a district of Cyrenaica called Ammonia. Pliny's derivation is from the sand (ἄμμος) in which it occurred.

Whether our sal-ammoniac was known to the ancients or not, there can be no doubt that it was well known to the alchemists as early as the 13th century. Albertus Magnus, in his treatise *De Alchymia*, informs us that there were two kinds of sal-ammoniac, a natural and an artificial. The natural was sometimes white, and sometimes red; the artificial was more useful to the chemist. He does not tell us how it was prepared, but he describes the method of subliming it, which can leave no doubt that it was real sal-ammoniac. In the *Opera Mineralia* of Isaac Hollandus the elder, there is likewise a description of the mode of subliming sal-ammoniac. Basil Valentine, in his *Currus Triumphalis Antimonii*, describes some of the peculiar properties of sal-ammoniac in, if possible, a still less equivocal manner.

Egypt is the country where sal-ammoniac was first manufactured, and from which Europe for many years was supplied with it. This commerce was first carried on by the Venetians, and afterwards by the Dutch. Nothing was known about the method employed by the Egyptians till the year 1719. In 1716 the younger Geoffroy read a paper to the French Academy, showing that sal-ammoniac must be formed by sublimation; but his opinion was opposed so violently by Homberg and Lemery, that the paper was not printed. In 1719 M. Lemaire, the French consul at Cairo, sent the Academy an account of the mode of manufacturing sal-ammoniac in Egypt. The salt, it appeared, was obtained by simple sublimation from soot. In the year 1760 Linnæus communicated to the Royal

Society a correct detail of the whole process, which he had received from Dr Hasselquist, who had travelled in that country as a naturalist. This account is published in the 51st volume of the *Philosophical Transactions*, 1760, p. 504. Almost the only fuel used in Egypt is the dung of cattle. The dung of black cattle, horses, sheep, goats, &c., which contains the sal-ammoniac ready formed, is collected during the first four months of the year, when the animals feed on the spring grass, a kind of clover. It is dried, and sold to the common people as fuel. The soot from this fuel is carefully collected and sold to the sal-ammoniac makers, who work only during the months of March and April, for it is only at that season of the year that the dung is fit for their purpose.

The composition of this salt seems to have been first discovered by Tournefort in 1700. The experiments of the younger Geoffroy in 1716 and 1723 were still more decisive, and those of Duhamel, in 1735, left no doubt upon the subject. Dr Thomson first pointed out a process by synthesis, which has the advantage of being very simple, and at the same time rigidly accurate, resulting from his observation that when muriatic gas and ammoniacal gas, both as dry as possible, are brought in contact with each other, they always combine in equal volumes.

The first attempt to manufacture sal-ammoniac in Europe was made, about the beginning of the 18th century, by Mr Goodwin, a chemist of London, who appears to have used the mother ley of common salt and putrid urine as ingredients. The first successful manufacture of sal-ammoniac in this country was established in Edinburgh by Dr Hutton and Mr Davy, about the year 1760. It was first manufactured in France about the same time by Baumé. Manufactories of it were afterwards established in Germany, Holland, and Flanders.

Chloride of ammonia is now manufactured in large quantity from the crude carbonate of ammonia obtained in gas-works, or from the destructive distillation of animal matter. This salt is changed into chloride by the addition of hydrochloric acid or the mother liquor of salt-works, called *bittern*, containing the chlorides of calcium and magnesium. When hydrochloric acid is not easily got for neutralisation, the crude gas liquor is transformed into sulphate, and this is mixed with an equivalent quantity of common salt. During the subsequent evaporation the sulphate of soda separates in hard granular crystals, which are apt to adhere to the sides of the boiler. The liquor is agitated to prevent this adhesion taking place, and assist in the separation of the sulphate of soda. The sulphate of soda is removed by drainers as it is formed, and the mother liquor boiled up to the crystallising point, and run off into coolers. The crystals of impure muriate of ammonia are dried carefully and subsequently sublimed.

Sal-ammoniac occurs usually in the form of a hard, white cake, opaque, or only slightly translucent. Its taste is cooling, saline, and rather disagreeable. It dissolves in 2·72 parts of water at 18°·7 C. with great reduction of temperature, and in about an equal weight of water at the boiling-point. The feathery crystals it forms are found on microscopic examination to be masses of cubes or octahedrons; their specific gravity is about 1·5. When exposed to a moist atmosphere, the salt gradually absorbs water, and deliquesces, though very slowly, becoming slightly acid. When heated, it sublimes unaltered in a white smoke, having a peculiar smell, very characteristic of sal-ammoniac. If a cold body be presented to this smoke, the sal-ammoniac condenses on it, and forms a white crust. When thus sublimed, it has the property of carrying along with it various bodies, which, when heated by themselves, are perfectly fixed.

For the other ammoniacal salts see CHEMISTRY.

AMMONIACUM, or AMMONIAC, a gum-resinous exudation from the stem of a perennial herb (*Dorema ammoniacum*) belonging to the natural order Umbelliferæ. The plant grows to the height of 8 or 9 feet, and its whole stem is pervaded with a milky juice, which oozes out on an incision being made at any part. This juice quickly hardens into round tears, forming the "tear ammoniacum" of commerce. Lump ammoniacum, the other form in which the substance is imported, consists of aggregations of tears, frequently incorporating large quantities of the fruits of the plant itself, as well as other foreign bodies. In order to free lump ammoniacum from these impurities, it has to be melted and strained, operations which depreciate its therapeutical value. Ammoniacum has a faintly fœtid unpleasant odour, which becomes more distinct on heating; externally it possesses a reddish yellow appearance, and when the tears or lumps are freshly fractured they exhibit an opalescent lustre. It is chiefly collected in the province of Irak in Persia; but some quantity is also produced in the Punjab, and comes to the European market by way of Bombay. Its composition, according to Hagen, is—resin, 68·6; gum, 19·3; gluten, 5·4; volatile oil and water, 2·8; extractive, &c., 3·9. Ammoniacum is closely related to assafœtida, not only in the plant yielding it, but also in its therapeutical effects. It may be used as a substitute for assafœtida, although, containing a much smaller proportion of volatile oil, its effect is less powerful. Internally it is used in conjunction with squills in bronchial affections; and in asthma and chronic colds it is found useful. It is, however, more used externally in the form of plasters, as a discutient or resolvent application in indolent tumours, affections of the joints, &c.

African ammoniacum is a totally different substance, though often confounded with the real gum-resin, which is produced only in the East. It is the product of an unknown plant growing in North Africa, and occasionally shipped to our markets from Marocco. It is a dark-coloured gum-resin, possessed of a very weak odour and a persistent acrid taste. A considerable commerce in it is carried on between Mogador and Alexandria, where it is in demand for purposes of fumigation.

AMMONITES, called also very frequently *the children of Ammon*, a people allied by descent to the Israelites, and living in their vicinity, sprung from Lot, Abraham's nephew, by the younger of his daughters, as the immediately adjoining people, the Moabites, were by the elder (Gen. xix. 37–38). Both peoples are sometimes spoken of under the common name of the children of Lot (Deut. ii. 19; Ps. lxxxiii. 8); and the whole history shows that they preserved throughout the course of their national existence a sense of the closest brotherhood. The original territory of the two tribes was the country lying immediately on the east of the Dead Sea and of the lower half of the Jordan, having the Jabbok for its northern boundary; and of this tract the Ammonites laid claim to the northern portion, the "half mount Gilead" (Deut. iii. 12), lying between the Arnon and the Jabbok, out of which they had expelled the Zamzummim (Judg. xi. 13; Deut. ii. 20, 21; *cf.* Gen. xiv. 5), though apparently it had been held, in part at least, conjointly with the Moabites, or perhaps under their supremacy (Num. xxi. 26, xxii. 1; Josh. xiii. 32). From this their original territory they had been in their turn expelled by the Amorites, who were found by the Israelites after their deliverance from Egypt in possession of both Gilead and Bashan, that is, of the whole country on the left bank of the Jordan, lying to the north of the Arnon (Num. xxi. 13). By this Amorite invasion, as the Moabites were driven to the south of the Arnon, which formed their northern boundary from that time so the Ammonites were driven out of Gilead

across the upper waters of the Jabbok where it flows from south to north, which henceforth continued to be their western boundary (Num. xxi. 24; Deut. ii. 37, iii. 16). The other limits of the *Ammonitis*, or country of the Ammonites (Ἀμμανῖτις χῶρα, 2 Mac. iv. 26), there are no means of exactly defining. On the south it probably adjoined the land of Moab (but *cf.* Ewald, *Gesch. Israels*, ii. 266); on the north it may have met that of the king of Geshur (2 Sam. xiii. 37); and on the east it probably melted away into the desert peopled by Amalekites and other nomadic races.

The chief city of the country, called Rabbah, or Rabbath of the children of Ammon, *i.e.*, the metropolis of the Ammonites (Deut. iii. 11), and Rabbathammana by the later Greeks (Polyb. v. 7, 4), whose name was changed into Philadelphia by Ptolemy Philadelphus, a large and strong city with an acropolis, was situated on both sides of a branch of the Jabbok, bearing at the present day the name of Moiet or Nahr Amman, the water or river of Ammon, whence the designation "city of waters" (2 Sam. xii. 27; *cf.* Burckhardt, *Syria*, p. 361). The ruins called Amman by the natives are extensive and imposing. The country to the south and east of Amman is distinguished by its fertility; and ruined towns are scattered thickly over it, attesting that it was once occupied by a population which, however fierce, was settled and industrious (see Burckhardt, *op. cit.*, 357, *cf.* Lindsay, *Holy Land*, 5th ed., p. 279), a fact indicated also by the tribute of corn paid annually to Jotham (2 Chron. xxvii. 5). The Israelites on their journey out of Egypt to the land of promise were forbidden to meddle with the territory of Ammon as of Moab (Deut. ii. 19); and it seems to indicate that friendly relations subsisted at first between this people and the chosen nation, that after the latter had conquered and slain Og, the giant king of Bashan, the enemy of both, his bedstead was placed in Rabbah (Deut. iii. 11). Like Moab, however, the Ammonites beheld with jealousy the rising greatness of Israel. They joined the former in hiring Balaam to curse them (Deut. xxiii. 4); and thenceforward their history, so far as known, reveals a spirit of bitter hostility against the people of Jehovah—shown in invasions repeated and violent, and cruelties the most outrageous and unsparing (Judg. x. 8; Amos i. 13). They could not forget that the Gileadite portion of the inheritance of Israel had once been their possession, nor cease to press their claim for its recovery (Judg. xi. 13). We find them joined first with Moab (Judg. iii. 12), and then with the Philistines (Judg. x. 7, 8), in the invasion and oppression for lengthened periods of the land of their enemies. Subdued by the prowess of Jephthah, they began again to act on the offensive in the days of Saul, laying siege to Jabesh-Gilead (1 Sam. xi. 1). David offered his friendship to the king of Ammon, but his offer was rejected with contumely and outrage, for which a terrible vengeance was exacted in the capture and overthrow of their metropolis, and the deliberate slaughter of the people (2 Sam. x.) They were united with Moab against Judah in the days of Jehoshaphat (2 Chron. xx. 1); they paid tribute to Uzziah and Jotham (2 Chron. xxvi. 8, xxvii. 5); and with the neighbouring tribes helped the Chaldean monarch against Jehoiakim (2 Kings xxiv. 2). When, after the destruction of Jerusalem, the poor remnants of the Israelites were gathered together under the protectorate of Nebuchadnezzar, it was by the instigation of a king of Ammon that Gedaliah, the ruler appointed over them, was murdered, and new calamities were incurred (Jer. xli. 14); and when Jerusalem was to be rebuilt, the foremost in opposing the patriotic Jews were a Moabite and an Ammonite (Neh. ii. 10, 19; iv. 1-3). True to their antecedents, the Ammonites, with some of the neighbouring tribes, did their utmost to resist and check the revival of the Jewish power under Judas Maccabæus (1 Macc. v. 6; *cf.* Jos. *Ant. Jud.* xiii. 8, 1). The last historical notice of them is in Justin Martyr (*Dial. cum Tryph.* § 119), where it is affirmed that they were still a numerous people. The Ammonites are repeatedly mentioned under the form Bit-Amman, *i.e.*, house of Amman, in the inscriptions of Nineveh among the tributaries of the kings of Assyria (Schrader, *Keilinschriften und d. A. T.* 52). The names of their kings, so far as known,—in Scripture, Nahash, Hanun, Baalis, or Baalim (2 Sam. x. 2; Jer. xl. 14); in Assyrian, Puduilu (*cf.* Pedahel (Num. xxxiv. 28), Basa (*cf.* Baasha, 1 Kings xv. 33), and Sanibi (of less obvious analogy),—testify, in harmony with other considerations, that their language was Semitic, closely allied to the Hebrew; and this fact is now placed beyond question by the discovery of the Mesha-stele, presenting the language of the Moabites, and doubtless that also of the brother tribe (see MOABITES). Their national deity, Moloch or Milcom (see MOLOCH), was worshipped with cruel rites,—a circumstance tending to foster that fierceness of character which distinguished this people throughout their history.

AMMONIUS, surnamed HERMIÆ, or the son of Hermias, studied at Alexandria, along with his brother Heliodorus, under the neo-Platonist Proclus during the latter part of the 5th century A.D. He was afterwards the head of a school for philosophy; and among his scholars were Asclepias, John Philoponus, Damascius, and Simplicius. Although a neo-Platonist, Ammonius appears to have devoted most of his attention to the works of Aristotle. Commentaries on some of these are all that remains of his reputedly numerous writings. Of the commentaries we have—1. One on the *Isagoge* of Porphyry, published at Venice, 1500, fol.; 2. One on the *Categories*, Venice, 1503, fol., the authenticity of which is doubted by Brandis; 3. One on the *De Interpretatione*, Venice, 1503, fol. Of each of the commentaries there are several Latin translations, and the three have been published in a collected form, with a Latin translation, Venice, 1546, 3 vols. 8vo. They are also printed in Brandis' Scholia to Aristotle, forming the fourth volume of the Berlin *Aristotle*. The special section on fate has been published separately by Orelli, *Alex. Aphrod. Ammonii et all. de Fato quæ supersunt*, Zurich, 1824. A life of Aristotle, generally ascribed to Ammonius, but with more accuracy to John Philoponus, is often prefixed to editions of Aristotle. It has been printed separately, with Latin translation and Scholia, at Leyden, 1621, and again at Helmstädt, 1666. Other commentaries on the *Topics* and the first six books of the *Metaphysics* still exist in manuscript. Of the value of the logical writings of Ammonius there are various opinions. Prantl, perhaps the highest recent authority, speaks of them with great but hardly merited contempt (*Geschichte der Logik*, i. 642). (For list of his works, see Fabricius, *Bibliotheca Græca*, v. 704–707; and also Brandis, *Memoirs of the Berlin Academy*, 1833.)

AMMONIUS, surnamed SACCAS, or "The Sack Carrier," from the fact of his having been obliged in the early part of his life to gain his livelihood by acting as a porter in the market, lived at Alexandria during the 2d century A.D., and died there 241 A.D. Very little is known of the events of his life. He is said by Porphyry to have been born of Christian parents, and to have belonged originally to their faith, from which he afterwards apostatised. Eusebius (*Church History*, vi. 19) denies this apostasy, and affirms that Ammonius continued a Christian to the end of his life. It is clear, however, that Eusebius is referring to another Ammonius, a Christian who lived at Alexandria during the 3d century A.D. Ammonius, after long study and meditation, opened a school for philosophy in Alexandria. Among his pupils were Herennius, the two Origens, Longinus, and, most distinguished of all, Plotinus, who in his search for true wisdom found himself irresistibly attracted by Ammonius, remained his close companion for eleven years, and in all his later philosophy professed to be the mere exponent of his great master. Ammonius himself designedly wrote nothing, and the doctrines taught in his school were, at least during his life, kept secret, after the fashion of the old Pythagorean society. Thus, while all the later developments of neo-Platonism are in a general way referred to him as their originator, little is known of his special tenets. From the notices of Hierocles, a scholar of Plutarch, in the early part of the 5th century A.D., preserved in Photius, we learn that his fundamental doctrine was an eclecticism, or union of Plato and Aristotle. He attempted to show that a system of philosophy, common to both and higher than their special views, was contained in their writings. He thus, according to his admirers, put an end to the interminable disputes of the rival schools. What other elements Ammonius included in his eclectic system, and in particular how he stood related to the Jewish and Christian theosophies, are points on which no information can be procured. Few direct references to him exist, and even

these are not of unquestionable authority. He undoubtedly originated the neo-Platonic movement, but it cannot be determined to what extent that philosophy, as known to us through Plotinus and Proclus, represents his ideas. Eusebius (*Church History*, vi. 19) mentions some Christian works by Ammonius. As Porphyry expressly tells us that Ammonius the philosopher wrote nothing, Eusebius must be referring to the later Christian of the same name. To this later Ammonius belongs the *Diatescaron, or Harmony of the Four Gospels*, sometimes ascribed to the philosopher. (See Fabricius, *Bibliotheca Græca*, v. 701, 713; and Zeller, *Phil. d. Griechen*, 2d ed., iii. 2, 398, note 6.) On Ammonius the philosopher, besides general works on the Alexandrian school and the history of philosophy, see Rösler, *De Commentitiis Philosophiæ Ammoniacæ Fraudibus et Noxis*, Tübingen, 1786; and Dehaut, *Essai Historique sur la Vie et la Doctrine d'Ammonius Saccas*, Brussels, 1836.

AMMUNITION in its general sense comprises not only the powder and projectiles employed in guns of all classes, but also all stores directly connected with artillery fire, such as friction-tubes, fuses, percussion-caps, and rockets.

Gunpowder, as manufactured in England, consists of 75 parts of saltpetre, 15 parts of charcoal, and 10 parts of sulphur, reduced to a fine powder and mechanically mixed together, pressed into a cake, and granulated to a size varying according to the purpose which it is designed to fulfil. In cannon, a large grain is necessary for regular and thorough burning, a fine powder choking up the interstices, and so preventing the flame from finding its way through the entire charge. On the other hand, a large grain is blown out of a small piece before it is burnt to the centre. For the very heavy guns recently introduced into the British service powder formed into "pellets" or "pebbles" has been adopted, by which the pressure of the gas is kept up till the shell leaves the muzzle, without being at any instant excessive and likely to injure the gun. Modified forms of powder and gun-cotton have been employed experimentally as the charges of guns.

For heavy guns or cannon the charge is carefully weighed and made up in a serge cartridge sewn with worsted, which entirely consumes in firing—any residue left ignited in the bore being liable to cause explosion when the cartridge of the succeeding round is rammed down on it, and so to blow off the arms of the gunner using the sponge stave. The shell or other projectile employed is forced home on the cartridge (*vide* fig. 1) in muzzle-loading guns. In breech-loaders the shell is introduced first, and pressed into the shot chamber, beyond which it can only pass by the "lands" of the rifling cutting into the lead coat, which is effected by the explosion of the charge. The cartridge is pressed forward against the base of the projectile.

Rifled guns—that is, guns constructed to impart rotation to the projectiles they discharge—have superseded smooth-bored cannon in the armaments of all civilised nations; elongated projectiles, which are impeded by the resistance of the air much less than spherical ones, being in all cases employed. Fig. 1 shows a section of the bore of the

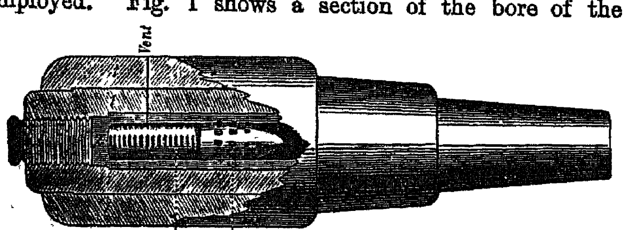


FIG. 1.—1, 1, wrought-iron coils; 2, steel; 3, copper studs; 4, worsted braids.

muzzle-loading gun, whose projectiles are made to rotate by means of gun-metal studs which fit in the spiral grooves of the bore. The following kinds of projectiles are fired from rifled cannon in the British service:—Common shell, Shrapnel shell, Palliser shell and shot, and case-shot. Light balls, carcasses, and spherical shells are discharged from smooth-bored mortars. The two last mentioned, as well as spherical Shrapnel, round shot, grape, and case, are fired from smooth-bored guns.

Common shell for rifled guns are simply hollow elongated projectiles filled with powder, which is fired by the action of a fuse, and bursts the shell with great violence, acting in walls or earth into which it has penetrated like a small mine, the largest shells, which are twelve inches in diameter, containing nearly 37 lb of powder. Gun cotton, nitro-glycerine, and other substances, have been tried for bursting purposes, but it has been found very difficult to prevent premature explosion from the sudden shock of discharge of the gun. Picrate of potash, or "picric powder," has been recommended as stronger than gunpowder and quite safe, but it is not as yet adopted. Common shells are generally fired at earthworks, buildings, and wooden ships. When carried, as in English men-of-war, filled and fused with percussion fuses, they can be discharged as rapidly as shot. The most terrible instance of their use in history is the entire destruction of the Turkish frigates by the Russian fleet at Sinope on November 30th, 1853. At the battle of Sedan in 1870 the Prussians made such havoc among the crowded French troops that the ground became covered with "heaps of flesh and rags;" and a similar result was produced by the fire of mortars concentrated on the Russian troops in the Redan at the termination of the siege of Sebastopol. The slaughter in the two last named instances is, however, to be attributed to the concentration of fire on masses of men rather than to the description of shell used, for the showers of bullets ejected by Shrapnel shell would have struck many more men, although the ghastly spectacle of dismembered human bodies would not have been exhibited.

Shrapnel shell are hollow projectiles containing bullets and a very small bursting charge. Fig. 2 exhibits the construction of the Boxer Shrapnel shell for the 40-pounder breech-loading Armstrong gun, and is a good specimen of this class of projectile. The shell follows the usual course of flight up to within about 100 yards of the object, when the time fuse, if properly set, fires the bursting charge, and opens the shell by splitting it along certain grooves forming lines of least resistance. The bullets and fragments then continue their course in the form of a shower of missiles. This class of shell was designed for smooth-bore guns by General Shrapnel. It was used with great effect during the Peninsular war, especially in clearing the breach and ramparts of St Sebastian of defenders, over the heads of the English storming party, who drew back into the ditch for a time. The projectile has never been understood and thoroughly taken up by foreign powers, and has never been used to full advantage on service. In skilful hands it is capable of producing results far beyond any that have as yet been achieved.

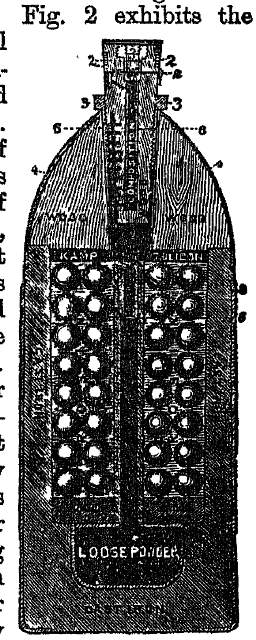


FIG. 2.—2, 2, copper parts; 3, 3, gun metal; 4, 4, wrought-iron or mild steel; 5, lead; 6, paper.

The *Armstrong segment shell* fulfils the same general purpose,—that is to say, it is designed to sweep down bodies

of troops, but it opens rather more suddenly, segments of iron taking the place of lead and antimony bullets, which segments being built up in a ring with the bursting charge in the centre, are dispersed more widely when the shell opens than the bullets of the Shrapnel. The segment shell consequently is rather suited for the action of a percussion fuse on striking the head of a column of men, or the ground close in front of it. In this way results have been obtained which are out of all proportion to anything that has ever occurred in actual service. At Dartmoor in 1869 the average number of hits for every segment shell fired during the series of experiments, including failures of all kinds, was 17·1. The meaning of this estimate may be appreciated by applying it to some action. For example, at Waterloo the English artillery fired 9467 rounds. On the Dartmoor scale this would give 161,885 casualties. This result shows that after making the most liberal deductions for the peculiar circumstances of war, appalling effects might be produced by modern artillery with segment or Shrapnel shells.

Palliser shell and shot are projectiles made with specially hard and rigid heads, with the object of piercing the sides of armour-clad vessels. The form of the head, which is termed "ogival," is seen inside the gun in Fig. 1. A point of this shape causes the resistance of the plate to fall on the shell as an increasing pressure, acting inwards towards points distributed along the axis, rather than as the full sudden blow that would be experienced by a round shot. This enables *chilled iron* to be used, which has great hardness and crushing strength, but is very brittle. Sir W. Palliser first proposed chilled projectiles; subsequently mottled iron projectiles with chilled heads have been used. Sir J. Whitworth has obtained great results with flat-headed projectiles of a special quality of steel, which have been made to penetrate iron plates at an angle even more oblique than 45°. Solid and hollow shot, as well as shell, have been employed against plates. The shot, having thicker sides or walls, have some advantage in penetration. Shells, by their explosion, destroy wood backing better than shot, when the front plating is not too thick for them to penetrate. They are charged with powder through a filling hole in the base of the shell, closed with a strong screw plug. No fuse is required, impact against thick iron being sufficient to explode the bursting charge of a shell without any fuse. The greatest penetration that has yet been obtained in armour was achieved by the 35-ton Woolwich gun (termed the Woolwich "infant"), at Shoeburyness on June 20th, 1872, the head of a Palliser projectile passing entirely through $18\frac{1}{2}$ inches of iron and 12 of teak, a thickness of armour exceeding that of any iron-clad vessel afloat.

Solid shot have gradually disappeared since the introduction of rifled guns, and the reasons are obvious. A round shot fired from a smooth-bored gun, after its first graze, continued to ricochet in a straight line; it produced, therefore, a considerable moral effect, and on smooth ground was actually formidable. A rifled shot, on the other hand, is violently deflected after each graze, from the fact that it is rotating rapidly as it touches the ground, and this, coupled with its liability to bury itself, detracts greatly from its efficiency. Shells for any rifled gun may be made of such length as to bring them to the *same weight* as the corresponding shot, which was not the case with smooth-bore projectiles, they being all of one *size* instead of one *weight*. In short, Palliser shell with thick walls (fired as hollow shot) excepted, the only projectiles of the shot class now employed with rifled guns are *case shot*. Owing, however, to the fact that the charge of a rifled gun varies from $\frac{1}{8}$th to $\frac{1}{4}$th the weight of the projectile, while in smooth-bored guns it was sometimes as great as $\frac{1}{3}$d that of the shot, the effect of rifled case is comparatively weak. At any time the range of case shot hardly exceeds 300 yards, while its efficiency depends on the ground along which it bounds being hard and level. Each shot consists of a number of balls enclosed in a thin metal cylinder, which breaks up in the gun, the balls scattering from the muzzle, but sweeping the ground with great effect under favourable circumstances. *Grape* differs only in the balls being larger. At the battle of Friedland, at the bridge of Lodi, and at Sebastopol, grape and case were fired with great effect.

Time and percussion fuses have been mentioned. *Time fuses* are those which open a shell at any given time, whether in the air or during penetration. Fig. 2 shows the "Boxer 9-second fuse" for breech-loading guns, fixed in the shell. On the shell moving, the hammer in the head, by its inertia, shears a copper wire, fires a detonating patch of composition beneath it, and lights the fuse composition. This burns until it reaches the point at which a hole is bored in the fuse, when it flashes down the channel shown on the left side of the cut, and fires the powder primer and bursting charge of loose powder. The action of this fuse therefore depends on its correct boring and regular burning. A *percussion fuse* is one that acts on impact or graze. Fig. 3 shows the Pettman general service fuse. On the first movement of the shell, the detonating ball A, and the plugs above and below it, by their inertia, crush the lead cap C, and shear the copper pin above F. During flight the ball becomes detached from the upper or steady plug B, and on impact is fired by its momentum against the part in front of it. The steady plug itself has also a ring of detonating composition, DD, which, should the plug fail to escape from the detonating ball, and so hold against it, is thrown against the little plain ball E. The flash in either case acts down the tube F, and fires the bursting charge of the shell. This fuse is made not to explode against a wave, being chiefly used for sea service. It acts both with smooth-bored and rifled guns. For land service more sensitive ones are employed to explode on graze.

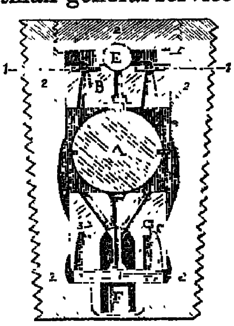


Fig. 3.—1, copper parts; 2, gun-metal; 3, lead.

Friction tubes are copper tubes driven with mealed powder, and pierced from end to end. A friction bar in the head is rubbed against patches of detonating composition by pulling a lanyard, which hooks into a loop at the end of it. The tube is entered in the vent of a gun, which is thus fired by pulling the lanyard.

For mitrailleuses and breech-loading small arms, lead bullets or lead and tin bullets, fixed in central-fire cartridges, are used. The cases are made of sheet brass, with a thick base disc containing a cap chamber, cap, and anvil. Fig. 4 shows the Boxer-Henry ammunition for the Martini-Henry rifle. These metal-cased cartridges are not liable to explode in store, even from the firing of a small charge of powder confined inside the same packing-case with them. They admit of a very rapid rate of firing. The Gatling mitrailleuse has discharged 657 rounds in two minutes at Shoeburyness. The Martini-Henry rifle has fired 25 rounds in a minute.

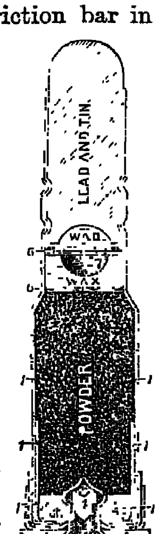


Fig. 4.—1, 1, sheet brass; 2, copper; 3, wrought iron; 4, paper; 6, 6, mill-board; 7, bees'-wax.

Rockets are projectiles containing composition which, as it burns, generates sufficient gas to drive forward the rocket by an action resembling that of the recoil of a gun. Of rockets there are three kinds: first, war rockets, with iron cases, introduced by Sir W. Congreve, and subsequently

brought by Mr Hale to the form shown in Fig. 5. Congreve rockets were kept point first by sticks screwed into their bases, which acted on the principle of the feathers of an arrow. The Hale rocket is kept point first by rotation, caused by the gas escaping from the vents pressing against the curved shields. The second class of rockets are signal rockets, made of paper, and containing stars, which throw a bright light in falling. The third class are the rockets used to carry a line and establish communication between a wrecked vessel and the sea-shore. (C. O. B.)

Fig. 5.

AMNESTY (ἀμνηστία, oblivion), an act of grace by which the supreme power in a state restores those who may have been guilty of any offence against it to the position of innocent persons. It includes more than pardon, inasmuch as it obliterates all legal remembrance of the offence. It is chiefly exercised towards associations of political criminals, and is sometimes granted absolutely, though more frequently there are certain specified exceptions. Thus in the case of the earliest recorded amnesty, that of Thrasybulus at Athens, the thirty tyrants and a few others were expressly excluded from its operation; and the amnesty proclaimed on the restoration of Charles II. did not extend to those who had taken part in the execution of his father. Other celebrated amnesties are that proclaimed by Napoleon on 13th March 1815, from which thirteen eminent persons, including Talleyrand, were excepted; the Prussian amnesty of 10th August 1840; and the general amnesty proclaimed by the Emperor Francis Joseph of Austria in 1857. The last Act of amnesty passed in Great Britain is 20 Geo. II., c. 52, which proclaimed a pardon to those who had taken part in the second Jacobite rebellion.

AMOL, or Amul, a town of Persia, in the province of Mazanderan, about 12 miles above the mouth of the Heraz, a river which flows into the Caspian Sea. It is not walled, and is now a place of no great importance, but in and around it there are ruins and ancient buildings which bear witness to its former greatness. Of these the most conspicuous is the magnificent mausoleum of Seyed Quam-u-deen, king of Sari and Amol, who died in 1378. At Amol there is a bridge of twelve arches over the Heraz, and the bazaars of the town are large and well supplied. The population is about 40,000, but a great number of these leave the city in summer to tend their flocks.

AMONTONS, Guillaume, a celebrated French experimental philosopher, was the son of an advocate who had left his native province of Normandy and established himself at Paris, where the subject of this notice was born on the 31st August 1663. The exertions of genius frequently take a particular direction from accidental circumstances. A severe illness with which Amontons was afflicted in his early youth had the effect of rendering him almost entirely deaf, and consequently of secluding him in a great measure from the ordinary intercourse of society. Being compelled by this accident to depend for his enjoyments on the resources of his own mind, he began to take great pleasure in the construction of machines of various kinds, and in the study of the laws of mechanics, a path of inquiry which he pursued through life with unremitting ardour and distinguished success. One of the first objects which engaged his attention was the discovery of the perpetual motion,—an attempt which, though necessarily unsuccessful, was productive of greater advantage to him than it has usually been to those who have pursued that vain chimera. Amontons devoted himself particularly to the improvement of instruments employed in physical experiments, a subject which requires the finest applications of mechanical principles, and which till that time had not met with a due share of attention. In 1687, before he had attained his 24th year, he presented to the Academy of Sciences an hygrometer of his own invention, which was received with approbation by that learned body. In 1695 he published the only work which he has given to the world. It was dedicated to the Academy, and entitled *Remarques et Expériences Physiques sur la Construction d'un Nouvel Clepsydre, sur les Baromètres, les Thermomètres, et les Hygromètres.* After Huyghens's beautiful application of the pendulum to the regulation of the motion of clocks, any attempt to revive the clepsydra, an incommodious instrument, and not susceptible of much accuracy, might seem to subject its author to the imputation of not sufficiently appreciating the great importance of a discovery which has so completely changed the face of astronomical science; but the object of Amontons was to produce an instrument capable of measuring time on board ship, in circumstances where the motion of the vessel rendered such timekeepers as were then known useless. The machine which he constructed is said to have been extremely ingenious, and probably differed entirely from those of the ancients, among whom the clepsydra was in common use. In 1689 Amontons was admitted into the Academy of Sciences, the Memoirs of which he enriched with many important contributions. The first paper which he presented after his admission was one on the theory of *friction*, a subject then involved in great obscurity, and on which his inquiries tended to throw considerable light. After that appeared in succession descriptions of a new thermometer, and of numerous experiments made with the barometer relative to the nature and properties of air,—a detailed account of all which is given in the history of the Academy. In the course of these investigations he found that the boiling point of water varies with the pressure of the atmosphere, a discovery made almost contemporaneously in England by Dr Halley. By his countrymen he is generally regarded as the inventor of the telegraph; and he had the honour of exhibiting the methods by which he proposed to accomplish the object in view before some members of the royal family. It appears, however, from a paper read by Dr Hooke to the Royal Society in 1684, that that ingenious philosopher had brought the telegraph, in theory at least, to a state of far greater maturity than Amontons, and nearly 20 years earlier. The experiments of the latter were made about the year 1702. It may be regarded as a curious fact in the history of inventions, that although the great importance of telegraphic communication is obvious, and the method of accomplishing it was clearly explained by Hooke, and its practicability demonstrated by Amontons, it continued to be regarded as of no practical value, and was not regularly applied to useful purposes till nearly a century afterwards, at the time of the French Revolution. Amontons died in 1705, aged 42.

AMOOR, Amour, or Amur, a large and important river of eastern Asia, formed by the confluence of the Argun and the Shilka, at a place called Ust Strelkoi, in 53° 19′ N. lat. and 121° 50′ E. long. Both these rivers come from the south-west: the Argun, or Kerulen as it is called above Lake Kulon, through which it flows about half-way between its source and Ust Strelkoi, rises near Mount Kentei, in 49° N. lat. and 109° E. long.; the Shilka is formed by the union of the Onon and the Ingoda, both of which rise in the Kingan mountains, not far from the source of the Argun. The Amoor proper flows at first in a south-easterly direction for about 800 miles, as far as 47° 42′ lat.; it then turns to the north-east, and after a total course of over 1600 miles discharges itself into the Sea of Okhotsk, opposite to the island of Saghalien. Its principal tribu-

taries from the south are the Songari, which the Chinese consider to be the true head river of the Amoor, and the Ussuri; from the north it receives the Zeya, the Bureia, the Gyrin, and the Omogun. The climate of the valley of the Amoor varies very much in different parts: in the upper portion of its course there are long and cold winters and short summers; as the river descends into more southern latitudes the rigour of the climate relaxes, and the heat becomes almost tropical; the vegetation is rich and luxuriant, and large forests of oaks, limes, and elms replace barren larches and firs; while on the lower Amoor the cold again to a certain extent prevails, and at the mouth the river is ice-bound for more than half the year, a circumstance which greatly impairs its otherwise admirable facilities for navigation. The river is abundantly stocked with fish, and the mountains near it are believed to contain iron and gold. The Amoor became known to the Russians in 1639, and they resolved to annex it to their empire along with the territory through which it flows. In 1651 a party of Cossacks, under a bold leader named Khabaroff, built a fort at Albazin, about 100 miles below Ust Strelkoi. Many sanguinary conflicts between the Chinese and the Russians followed. Albazin more than once changed owners; but at last, in 1689, a treaty was concluded, by which the river Gorbiza or Kerbeche became the easterly limit of the Russian empire on the Amoor, the boundary stretching from the source of the Gorbiza, along the Yablonnoi mountains, to the Sea of Okhotsk. This state of matters continued till 1847, when the Russians again began to make preparations for the conquest of the Amoor valley. In 1850 and the three succeeding years, expeditions were sent up the river, and the towns of Nikolaevsk, Marinsk, and Blagovchenk were founded; in 1854 a powerful flotilla sailed down from Ust Strelkoi to the mouth of the river. A large and very important tract was added to the Russian empire by the cession in 1858 of the whole left bank of the Amoor and the right bank below the Ussuri, and the further cession in 1860 of all the territory between the Ussuri and the Eastern Sea.

AMORITES, a powerful people, widely spread through the Promised Land before the settlement of the Israelites, belonging to the Canaanitic stock, according to Gen. x. 16, though some think they belong rather to the pre-Canaanitic inhabitants of the Jordan basin (see Knobel, *Völkertafel*, 201, sq., who refers them to the Shemitic race of Lud). In all probability there were incorporated among them the remnants of the older tribe of the Rephaim. Their name, "the high ones," has by Ewald (*Gesch. Israels*, i. 315), after Simonis (*Onomasticon*, s.v.) been interpreted highlanders, or inhabitants of the heights, as Canaanites is supposed to mean lowlanders, or inhabitants of the plains (cf. Num. xiii. 29; Deut. i. 44; Josh. v. 1, x. 6). Others call this in question, and find an explanation rather in the tallness of stature by which they seem to have been distinguished (Num. xiii. 32, 33; Amos ii. 9, cf. Kurtz, *Gesch. d. Alt. Bundes*, i. § 45; Pusey, *Minor Prophets*, 174, n.)

That this people had a certain preponderance among the Canaanitic tribes is shown by their name often standing in Scripture for Canaanites in general (Gen. xv. 16; Josh. xxiv. 18; Jud. vi. 10). Their principal seat on the west of the Jordan was the mountains of Judah and their southern slopes,—to the whole of which mountainous region, indeed, the name the Mount of the Amorites is applied (Gen. xiv. 7, 13; Num. xiii. 29; Deut. i. 7, 20, 44; Josh. xi. 3; Jud. i. 36). We hear of them also at Gibeon, north-west of Jerusalem (2 Sam. xxi. 2), at Aijalon, west of Gibeon, and in the northern part of the Philistine plain (Jud. i. 34, 35), and in the land of Ephraim (Gen. xlviii. 22). On the east of Jordan, after having driven back the Ammonites and Moabites, they occupied the whole of Gilead and Bashan, from the Arnon, the northern limit of Moab, as far as Mount Hermon, forming in this region at the epoch of Moses two powerful kingdoms,—that of Sihon, whose capital was Heshbon, the more southerly; and that of Og, whose capital was Ashtaroth, the more northerly (Num. xxi. 21-35; Deut. iii. 8, 10; iv. 48). It was with this east-Jordanic section of the Amorites that the Israelites first came into conflict. After these had been subdued, and after the Israelites had crossed the Jordan and had begun to capture the Canaanitish towns, five of the most powerful of the Amorite kings of the western section formed a confederacy to oppose the advancing host (Josh. x. 5, sq.) When this combination had been overthrown, a final attempt at resistance was made by the more northerly portion of the Canaanites, under the auspices of Jabin, king of Hazor; and in the united forces, which were overthrown at the waters of Merom, Amorites were included (Josh. xi. 3). Those of this and the other tribes of the Canaanites who survived the conquests of Joshua, either gradually became mingled with the Philistines and others of the neighbouring nations, or they continued to live among the Israelites in the condition of tributaries and slaves (Josh. xi. 22; Jud. i. 34, 35; 1 Kings ix. 21; 2 Chron. viii. 8).

In old Egyptian literature mention is frequently made, from the time of Sethos I., of an Asiatic people called the Amar or Amaor, whom Egyptologers agree in identifying with the Amorites (Bunsen, *Egypt's Place*, vol. iii. 212). There is as yet less agreement in regard to the position of their country. Brugsch is of opinion that the people in question are located in the north of Syria, on the banks of the Orontes (see his *Geog. Inschriften*, Bd. ii. 21; *Hist. d'Egypte*, 132, 187). The later researches of Chabas, however, have rendered the interpretation on which this view depends very doubtful, and shown that in all probability their territory lies, in entire harmony with the representations of Scripture regarding the Amorites, on the west of the Dead Sea and south of the land of Judah (Chabas, *Etudes sur l'Antiquité*, 267, f.; *Recherches*, 44, 107.) Among the towns of the Amaor are mentioned Dapur and Kodesh, evidently to be identified with the scriptural Debir and Kadesh.

The language, &c., of the Amorites will be more conveniently considered under CANAANITES.

AMORPHISM (from α privative, and μορφή, form), a term used in chemistry and mineralogy to denote the absence of regular structure in a body. Glass, resin, coal, albuminous substances, &c., are amorphous, exhibiting uniformity of properties in every direction: they have no planes of cleavage, as crystals have; they conduct heat equally in all directions; and they do not show double refraction unless in a *constrained* state. Amorphism is not peculiar to one kind of substances, for the same molecules may exist either in the amorphous or the crystalline state. Thus charcoal or lamp-black is the amorphous form of the diamond; sulphur and phosphorus, when slowly cooled, assume a crystalline arrangement, but when rapidly cooled are perfectly homogeneous—the suddenness of transition from the liquid or fused state giving no time for definite arrangement of particles.

AMOS (not the same as Amoz, the father of Isaiah) was an inhabitant of the district of Tekoa, a fortified town (2d Chron. xi. 6) among the hills of the south of Judah, where a breed of stunted sheep and goats, prized, however, for their wool and hair, found a scanty pasturage (Amos i. 1). Possibly he was a common day labourer; certainly he was far from wealthy, as the Jewish commentators would have him; for though he is called a "nōkēd" (*loc. cit.*), like one of the kings of Moab (2 Kings iii. 4), he tells us himself that he was glad to combine this employment with that of a dresser of sycamore fruit (vii. 14). He may thus be contrasted, as the peasant prophet, with Isaiah, the prophet of the capital and the court. It does not, however, follow that Amos was devoid of such cultivation as could then be had. Distinctions of rank were not, among the primitive Semitic races, coincident with those of culture; it is enough to refer to the pre-Mohammedan Arabs, whose poetry has been so accurately reproduced by Rückert. And in the case of Amos there is evidence in his own works that he was well acquainted with the literature of his day. It is true that he boldly admits the irregularity, from an official point of view, of his prophetic ministrations—"No prophet I, and no prophet's disciple I" (vii. 14); but his discourses are not only full of references (sometimes dubious) to the book of Joel and the Pentateuch, but framed, however

imperfectly, on a genuine artistic plan. This is unmistakably the case in the discourse contained in i. 3–ii. 16; but with greater or less correspondence to the course of thought in the remainder of the book. Thus, according to Ewald (who aims, it is true, at an unattainable precision), chapters iii. and iv. consist of five strophes—iii. 1–8, iii. 9–15, iv. 1–3 (incomplete), iv. 5–11, iv. 12, 13; chapters v. and vi. of a prologue (v. 1–3) and four strophes —v. 4–6, 8, 9; v. 7, 10–17; v. 18–27; vi. 1–10; with a sort of epilogue in vi. 11–14. And the great critic De Wette goes so far as to declare that no Hebrew prophet has shown an equal regard for clearness and harmony of proportion. (Comp. Dr Pusey, *Minor Prophets*, p. 152.)

The date of the first public appearance of Amos cannot be ascertained. From the heading of the book (i. 1), which, though not by the prophet himself, has the air of a genuine tradition (Ewald, *Die Propheten*, i. 123), we learn that he "saw"—that is, prophesied—"two years before the earthquake." This earthquake is referred to again in Zech. xiv. 5, and, as some think, in passages of Joel and other prophets. It seems, therefore, to have constituted an era in popular tradition, but is of no significance for chronology, as has been well shown by Dr Pusey (*Minor Prophets*, p. 148). More to our purpose is the former part of the heading, which limits the prophetic career of Amos to the twenty-five years that Uzziah and Jeroboam II. were contemporary—*i.e.*, 810–784, according to the common chronology; 775–750, according to the Assyrian. (Comp. Schrader, *Die Keilinschriften und das Alte Testament*, p. 120.) He flourished, therefore, in the greatest age of Hebrew prophecy. He seems to have been younger than Joel, to whose prophecy he makes several references, and more or less senior to Hosea and Isaiah. This view is fully borne out by the gradual emergence of the Assyrians on the prophetic horizon. Altogether absent from Joel's prophecy, they are but vaguely alluded to in Amos, and first mentioned by name in Hosea and Isaiah.

It was while "following the flock" (vii. 14, 15) that Amos received a prophetic impulse to leave his home and preach in the sister country. The circumstances are on several accounts worthy of notice. They indicate—1. A distinction between Hebrew prophecy, in its mature stage, and non-Hebrew—viz., that the former is not dependent on a special artificial training; 2. That though his writings are included in the prophetic canon, Amos did not consider himself officially a prophet (which has a bearing on the great controversy of Daniel); and 3. That prophets of the higher or spiritual order did not recognise the revolt of the first Jeroboam (comp. ix. 11; Hos. iii. 5). But the prophecies of Amos had a wider scope than the destiny of Israel. They show a dim presentiment of the philosophy of history, and of the reproductive power of revolutions. Accordingly, Syria, Philistia, Phœnicia, Edom, Ammon, Moab, and Judah were successively rebuked by the inspired messenger. But the chief blame fell upon Israel, whose unparalleled prosperity under Jeroboam II. had developed the germs of vices inconsistent with the religion of Jehovah. The denunciations of Amos produced a powerful impression. He was expelled with contumely by Amaziah, a priest of the reactionary image cultus at the frontier town of Bethel (vii. 10–17).

It is not to be supposed that the discourses of Amos were delivered exactly as they stand. This view is precluded by their elaborate literary character, and by the allusions to the prophet's experience in Israel in ii. 12, v. 10, 13. He probably put them together, with the addition of a grand Messianic epilogue, after his return to Tekoa. There has never been a doubt of their genuineness. The text is good, but there are a few corrupt passages.

Some of the characteristics of Amos have been already mentioned. The tradition that he was a stammerer (based on an absurd etymology of his name), and the statement of Jerome that he was "imperitus sermone (sed non scientiâ)," only prove the incapacity of the ancients for literary criticism. The simplicity of his style is that of the highest art. He delights in abrupt short clauses, but they are linked together by the closest parallelism. And the supposed rusticity of his dialect is deduced from the spelling of only five words, analogies to which may be traced in the great poem of Job. All that we can admit as probable is, that the native force and talent for observation displayed by this prophet were derived from his early converse with nature on the wild hills of Judah. His imagery, in fact, from its freshness and appropriateness (comp. ii. 13; iii. 5, 12; iv. 2, 9; v. 19; vi. 12; ix. 9), almost reminds us of Dante, and entitles him to as high a place in the history of literature as in that of theistic religion. (T. K. C.)

AMOY, a city and seaport in the province of Fo-kien, China, situated on the slope of a hill, on the south coast of a small and barren island of the same name, in 24° 28′ N. lat. and 118° 10 E. long. It is a large and exceedingly dirty place, about 9 miles in circumference, and is divided into two portions, an inner and an outer town, which are separated from each other by a ridge of hills, on which a citadel of considerable strength has been built. Each of these divisions of the city possesses a large and commodious harbour, that of the inner town, or city proper, being protected by strong fortifications. Amoy may be regarded as the port of the inland city of Chang-chu, with which it has river communication; and its trade, both foreign and coastwise, is extensive and valuable. In 1870, 560 vessels, exclusive of Chinese junks, entered the port, of an aggregate burden of 224,436 tons; of these, 315, of 150,171 tons, were British. The chief articles imported were sugar, rice, raw cotton, and opium, as well as cotton cloths, iron goods, and other European manufactures; their value was £1,915,427. In the same year, 554 vessels, of 226,911 tons, cleared the port, including 314 British, of 150,826 tons; the chief exports were tea, porcelain, and paper, and their value was £1,144,046. It is not possible to give the statistics of the trade that is carried on by means of Chinese junks, but it is said to be large; and the native merchants are considered to be among the wealthiest and most enterprising in China. Amoy was captured by the British in 1841, after a determined resistance, and is one of the five ports that were opened to British commerce by the treaty of 1842; it is now open to the ships of all nations. The population of Amoy is estimated at 250,000.

AMPÈRE, ANDRÉ-MARIE, the founder of the science of electro-dynamics, was born at Lyons in January 1775. He took a passionate delight in the pursuit of knowledge from his very infancy, and is reported to have worked out lengthy arithmetical sums by means of pebbles and biscuit-crumbs before he knew the figures. His father began to teach him Latin, but left this off on discovering the boy's greater inclination and aptitude for mathematical studies. The young Ampère, however, soon resumed his Latin lessons, to enable him to master the works of Euler and Bernouilli. In later life he was accustomed to say that he knew as much about mathematics when he was eighteen as ever he knew; but his reading embraced nearly the whole round of knowledge,—history, travels, poetry, philosophy, and the natural sciences. At this age he had read the whole of the *Encyclopédie*, and with such interest and attention that he could repeat passages from it fifty years after. When Lyons was taken by the army of the Convention in 1793, the father of Ampère, who, holding the office of *juge de paix*, had stood out resolutely against the previous revolu-

tionary excesses, was at once thrown into prison, and soon after perished on the scaffold. This event produced such an impression on the susceptible mind of Ampère, that he continued for more than a year in a state little removed from idiocy. But Rousseau's letters on botany falling into his hands, the subject engrossed him, and roused him from his apathy. His passion for knowledge returned. From botany he turned to the study of the classic poets, and to the writing of verses himself. About this time (1796) an attachment sprang up, the progress of which he naively recorded in a journal (*Amorum*). In 1799 he was happily married to the object of his attachment. From about 1796 Ampère gave private lessons at Lyons in mathematics, chemistry, and languages; and in 1801 he removed to Bourg, as professor of physics and chemistry, leaving his ailing wife and infant son at Lyons. His wife died in 1804. After two years' absence he returned to Lyons, on his appointment as professor of mathematics at the Lyceum. His small treatise, *Considérations sur la Théorie Mathématique du Jeu* (Lyons, 1802), in which he successfully solved a problem that had occupied Buffon, Pascal, and others, and demonstrated that the chances of play are decidedly against the habitual gambler, attracted considerable attention. It was this work that brought him under the notice of M. Delambre, whose recommendation obtained for him the Lyons appointment, and afterwards (1805) a subordinate position in the Polytechnic School at Paris, where he was elected professor of analysis in 1809. Here he continued to prosecute his scientific researches and his multifarious studies with unabated diligence. He was admitted a member of the Institute in 1814. It is on the service that he rendered to science in establishing the relations between electricity and magnetism, and in developing the science of electro-magnetism, or, as he called it, electrodynamics, that Ampère's fame mainly rests. On the 11th of September 1820 he heard of the discovery of Professor Oersted of Copenhagen, that a magnetic needle may be deflected by a voltaic current. On the 18th of the same month he presented a paper to the Academy, containing a far more complete exposition of the phenomenon, which he had in the interval investigated by experiment, and showing that magnetic defects can be produced, without magnets, by aid of electricity alone. In particular he showed that two wires connecting the opposite poles of a battery attract or repel each other according as the currents pass in the same or in opposite directions. According to the theory of magnetism which Ampère's subsequent investigations led him to adopt, every molecule of magnetic matter is acted on by a closed electric current, and magnetisation takes place in proportion as the direction of these currents approaches parallelism. The whole field thus opened up he explored with characteristic industry and care. He anticipated the invention of the electric telegraph, having suggested in 1821 an apparatus of the kind with a separate wire for each letter. Late in life he prepared a remarkable work on the classification of the sciences, which was published after his death. In addition to this and one or two works of less importance, he wrote a great number of memoirs and papers that appeared in scientific journals. He died at Marseilles in June 1836. The great amiability and child-like simplicity of Ampère's character are well brought out in his *Journal et Correspondence*, published by Madame Chevreux (Paris, 1872).

AMPÈRE, Jean-Jacques-Antoine, the only child of the preceding, was born at Lyons, August 12, 1800. He showed an early preference for literary pursuits, and this was strengthened by his intimate intercourse with the brilliant circle to which his introduction to Madame Récamier's celebrated *réunions* admitted him. He began his literary career as a contributor to the *Globe* and *Revue Française*, which Guizot conducted in opposition to the government of Charles X. After spending some time in travel, he commenced a course of lectures at the Athenæum of Marseilles in 1830, the first of which, *De l'Histoire de la Poésie*, he published. The revolution of July led to his return to Paris, where he lectured at the Sorbonne, till, in 1833, he succeeded Andrieux as professor of the history of French literature in the college of France. His lectures here, which were greatly admired, form the basis of several works, particularly of his *Histoire littéraire de la France avant le 12me Siècle*, 3 vols., Paris, 1839, 1840. Ampère was a constant contributor to various periodical publications. He wrote for the *Revue des Deux Mondes* sprightly accounts of his long journeys in Egypt and North America, as well as in various parts of Europe, which were afterwards collected under the title, *Littérature et Voyages* (2 vols., 1834). His principal work is the *Histoire Romaine à Rome* (4 vols., 1856–64), a series of papers, reprinted in part from the *Revue des Deux Mondes*, showing shrewd sense and great and varied learning, particularly on archæological questions, and written in an attractive though often discursive style. Ampère was officer of the Legion of Honour from 1846, and in 1847 was admitted to the French Academy. He died March 27, 1864.

AMPHIARAUS, in Greek legend, a son of Oïcles and Hypermnestra, descended on the paternal side from the kingly seer Melampus, and, like his ancestor, endowed with the prophetic gift; but at the same time known for his valour in the great enterprises of his time—the expedition of the Argonauts and the hunt of the Calydonian boar. The expedition, however, on which the chief events of his life hinge is that of the Seven against Thebes, into which he was unwillingly driven by the treachery of his wife, Eriphyle (*Odyssey*, xi. 326), a sister of Adrastus, who then ruled in Sicyon, and by whom the enterprise was planned to restore Polynices to the throne of Thebes. As prince of Argos, Amphiaraus was in a position to assist greatly; but when called upon by Adrastus to take a part, he declined, on the ground that the cause was unholy, and would end fatally. His marriage with Eriphyle, however, had not only been meant to heal previous quarrels between him and Adrastus, but was to be a bond of peace for the future in this way, that she should always arbitrate between them. To secure her favour now, Polynices gave her the fatal necklace which Cadmus had once given to Harmonia, and, though warned of the consequences, Eriphyle accepted it and decided against her husband. Knowing that he would never return, Amphiaraus enjoined his son Alcmæon, then a boy, to avenge his death upon his mother; and to his children generally he gave wise counsel. As he stepped into his chariot to depart he turned with a look of anger towards his wife, a scene which was represented on the chest of Cypselus. The assault of Thebes was disastrous to the Seven; and Amphiaraus, pursued by Periclymenus, would have fallen by his spear had not Jupiter, at a critical moment, struck the earth with a thunderbolt, and caused it to open and swallow him with his horses, Thoas and Dias, his chariot, and his charioteer, Baton. Jupiter and Apollo, it is said in the *Odyssey* (xv. 245), loved Amphiaraus dearly; yet he did not reach an old age, but fell at Thebes, through the gift accepted by his wife. After death he continued, as a deified hero, to exercise his prophetic power by giving oracles on the spot where he had sunk into the earth. In earlier times this was believed to have happened at Harma, on the way from Thebes to Potniæ, and it was there that the oracle of Amphiaraus was which Crœsus and Mardonius consulted (*Herodotus*, i. 49, 52; viii. 134). Afterwards this oracle yielded to that in the neighbourhood of Oropus, where was also a sanctuary to Amphiaraus (Jupiter Amphiaraus, as he was styled), with athletic and

musical festivals in his honour, and with a sacred enclosure (*temenos*) in which were two springs. At one of them he was thought to have risen from the lower world, and hence its water was employed for no sacred purpose. Invalids who had been cured by oracular prescriptions threw a piece of money in it. The water of the other spring was excellent to drink and to bathe in (Ἀμφιαράου λουτρά). The oracles were conveyed in dreams, to obtain which it was necessary to fast for a time, then to offer sacrifice at the great altar (Pausanias, i. 34, 2), and again to sacrifice a ram and to sleep on its skin. The ruins of the temple, with inscriptions which identify them as such, exist still at Maurodilissi, in the ancient Oropia. In the derivation of his name from ἀμφι-ἀράομαι, the piety for which Amphiaraus was celebrated is expressed. (A. S. M.)

AMPHIBIA

LINNÆUS originally employed this term to denote a class of the Animal Kingdom comprising crocodiles, lizards and salamanders, snakes and *Cæciliæ*, tortoises and turtles, and frogs; to which, in the later editions of the *Systema Naturæ*, he added some groups of fishes. In the *Tableau Elémentaire*, published in 1795, Cuvier adopts Linnæus's term in its earlier sense, but uses the French word "Reptiles," already brought into use by Brisson, as the equivalent of *Amphibia*. In addition, Cuvier accepts the Linnæan subdivisions of *Amphibia-Reptilia* for the tortoises, lizards (including crocodiles), salamanders, and frogs; and *Amphibia-Serpentes* for the snakes, apodal lizards, and *Cæciliæ*.

In 1799[1] Brongniart pointed out the wide differences which separate the frogs and salamanders (which he terms *Batrachia*) from the other reptiles; and in 1804, Latreille,[2] rightly estimating the value of these differences, though he was not an original worker in the field of vertebrate zoology, proposed to separate Brongniart's *Batrachia* from the class of *Reptilia* proper, as a group of equal value, for which he retained the Linnæan name of *Amphibia*.

Cuvier went no further than Brongniart, and, in the *Règne Animal*, he dropped the term *Amphibia*, and substituted *Reptilia* for it. Meckel,[3] on the other hand, while equally accepting Brongniart's classification, retained the term *Amphibia* in its earlier Linnæan sense; and his example has been generally followed by German writers; as, for instance, by Stannius, in that remarkable monument of accurate and extensive research, the *Handbuch der Zootomie* (Zweite Auflage, 1856).

In 1816, De Blainville,[4] adopting Latreille's view, divided the Linnæan *Amphibia* into *Squamifères* and *Nudipellifères*, or *Amphibiens*; though he offered an alternative arrangement, in which the class *Reptiles* is preserved and divided into two sub-classes, the *Ornithoides* and the *Ichthyoides*. The latter are Brongniart's *Batrachia*, *plus* the *Cæciliæ*, whose true affinities had, in the meanwhile, been shown by Duméril; and, in this arrangement, the name *Amphibiens* is restricted to *Proteus* and *Siren*.

Merrem's *Pholidota* and *Batrachia* (1820), Leuckart's *Monopnoa* and *Dipnoa* (1821), Müller's *Squamata* and *Nuda* (1832), are merely new names for De Blainville's *Ornithoides* and *Ichthyoides*, though Müller gave far better anatomical characters of the two groups than had previously been put forward. Moreover, following the indications already given by Von Bär in 1828,[5] Müller calls the attention of naturalists to the important fact, that while all the *Squamata* possess an amnion and an allantois, these structures are absent in the embryos of all the *Nuda*. Müller makes an appeal for observations on the development of the *Cæciliæ*, and of those *Amphibia* which retain gills or gill-clefts throughout life, which has unfortunately yielded no fruits from that time to this.

In 1825, Latreille published a new classification of the *Vertebrata*,[6] which are primarily divided into *Hæmatherma*, containing the three classes of *Mammifera*, *Monotremata*, and *Aves*; and *Hæmacryma*, also containing three classes —*Reptilia*, *Amphibia*, and *Pisces*. This division of the *Vertebrata* into hot and cold blooded is a curiously retrograde step, only intelligible when we reflect that the excellent entomologist had no real comprehension of vertebrate morphology; but he makes some atonement for the blunder by steadily upholding the class distinctness of the *Amphibia*. In this he was followed by Dr J. E. Gray; but Duméril and Bibron in their great work,[7] and Dr Günther in his *Catalogue*, in substance, adopt Brongniart's arrangement, the *Batrachia* being simply one of the four orders of the class *Reptilia*. Professor Huxley has adopted Latreille's view of the distinctness of the *Amphibia*, as a class of the *Vertebrata*, co-ordinate with the *Mammalia*, *Aves*, *Reptilia*, and *Pisces*; and the same arrangement is accepted by Gegenbaur and Haeckel. In the Hunterian lectures delivered at the Royal College of Surgeons in 1863, Professor Huxley divided the *Vertebrata* into Mammals, Sauroids, and Ichthyoids, the latter division containing the *Amphibia* and *Pisces*. Subsequently he proposed the names of *Sauropsida* and *Ichthyopsida* for the Sauroids and Ichthyoids respectively. It is proper to mention, finally, that Professor Owen, in his work on *The Anatomy of Vertebrates*, follows Latreille in dividing the *Vertebrata* into *Hæmatotherma* and *Hæmatocrya*, and adopts Leuckart's term of *Dipnoa* for the *Amphibia*.

The *Amphibia* are distinguished from the *Sauropsida* and *Mammalia* by very important and sharply-defined characters. The visceral arches of the embryo develop gills, which temporarily, or permanently, perform the respiratory function. There is no trace of an amnion, and it is still a question whether the urinary bladder, which all *Amphibia* possess, answers to the allantois of the higher *Vertebrata* or not. At any rate, it plays no part in the respiration of the embryo, nor is it an organ by which nutriment is obtained from the parent. There are two occipital condyles, and the basi-occipital region of the skull is either very incompletely, or not at all, ossified. There is no basisphenoidal ossification. When young, the *Amphibia* are provided with, at fewest, three, and usually four, cartilaginous, or more or less ossified, branchial arches. From *Pisces*, on the other hand, they are distinguishable only by the characters of their locomotive apparatus. When they possess median fins and limbs, these never present finrays; and the limbs exhibit, in full development, the type of structure which obtains among the *Sauropsida* and *Mammalia*, and differ very widely from the fins of any fish at present known. This difference obtains even among

[1] Brongniart's "Essai d'une Classification Naturelle des Reptiles" was not published in full till 1803. It appears in the volume of the *Mémoires presentés à l'Institut par divers Savans* for 1805.

[2] *Nouveau Dictionnaire d'Histoire Naturelle*, xxiv., cited in Latreille's *Familles Naturelles du Règne Animal*.

[3] *System der Vergleichenden Anatomie*, 1821.

[4] "Prodrome d'une Nouvelle Distribution du Règne Animal," *Bulletin des Sciences par la Société Philomatique de Paris*, 1816, p. 113.

[5] *Entwickelungs-Geschichte der Thiere*, p. 262.

[6] *Familles Naturelles du Règne Animal*.

[7] *Erpétologie Générale, ou Histoire Naturelle complète des Reptiles*, 1836.

the long extinct *Amphibia* of the Carboniferous epoch. In other respects, the lower *Amphibia* approach the *Chimæræ*, the *Ganoidei*, and the *Dipnoi* very closely; while, in their development, they present curious approximations to the *Marsipobranchii*.

With respect to the primary subdivisions, or orders, of the class *Amphibia*, no one can doubt the propriety of the separation of the recent forms into what may be broadly termed Newts (*Urodela*); Frogs and Toads (*Anura*); and *Cœciliæ* (*Peromela*) effected by Duméril; while all that is known of the organisation of the extinct *Amphibia* of the newer Palæozoic, and older Mesozoic, formations tends to show that they form a fourth natural assemblage of equal value to each of the others.

The names of *Urodela* and *Anura*, given to the first two of these livisions, are undoubtedly open to criticism; but if well-understood terms, which have acquired a definite scientific connotation, are to be changed whenever advancing knowledge renders them etymologically inappropriate, the nomenclature of taxonomy will before long become hopelessly burdened; and, to set a good example, the names of *Urodela*, *Anura*, *Peromela*, and *Labyrinthodonta* are adopted here for the four orders of the *Amphibia*, even although it be true that the *Labyrinthodonta* do not all possess the dental structure on which the name was founded; though there is reason to believe that some Labyrinthodonts were devoid of limbs, or peromelous; that the *Anura* are not more tail-less than are the *Peromela*; and that the tails of the *Urodela* are not more conspicuous than were those of the Labyrinthodonts.

Urodela. The URODELA are *Amphibia* with elongated bodies and relatively short limbs, devoid of scales or pectoral plates, with numerous præ-caudal vertebræ, and with amphicœlous, or opisthocœlous, vertebral centra. The hyoidean arch remains connected with the suspensorium throughout life, and its cornua are large in proportion to its body. The mandible is dentigerous. There are one or two pairs of limbs, the pectoral arch and limbs being always present. The manus never possesses more than four digits. The bones of the antebrachium and of the crus remain distinct, and the tarsus is not elongated. So far as the spermatozoa are known, they are elongated filaments with a vibratile fringe. The larva develops external gills only; and, except *Siren*, none are known to possess, at any time, a horny masticatory apparatus.[1]

Anura. The ANURA have relatively short and broad bodies, and both pairs of limbs are constantly present, the hinder being the longer and stronger. There are no scales, nor pectoral plates, but ossification sometimes occurs in the dorsal integument. The vertebræ vary in character, but are usually procœlous. The præ-sacral vertebræ never exceed nine in number, and the caudal portion of the vertebral column is represented by a peculiar styliform coccyx. The hyoidean arch detaches itself from the suspensorium, and almost always becomes connected with the pro-otic region of the skull. The cornua are usually slender, as compared with the broad body of the hyoid. The mandible is almost always devoid of teeth. The bones of the antebrachium and of the crus early ankylose, and the astragalus and calcaneum are much elongated. The manus has a rudimentary fifth digit. Except in *Bombinator*, the spermatozoa have flagelliform appendages, like those of ordinary *Vertebrata*. The larvæ develop first external, and afterwards internal, gills, and, so far as is known at present, are provided with deciduous horny masticatory plates. The gill apertures are closed by the growing over them of an opercular membrane.

Peromela. The PEROMELA have snake-like bodies, totally devoid of limbs and limb arches. In most, the integument is provided with transverse rows of imbedded cycloid scales, but there are no pectoral plates. The vertebræ of the trunk are very numerous, and are amphicœlous; those of the caudal region are very few, and are free. The hyoidean arch is attached neither to the suspensorium, nor to the skull; its cornua are very slender, and no distinct body is developed; it is followed by several slender, hoop-like, branchial arches. The mandible is dentigerous. Nothing is known of the early stages of development; but Müller discovered branchial clefts, with rudimentary branchial filaments, in young *Cœciliæ*.

Labyrinthodonta. The LABYRINTHODONTA for the most part resembled the *Urodela* in the proportions of the tail and limbs to the body, but some (as *Ophiderpeton*) were serpentiform, and apparently apodal; no raniform Labyrinthodonts have yet been discovered. The vertebræ are amphicœlous. The mandible is dentigerous. The bones of the antebrachium and crus remain distinct, and the tarsus is not elongated. The manus and pes appear to have been pentadactyle. Three sculptured pectoral plates and a peculiar dermal armour of small scales, confined to the ventral face of the body, are present in many genera. Nothing is known of the early stages of development, but the young *Archegosauria* appear to have possessed ossified branchial arches.

In giving a sketch of the organisation of the *Amphibia*, it will be necessary to enter much more fully into the characters of the SKELETON than into those of the other systems of organs.

The *Vertebral Column*, *Ribs*, and *Sternum*.—Leaving the extinct *Archegosauria* aside for the present, all the *Amphibia* possess well-ossified vertebræ, the arches of which, in the adult condition (except, perhaps, in some Labyrinthodonts), are not separated by a neuro-central suture from the centra. The latter may be amphicœlous, as in the lower *Urodela*, the *Peromela*, and the *Labyrinthodonta*; or opisthocœlous, as in the higher *Urodela* and some *Anura* (*e.g.*, *Pipa* and *Bombinator*); or procœlous, as in the majority of the *Anura* (with the exception of the eighth vertebra, which is usually amphicœlous; and of the ninth, which commonly has one convexity in front and two behind). In all the recent forms which have been examined, the centra and intervertebral masses contain more or less distinct remains of the notochord. The arches of the trunk vertebræ are connected by zygapophyses; the spinous processes are usually low, but attain a great relative length in the caudal region of some of the Labyrinthodonts (*e.g.* *Urocordylus*). Transverse processes are present in all the trunk vertebræ, except the atlas; they are shortest in the *Peromela*, longest in the *Anura*. In most *Urodela*, these transverse processes, at any rate in the anterior trunk vertebræ, are divided into two portions, a dorsal and a ventral, which diverge towards their free ends; or, more strictly speaking, these processes are made up of two subequal transverse processes, a dorsal "tubercular" process, and a ventral "capitular" process. Sometimes this division prevails throughout the whole length of the trunk, but, more commonly, the two transverse processes become fused into one, posteriorly.

In the long-bodied *Urodela* (*Siren*, *Proteus*, *Amphiuma*), only a small number of the vertebræ which succeed the atlas present traces of double transverse processes; further back, the coalesced transverse processes form trihedral projections, their dorsal and ventral contours converging instead of diverging, and giving a very characteristic aspect to these vertebræ.

[1] This circumstance appears to have been remarked only by Müller. Speaking of the larvæ of the Salamanders, he says—" Sie haben nicht den Hornschnabel der Froschlarven."—(*Beitrag zur Anat. der Amphibien*, p. 209.) Duméril and Bibron affirm the contrary (*op. cit.*, t. ix. p. 16).

In some Labyrinthodonts, the capitular and tubercular processess, divergent and subequal in some (probably the anterior) vertebræ, coalesce into one in other vertebræ; and the capitular division being shorter than the tubercular, transverse processes, like those of the middle thoracic region of the crocodiles, are thus produced.

In the *Peromela*, there is a short capitular process, but the tubercular process is represented by a mere facet placed below the prezygapophysis.

In the *Anura*, finally, the vertebræ have only a single transverse process (possibly representing the coalesced double transverse processes of the posterior trunk vertebræ of such *Urodela* as *Menopoma*), which, in some of the vertebræ, may attain a great length.

Ribs are present in a few *Anura*, in all *Urodela*, *Peromela*, and *Labyrinthodonta*; and, in the last-named and some *Urodela*, they attain as great relative dimensions as in other *Vertebrata*. But they are always vertebral ribs, no Amphibian being known to possess more than rudiments of sternal ribs. The atlas is never provided with ribs. In the *Peromela*, ribs are borne by all the other vertebræ, except the very hindmost. In the long-bodied *Urodela*, on the other hand, they are restricted to a few of the anterior vertebræ. In the other *Urodela* they are usually confined to the præ-sacral and sacral vertebræ; but, in some cases, one or two of the anterior caudal vertebræ have free ribs. The form of the proximal end of the rib corresponds with that of the transverse processes or process. Where this is double, the rib presents a fork, formed by the capitulum and tuberculum; and when the capitular and tubercular transverse processes are of equal length, the capitula and tubercula of the ribs are equal; but when either of the former is shorter than the other, the corresponding part of the rib is longer. The *Peromela* have no sternum, and that of the *Labyrinthodonta* (if they possessed any) is unknown. In the *Urodela*, the sternum never ossifies, and there is no trace of even a cartilaginous sternum in *Proteus*. In *Menobranchus*, there is a very small cartilaginous sternal plate, which sends lateral prolongations into two of the intermuscular ligaments, representing rudimentary sternal ribs.

In the Newts[1] the sternum becomes a broad and stout plate of cartilage, with a median, posterior, cristate, xiphoid process, and with articular surfaces on its antero-lateral margins for the reception of the coracoids. The sternum attains its highest development in the raniform *Anura*, the xiphoid process becoming elongated and dilated at its extremity, and more or less converted into bone, while calcification of the body of the sternum itself may also occur.

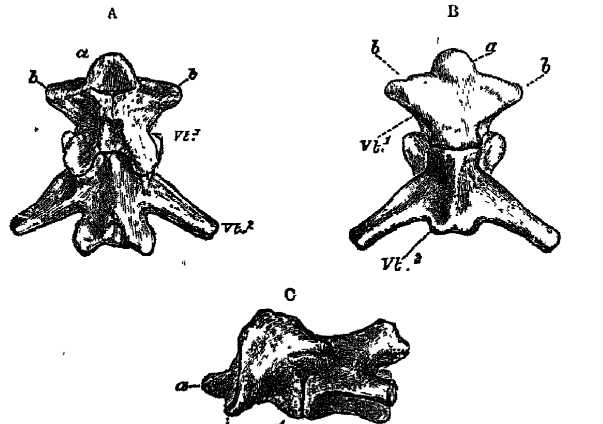


FIG. 1.—The first two vertebræ of *Menopoma* ($\times \frac{3}{2}$). *Vt*[1], atlas; *Vt*[2], second vertebra; *a*, intercondyloid process of the atlas; *b*, the articular surfaces for the occipital condyles. The ribs of the second vertebra are not represented. A, dorsal; B, ventral; C, lateral view.

[1] See Parker *On the Shoulder Girdle*, pp. 63, 68.

In the *Urodela*, the first vertebra always presents two slightly concave articular facets, the faces of which look outwards and forwards to adapt themselves to the occipital condyles. Between these facets, the dorsal moiety of the anterior face of the centrum gives rise to a process, which is little more than a ridge in *Proteus*, but in other genera becomes very prominent, and has a curious resemblance to the odontoid process of the axis vertebra of a bird. This "intercondyloid" process of the atlas sometimes (*Amphiuma*, *e.g.*) exhibits on each side, near its termination, an articular facet, which plays on a corresponding facet of the adjacent face of the occipital condyle.

Mayer (*Analecten*, p. 10) was misled by the form of this process into the supposition that the vertebra to which it belongs is not the atlas, but the odontoid, vertebra. But there is a similar process of the first vertebra in the Rays, and the relations of the vertebra to the nerves show that it is certainly not the homologue of the axis vertebra of other Vertebrates. The first spinal nerve, which has the distribution of the hypo-glossal of the higher *Vertebrata*, passes out of the spinal canal, either between the first and second vertebræ, or through a foramen in the arch of the first, in the *Amphibia*, which have no proper suboccipital nerve. This is a very curious circumstance, and requires elucidation by the study of development.

In the *Anura*, the atlas has the same general form, but the median process is either inconspicuous, as in *Rana esculenta*, or may be absent.

Among the *Labyrinthodonta*, the atlas of *Mastodonsaurus* only is known. It presents two concave facets anteriorly, separated for about half their length by a notch, which probably lodged a ligament.

The atlas of the *Peromela* has the two characteristic facets for the occipital condyles, but the intercondyloid process is absent, and the anterior margin of the arch of the vertebra projects forwards towards the corresponding margin of the occipital foramen (*Epicrium*).

In those *Urodela* which possess posterior limbs (except *Proteus* and *Amphiuma*), one vertebra, or sometimes two (*Menopoma*), are distinguished from the rest as "sacral" by having stouter ribs, the outer ends of which abut against, and are united by ligaments with, the ilia.

The *Anura* always possess a sacral vertebra (sometimes ankylosed with its predecessor or successor), the transverse processes of which are often enlarged, and sometimes greatly expanded, at their iliac ends. The characters of the sacrum of the *Labyrinthodonta* are not known.

In the *Urodela*, the anterior caudal vertebræ, except the first, have inferior arches, which, like the neural arches, are continuously ossified with the centra; and the same condition obtained in the caudal vertebræ of the Labyrinthodonts.

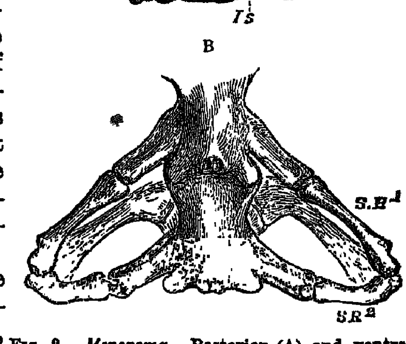


FIG. 2.—*Menopoma*. Posterior (A) and ventral (B) views of the sacral vertebræ (*S.V.*); *S.R*[1], *S.R*[2], sacral ribs; *Il.* Ilium; *Is.* Ischium.

In the *Anura*, the caudal vertebræ are replaced by a long coccyx, consisting of an osseous style, to the dorsal aspect of the anterior end of which two neural arches are

ankylosed. The anterior face of the style usually presents two concavities (one in *Bombinator* and some other genera), which articulate with the corresponding convexities on the posterior face of the centrum of the sacral vertebra. The number of the vertebræ in the spinal column of the *Urodela* and *Peromela* varies very much. In the long-bodied *Urodela* and *Peromela* they may be very numerous.

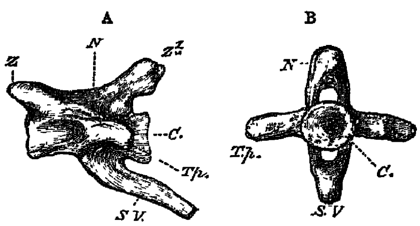


FIG. 3.—A caudal vertebra of *Menopoma*. *N*, neural arch; *C*, centrum; *Z*, *Z*[1], præ- and post-zygapophyses; *T.p.* transverse process; *S.V.* sub-vertebral arch. A, lateral; B, posterior view.

According to Cuvier, *Cæcilia* has 230; *Siren*, 99; *Amphiuma*, 75; in *Menobranchus* there are 18 præ-sacral and 25 caudal; in *Salamandra*, 15 and 26; and a similar variation appears to have obtained in the Labyrinthodonts. On the other hand, in the *Anura* the number of vertebræ (excluding the coccyx) is very constantly nine; though this number undergoes an apparent reduction, in some cases, by the ankylosis of the first and second vertebræ (*Ceratophrys dorsata, Pipa, Dactylethra, Breviceps*), and in others by that of the sacral vertebra with the coccyx (*Pipa, Dactylethra, Breviceps, Pelobates*).

In the carboniferous Labyrinthodont, *Archegosaurus*, the notochord appears to have persisted throughout life, and the ossification of the centra of the vertebræ to have gone no further than the development of bony rings, such as those with which the ossification of the centra of the vertebræ of a tadpole commences.

The Cranium.—The skull is always very depressed, and is usually broad in proportion to its length, though, in this respect, there is considerable variation, the skulls of *Proteus, Menobranchus*, and *Amphiuma* being narrow, when compared with those of *Siredon, Menopoma*, and the *Anura*. The occipital foramen is situated in the middle of the posterior face of the cranium, and there are always two occipital condyles. The long axis of the suspensorium, or pedicle by which the mandible is connected with the side-walls of the brain-case, varies much in its direction—passing obliquely downwards and forwards in the lower *Amphibia* and in the larval condition of all, but swinging back until it stands out at right angles to the axis of the skull, or becomes directed downwards and backwards, in the higher *Amphibia*. The suspensorium is almost immovable upon the skull, being clamped thereto by the squamosal bone, besides being, as a general rule, united with some part of the wall of the skull by synchondrosis. The "primordial skull," or chondro-cranium, usually remains, to a great extent, unossified, even in the adult. In the *Urodela*, the hyoidean arch is always connected by strong ligaments with the suspensorium; but, in the *Anura* and in the *Peromela*, it becomes completely detached from the suspensorium, and may be free (*Peromela*), or acquire a new attachment to the periotic region of the skull in front of the *fenestra ovalis* (*Anura*).

The bones which are always present in the Amphibian skull are the exoccipital, pro-otic, parasphenoid, vomer, parietal, frontal, squamosal, premaxillary, palatine, quadrate, dentary, splenial, and angular. The basi-occipital and the basisphenoid are always absent, or are represented by mere partial calcifications of the chondrocranium. There is always a *fenestra ovalis* closed by a stapes. The branchial arches do not exceed four pairs in number, and, in the perennibranchiate Amphibia, there are never fewer than three pairs.

The skull of the Frog (Figs. 4–7), as the most accessible member of the group, and that, the development of which has been most carefully studied, may be taken as the starting-point from whence to follow the various modifications of the Amphibian skull. At the sides of the occipital foramen, it presents two large exoccipital ossifications (*E. O.*), which bear the prominent occipital condyles, and, in old specimens, may meet in the middle ventral line. Dorsally, however, they remain separated by a narrow tract of cartilage, which may become more or less calcified. External to the condyles, are the foramina, by which the vagus and glosso-pharyngeal nerves emerge from the cranial cavity; and, beyond these, the bones expand outwards and forwards, so as to embrace the posterior half of the *fenestra ovalis*, while above, they enclose the greater part of the posterior vertical semicircular canal. The cartilage which incloses the summit of the arch of that canal, however, appears always to remain unossified, and its place is occupied by a groove in the dry skull (Fig. 4, *Ep.*) These ossifications, therefore, answer primarily to the exoccipitals, but, in addition, represent the opisthotic and epiotic elements. Above the *fenestra ovalis*, the wall of the otic capsule is produced outwards into a stout shelf, which forms the roof of the tympanic cavity, and corresponds with the *tegmen tym-*

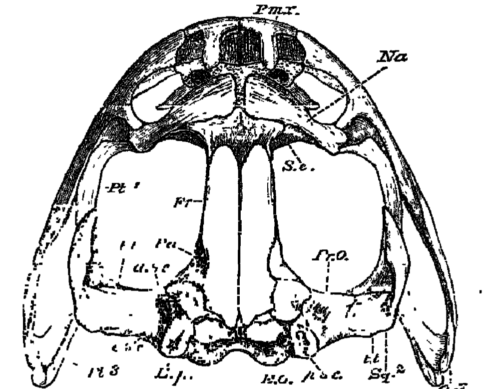


Fig. 4.

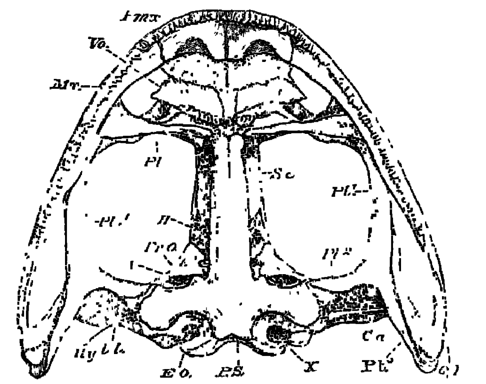


Fig. 5.

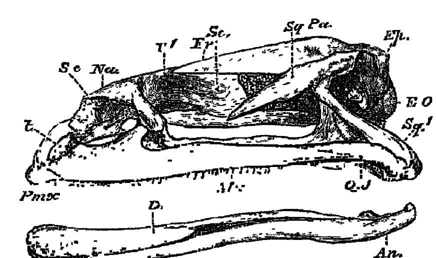


Fig. 6.

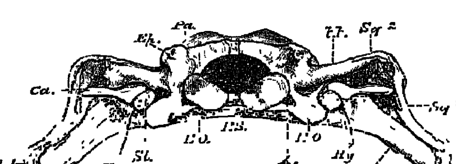


Fig. 7.

FIGS. 4, 5, 6, 7.—Dorsal, ventral, lateral, and posterior views of the skull of *Rana esculenta*. The letters have the same signification throughout. *Pmx.* premaxilla; *Mx.* maxilla; *Vo.* vomer; *Na.* nasal; *S.e.* sphen-ethmoid; *Fr.* frontal; *Pa.* parietal; *E.o.* exoccipital; *Ep.* epiotic process; *Pr.O* pro-otic; *t.t.* tegmen tympani; *Sq.* squamosal; *Q.J.* quadrato-jugal; *Pt.*[1] pterygoid, anterior process; *Pt.*[2] internal process; *Pt.*[3] posterior or external process; *C.a.* columella auris; *St.* stapes; *Hy.* hyoidean cornu; *P.S.* parasphenoid; *An* angulare; *D.* dentale. V. foramen of exit of the trigeminal; II. of the optic; X. of the pneumogastric and glosso-pharyngeal nerves; V.[1] foramen by which the orbito-nasal or first division of the fifth passes to the nasal cavity

pani in man (*t.t.*) This is largely ossified in continuity with the exoccipital[1] posteriorly, and the pro-otic (to which in all probability it properly belongs) in front. The outer extremity of the tegmen, however, remains cartilaginous, and, in front, it passes into a curved band of cartilage, which, as it is continued backwards into the suspensorium, may be termed the "dorsal crus" of the suspensorium (Fig. 9, *c.d.*) The T-shaped squamosal bone (*Sq.*) sends a broad, flat process inwards, which rests upon the *tegmen tympani*, while its long descending process lies external to the cartilaginous suspensorium, and the posterior half of its cross-piece, or proper squamoso-zygomatic part, has the same relation to the dorsal crus of the suspensorium. The suspensorium has a second attachment to the skull, by a "ventral crus" (Fig. 9, *c.v.*), which diverges from the dorsal crus at the anterior extremity of the suspensorium, and is continued into two branches. One of these, passing outwards and forwards, becomes the pterygoid cartilage. The other (Fig. 9, *pd.*), directed backwards and inwards, may be termed the "pedicle of the suspensorium;" it becomes thickened at its inner extremity, and articulates with a facet in front of the *fenestra ovalis*, and close to the attachment of the hyoidean cornu. A thin fibrous band extends from this inferior crus to the side walls of the skull, passing between the first division of the fifth nerve in front, and the second and third divisions behind. The space between the dorsal crus of the suspensorium and the pedicle is filled, in the fresh state, with fibrous tissue, which constitutes the anterior boundary of the tympanum. It is traversed (as Dugès long since pointed out) by the posterior division of the seventh nerve, which therefore lies above the pedicle. The pro-otic ossification (*Pr. O.*) not only walls in the anterior part of the otic capsule, but extends for a short distance forwards in the side walls of the skull. Hence, the foramen of exit for the trigeminal and *portio dura* (V.) is pierced in this portion of the pro-otic; and the foramen for the sixth nerve is seen at its lower margin. In front of the pro-otic, the lateral walls of the skull remain cartilaginous for some distance, and are perforated by the large optic foramen (II.) Anteriorly to the exit of the optic nerves, the side walls of the skull are formed by elongated plates of bone, which are parts of an extensive ossification of the anterior moiety of the brain-case and the posterior part of the nasal capsules, constituting the complex structure termed by Cuvier "os en ceinture," and by Dugès "ethmoide." As it takes the place of the ethmoid, presphenoid, and orbitosphenoids, it may be termed the *sphen-ethmoid* (*S.e.*) It may be compared to a dice-box, one-half of which is divided by a longitudinal partition. This half is anterior, the longitudinal partition being represented by the ossified mesethmoid; while the posterior, undivided, half lodges the anterior portion of the cerebral hemispheres and the olfactory lobes. The front wall of this posterior cavity is perforated by the olfactory foramina; while the outer and posterior wall of each anterior, or nasal, chamber presents, where it forms the anterior and inner boundary of the orbit, a small aperture (V^1) through which the orbito-nasal nerve passes. The exoccipitals, pro-otics, and sphen-ethmoid are ossifications which involve the chondrocranium, though they largely consist of secondary bone. The supraoccipital is represented, if at all, by a mere calcification of the cartilage, and the like is true of the quadrate, which is an ossification of the distal end of the suspensorium. The quadrate, however, very early becomes continuous with a slender style of membrane bone, the proper jugal, which applies itself to the inner face of the posterior end of the maxilla, and thus gives rise to the quadrato-jugal (*Q.J.*) Ligamentous fibres also connect the anterior end of the zygomatic process of the squamosal directly with the pterygoid, and indirectly with the maxilla and jugal, and pass from the same process to the fronto-parietal bone, forming a fascia over the levators of the mandible, and encircling the orbit. A strong band is continued forwards, over the ascending process of the maxilla, to the alinasal cartilage of the chondrocranium.

The short premaxillæ (*Pmx.*) are united suturally in the middle line, and have stout ascending processes, which become closely connected with the "rhinal processes" by means of oval nodules of cartilage adherent to their posterior surfaces. The long maxillæ unite with the premaxillæ in front, and with the jugals behind: each sends up a short anterior ascending process towards the alinasal cartilage, with which it is united by ligament,[2] and further back, gives off a longer ascending process which becomes connected with the nasal bones. The palatine bones (*Pl.*) are straight, slender, and flattened. They lie transversely to the axis of the skull, behind the posterior nares, closely applied to the ventral surface of the sphen-ethmoid and of the antorbital processes of the chondrocranium. Externally they come into contact with the pterygoids and maxillæ; internally and anteriorly with the vomers. Each pterygoid (*Pt.*) is a triradiate bone, with an anterior, an inner, and a posterior, or outer, ray. The first, or anterior, process of the pterygoid (Pt^1) is the longest, and lies, for a considerable distance, in contact with the maxilla, reaching forward to the outer extremity of the palatine. The second (Pt^2) underlies the pedicle of the suspensorium, and comes into contact with the end of the transversely elongated, sub-auditory, portion of the parasphenoid. The third, or posterior, process of the pterygoid (Pt^3) is prolonged, in correspondence with the backward elongation of the suspensorium, along the inner side of which it lies, as far as the articulation of the mandible.

The vomers (*Vo.*) are broad triangular plates of bone, with irregularly-notched outer edges, which are closely applied to the ventral surface of the sphen-ethmoid. Their inner edges are separated by a narrow interval, and each bears numerous teeth, set along a line which is not quite transverse to the axis of the skull. On the dorsal aspect of the skull two elongated flattened bones, united in a median suture, represent the coalesced frontal and parietals (*Fr.*, *Pa.*), which are separate in the young frog. In front of these, also meeting in the middle line, are two triangular bones, the apices of which extend outwards to the ascending processes of the maxillæ, and which roof over the nasal capsules (*Na.*) These correspond in position and relations with the nasal and so-called "prefrontal" bones of *Sauropsida*, and perhaps with the lachrymals: for brevity's sake, they may be termed nasals.

The parasphenoid has the form of a dagger with a very wide guard and short handle. The latter lies beneath the ventral junction of the exoccipitals, while the blade extends forwards, and its point underlies the posterior moiety of the sphen-ethmoid, but does not reach the vomers. The "guard" passes outwards on each side beneath the auditory capsules, and ends by an abruptly-truncated extremity, its anterior and external angle coming into relation with the inner process of the pterygoid.

The slender, permanently cartilaginous, hyoidean cornu (*Hy.*) passes into the cartilage of the auditory capsule on the ventral side, between the *fenestra ovalis* and the articular surface for the inferior crus of the suspensorium. The *fenestra ovalis* lies in a cartilaginous interspace between the exoccipital and the pro-otic, and is filled by the oval

[1] Dugès (p. 37) states that the pro-otic and the exoccipital always remain distinct in *Rana esculenta;* but it is common to find them extensively ankylosed and inseparable in old frogs of this species.

[2] The small ossifications in this region, termed "cornets" by Dugès, were absent in the skull figured.

cartilaginous stapes (*St.*) The anterior face of this presents a concave facet, for articulation with a corresponding surface occupying the posterior half of the inner end of the *columella auris* (*C. a.*), the anterior half of which fits into a fossa in the pro-otic bone. The *columella auris* itself consists of three portions—a middle elongated osseous rod, an inner swollen and enlarged cartilaginous part, which articulates partly with the pro-otic and partly with the stapes, and an outer portion, which is elongated at right angles to the rest, fixed into the tympanic membrane, and attached by its dorsal end to the *tegmen tympani*.

The mandible presents one cartilaginous and three osseous constituents on each side. Of the latter, one, the "Mento-Meckelian" (Parker), is a short curved rod of bone, which unites with its fellow in the symphysis, and is, in fact, the ossified symphysial end of Meckel's cartilage, which extends thence through the length of the ramus, becoming thicker posteriorly, and furnishing the articular surface for the quadrate. The second, and largest, bony constituent of the mandible is a long membrane bone, which ensheaths the inner and under region of the outer surface of Meckel's cartilage, rising at one part into a low coronoid process. It obviously represents the angular, coronary, and splenial elements, and may be termed the *angulo-splenial* (*An.*) A small dentary element, which bears no teeth, lies over the outer face of the anterior half of Meckel's cartilage.

The hyoidean apparatus of the adult frog (Fig. 8) presents a body and two slender cornua. The body consists of a broad and thin squarish plate of cartilage, produced on each side into three processes, which may be called anterior, lateral, and posterior. The anterior process (*a*) is slender, curves outwards, and very soon divides into two processes, one short, anterior, forming a loop by its ligamentary connection with the second, or posterior, branch, which passes into the long and slender cornu of the hyoid. The lateral process (*b*) passes outwards and slightly dorsad—expanding into a broad, hatchet-shaped free extremity. The posterior process (*c*) is a mere prolongation of the postero-lateral angles of the body of the hyoid. Finally, from the middle of the posterior margin of the body of the hyoid there project two strong bony rods, wider at the ends than in the middle, which embrace the larynx, and have been termed the *thyro-hyals* (*d*).

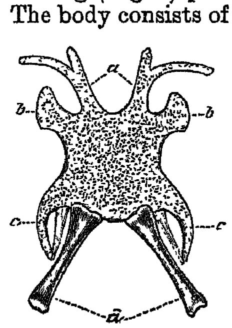


FIG. 8.—Ventral view of the hyoid of *Rana esculenta*. *a*, anterior, *b* lateral, *c*, posterior processes; *d*, thyro-hyals.

The parieto-frontals, nasals, premaxillæ, maxillæ, squamosals, palatines, pterygoids, and parasphenoid, the dentary and angulo-opercular bones, may be removed from the frog's skull without injury to the chondrocranium, the structure of which then becomes apparent (Fig. 9).

It furnishes a floor, side walls, and roof to the brain case, interrupted only by a large space (fontanelle), covered in by membrane, which lies in the interorbital region under the parieto-frontals; and by the foramina for the exit of the cranial nerves. It consists entirely of cartilage, except where the exoccipitals, the pro-otics, and the sphen-ethmoid invade its substance. In front of the septum of the anterior cavity of the sphen-ethmoid, it is continued forward, between the two nasal sacs, as the cartilaginous septum narium, from which are given off, dorsally and ventrally, transverse alæ of cartilage, which furnish a roof and a floor, respectively, to the nasal chamber. Of these, the floor is the wider. The dorsal and ventral alæ pass into one another where the chondrocranium ends anteriorly, and give rise to a truncated terminal face, which is wide from side to side, narrow from above downwards, and convex in the latter direction. The lateral angles of this truncated face are produced outwards and forwards into two flattened præ-nasal processes (*p. nl.*); these widen externally, and end by free edges, which support the adjacent portions of the premaxillæ and maxillæ. From the ventral face, just behind the truncated anterior end of the chondrocranium, spring two slender cartilages (*r.p.*, *r.p.*), which do not seem to have been noticed hitherto. Each of these inclines towards the middle line, and ends against the middle of the posterior face of the ascending process of the premaxilla by a vertically elongated extremity. These may be termed the *rhinal* processes. An oval nodule of cartilage is attached to the posterior face of the dorsal end of the ascending process of the premaxilla, and serves to connect it with the rhinal process. On the dorsal face of the chondrocranium, just above the point of attachment of the rhinal processes, the external nasal apertures are situated, and the outer and posterior margins of each of these apertures is surrounded and supported by a curious curved process of the cartilaginous ala—the alinasal process (*a.n.*) Where the sphenoidal and the ethmoidal portions of the sphen-ethmoid meet, a stout, transverse, partly osseous and partly cartilaginous, bar (*A.O.*) is given off, which is perforated, at its origin, by the canal for the orbito-nasal nerve. It then narrows, but becoming flattened from above downwards, rapidly widens again, and its axe-head-like extremity abuts against the inner face of the maxilla. The anterior angle of the axe-head is free; the posterior angle is continued back into a slender cartilaginous rod, which bifurcates posteriorly; the outer division passes into the ventral crus (*c.v.*) of the suspensorium. The inner (*pd.*) is the pedicle of the suspensorium already described.

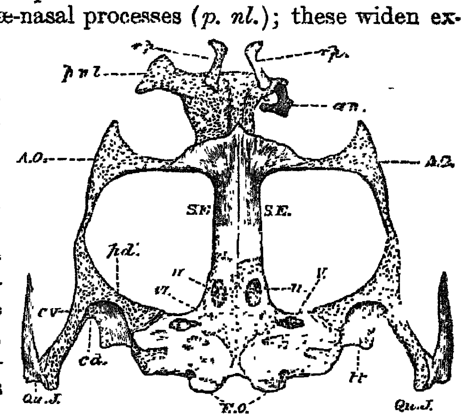


FIG. 9.—Chondrocranium of *Rana esculenta*—ventral aspect. *r.p.* the rhinal process; *p.n.l.* the prænasal processes; *a.n.* the alinasal processes, shown by the removal of part of the floor of the left nasal chamber; *A.O.* the antorbital process; *pd.* the pedicle of the suspensorium continued into *c.v.* the ventral crus of the suspensorium; *e.d.* its dorsal crus; *t.t.* the tegmen tympani; *S.E.* the sphen-ethmoid; *E.O.* the exoccipitals; *Qu.J.* the quadratojugal. II. V. VI. foramina by which the optic, trigeminal and portio dura, and abducens nerves leave the skull.

Meckel's cartilage, articulated to the free end of the suspensorium, is unossified throughout the greater part of its extent, no osseous *articulare* being developed; but, at its symphysial end, each cartilage becomes ossified, and forms the "mento-Meckelian" element of the mandible.

The slender cornu of the hyoid passes directly into the periotic cartilage immediately in front of, though below, the fenestra ovalis. It is unossified throughout its whole length.[1]

With many variations in detail, the skulls of the *Anura* in general are readily reducible to the type of that of the frog. In the *Aglossa*, which differ so widely in many respects from the other *Anura*, the cranium presents some notable peculiarities.

In *Dactylethra*[2] the skull is similar to that of the ordinary *Anura* in general form, but the nasal region is small in proportion to the orbito-temporal space. The fronto-parietals are ankylosed together, and extend forwards as far as a line drawn along the anterior edge of the antorbital

[1] Compare Mr Parker's full account of the structure of the skull of *Rana temporaria*, *Philosophical Transactions*, 1871.

[2] This description applies especially to *D. lævis*.

processes. Here they overlap a very singular bone, consisting of two broad alæ, which lie between the anterior edge of the frontal and the external nares, and of a median portion which is continued forwards, as a narrow, flat, curved process, between the nasal chambers, being received into a sort of groove of the chondrocranium. The bone is readily raised up from the subjacent chondrocranium, of which it appears to be quite independent. At the outer end of each of its alæ, and between the antorbital process and the nasal capsule, is a small, transversely elongated, slender bone, loosely connected by fibrous tissue with the foregoing. The ethmoid is completely cartilaginous. The parasphenoid has the ordinary sword shape, except that the "guard" is extremely short; but its point extends along the base of the skull, passing between the nasal sacs, underlying their septum, and terminating close to the premaxillæ. The vomers are represented by a transversely elongated rhomboidal osseous plate, devoid of teeth, which lies between the two posterior nasal apertures, and therefore much behind the anterior end of the parasphenoid. The side walls of the cranial cavity are ossified from the antorbital process to the anterior boundary of the foramen for the fifth nerve, just in front of which they are pierced by the optic foramen. There is no palatine bone. The pterygoid, in the main, resembles that of the ordinary frogs; but, in consequence of the shortness and little backward extension of the suspensorium, the outer process passes almost directly outwards, with hardly any backward inclination. A bony plate, which extends backwards from the posterior edge of the inner and outer branches of the pterygoid, underlies the tympanic cavity and the auditory capsule, and forms the floor of the Eustachian canal. The squamosal is a short broad bone, with a long anterior process, which becomes connected, by direct articulation, with the pterygoid, and by ligament with the maxilla. The premaxillæ are small, and the maxillæ are connected merely by ligaments with the suspensorium, there being no jugal. The *columella auris* is remarkably strong, and is bent in the middle, so that its two halves form an obtuse angle; the anterior half lies against the inner face of the tympanic membrane. The posterior half runs parallel with the posterior edge of the tegmen tympani, towards the fenestra ovalis. Ligamentous fibres fix the columella firmly, though movably, to the superior margin of the tympanic cavity, where it is bounded by the squamosal. The stout cartilaginous hyoidean cornua are attached just beneath the anterior and inferior part of the margin of the fenestra ovalis. The body of the hyoid is very small, but the two "thyro-hyals" are extremely long and broad cartilages. There is no ossified "mento-Meckelian" element.

In *Pipa*, the skull is extraordinarily depressed and broad. The nasal bones are wide, flat, triangular, and quite distinct from one another, a forward prolongation of the coalesced fronto-parietals extending between the two. The parasphenoid, very broad in the greater part of its extent, and having the guard rudimentary, sends a narrow median process forwards underneath the nasal septum, as in *Dactylethra*. No trace of a vomer, or palatine bone, was to be found in the specimen examined. The pterygoid is very like that of *Dactylethra*, but its inner branch is greatly prolonged, and the floor sent under the Eustachian tube unites much more closely with the produced exoccipital. The squamosal is very small, and the place of its zygomatic process is taken by ligament. This ligament, however, unites with the pterygoid in the same way as the bony process which answers to it in *Dactylethra*. The columella is less massive than in *Dactylethra*, and the end which abuts against the tympanic membrane is imbedded in a disk of cartilage. The occipital condyles look outwards and backwards, instead of inwards and backwards, as in *Dactylethra*. The hyoidean cornua are wanting, the thyro-hyals being large, but not so large proportionally as in *Dactylethra*.

The skulls of the Urodela present a very interesting series of modifications, leading from a condition in which the cranium retains, throughout life, a strongly-marked embryonic character, up to a structure which closely approximates that found in the *Anura*.

In *Menobranchus*, for example, the chondrocranium of the adult is in nearly the same state as that in which it

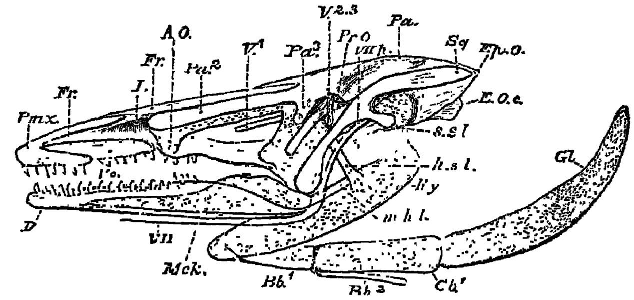


Fig. 10.

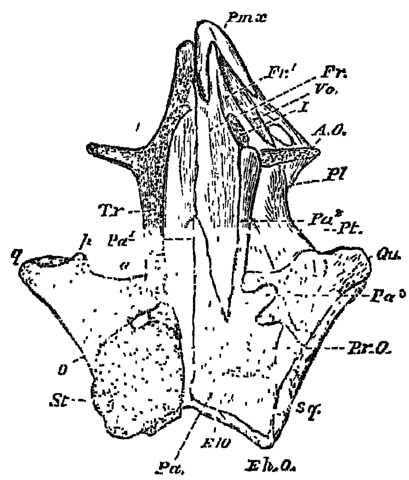


Fig. 11.

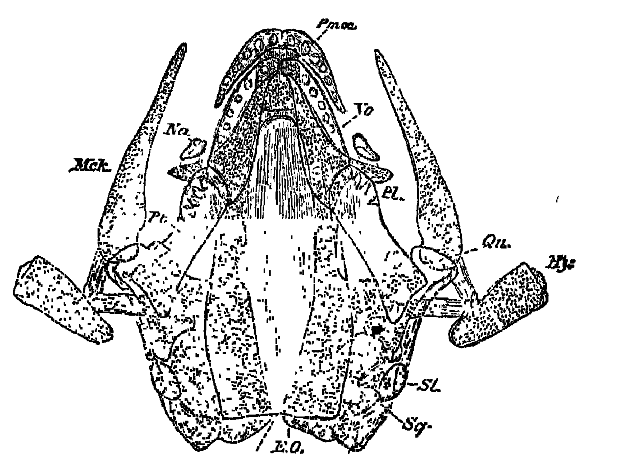


Fig. 12.

Figs. 10, 11, 12.—Lateral, dorsal, and ventral views of the cranium of *Menobranchus lateralis*. In the dorsal view, the bones are removed from the left half of the skull; in the ventral view, the parasphenoid, palato-pterygoid, and vomers are given in outline. The letters have, for the most part, the same signification as before. VII. *p.* posterior division of the seventh nerve; VII. chorda tympani; V^1, V^2, V^3, first, second, and third divisions of the trigeminal; *s.s.l.* stapedio-suspensorial ligament; *h.s.l.* hyo-suspensorial ligament; *m. h. l.* mandibulo-hyoid ligament; *a*, ascending process of the suspensorium; *p*, pterygo-palatine process; *q*, quadrate process; *o*, otic process; *Na.* posterior nares; *Mck.* Meckel's cartilage; *Gl.* (Fig. 10), the position of the glottis. Bb^1, Bb^2, basibranchials.

exists in a young tadpole or larval salamander (Figs. 10, 11, 12).

Instead of there being a well-developed cartilaginous brain-case, interrupted only by a dorsal fontanelle, as in the frog, both the floor and roof of the cranial cavity are formed by merely fibrous tissue, which underlies the frontal and parietal bones, and overlies the parasphenoid; and only its sides and its anterior end are bounded by cartilage.

The occipital region remains membranous in the middle line, both dorsally and ventrally, and exhibits, in the latter aspect, the remains of the notochord. The cartilaginous rods (*Tr.*), which bound the cranial cavity laterally, and represent the *trabeculæ* of the embryonic vertebrate skull, are separated by a wide oval space, which occupies the whole length of the floor of the cranial chamber. Anteriorly, they converge, and, just before they do so, give attachment to the slender antorbital processes (*A. O.*) which lie behind the posterior nares. They then unite, and, becoming applied together, coalesce into a flattened narrow mesethmoid, to the anterior extremity of which the premaxillary bones are applied. They give off neither alinasal nor subnasal processes, and therefore furnish neither roof nor floor to the nasal chamber. Posteriorly, they become flattened from above-downwards, and coalesce with the auditory capsules, and with the cartilage which extends beneath these, and gives rise to the occipital condyles (*E. O.*)

Each auditory capsule has a generally oval form, but is produced posteriorly, so as to give rise to a conical epiotic process (*Ep. O.*), which projects beyond the level of the occipital condyle. Fitted into the outer wall of each is the relatively large, conical, stapes, whence strong ligamentous fibres proceed to the posterior face of the suspensorium.

Immediately in front of the auditory capsule, the suspensorium passes by a strong pedicle (shown, but not lettered in Fig. 12) into the trabecula, and then, directed outwards, downwards, and forwards, ends in the quadrate process (*q*), with which the dorsal end of Meckel's cartilage articulates. A large process (*o*) ascends from the posterior face of the suspensorium, and applies itself to the outer and anterior face of the auditory capsule. A small and hardly perceptible elevation (*p*) is seen near the quadrate process of the suspensorium. Finally, a flat process (*a*, Fig. 11) ascends above the pedicle, and applies itself to the dorsal face of the trabecula.

On comparing this with the suspensorium of the frog, it is clear that the rudimentary process (*p*) answers to the pterygoid cartilage; and that the process *o* (the *otic* process) answers to the dorsal crus of the suspensorium. In fact, the posterior, or hyo-mandibular, branch of the seventh nerve passes back beneath this, and above the stapedial ligament, to its distribution.

The pedicle answers to the part so named (including the ventral crus of the suspensorium) in the frog, though it retains the embryonic relations to the trabecula, such as exist in the tadpole. The ascending process (*a*) lies between the orbito-nasal and the other branches of the trigeminal, the orbito-nasal passing between it and the trabecula. A similar process is very generally found in the *Urodela* (being particularly large, for example, in *Menopoma*), but appears to be represented only by fibrous tissue in the *Anura*.

Meckel's cartilage (*Mck.*, Fig. 12) is thick and deep at its articular end, but, after furnishing a surface of attachment for the elevator muscles of the jaw, it rapidly narrows, and ends in a point, at some distance from the symphysis of the dentary bones.

The hyoidean apparatus (Fig. 13) is represented, on each side, by a cartilaginous rod, subdivided into a short *hypohyal* (*H. h.*) and long *cerato-hyal* (*C. h.*) A strong ligament extends from the front face of the latter, below its free summit, to the suspensorium, reaching this at the same place as the stapedial ligament, into which it is continued. From a point a little above the attachment of this ligament, another ligamentous band arises, and, crossing the former, on the inner side of which it passes, becomes attached to the angle of the mandible. It answers to the interoperculum of a fish, and has nearly the same relations as the stylo-maxillary ligament of the higher Vertebrata.

In the ventral median line, the hypo-hyals are connected only by fibrous tissue. Firmly united with this, however, there is a median *first basibranchial* cartilage (Bb^1), succeeded by a *second basibranchial* (Bb^2), which is ossified, and is the only bony constituent of the hyobranchial apparatus. There are only three branchial arches. The first consists of a stout and long cerato-branchial (Cb^1), bearing an equally well-developed epibranchial (Epb^1). The second is represented by a mere nodule of cartilage (Cb^2), with which the expanded end of the second epibranchial ($Ep.b^2$) articulates. The third and smallest epibranchial ($Ep.b^3$) is articulated with the step-like broad end of the second. There is no trace of any fourth branchial arch, such as exists in tadpoles and in young salamanders; and in *Siredon*, *Siren*, *Amphiuma*, and *Menopoma*.

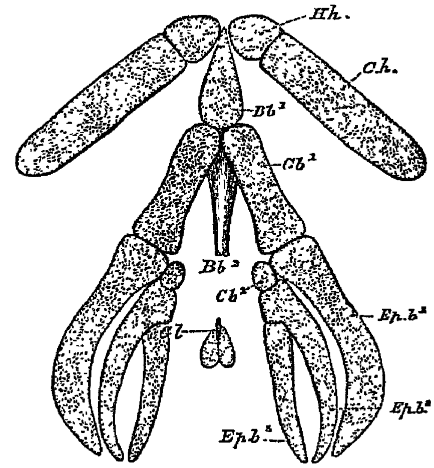


FIG. 13.—Hyoid and branchial apparatus of *Menobranchus lateralis*. *Hh.* hypo-hyal; *Ch.* cerato-hyal; Bb^1, first basibranchial; Bb^2, ossified second basibranchial; $Ep.b^1$, $Ep.b^2$, $Ep.b^3$, first second, and third epibranchials; *Gl.* glottis.

The most curious feature in the bony skull, or *osteo-cranium*, of *Menobranchus* is the presence of the prominent conical ossifications which lie external to the exoccipitals, and occupy the place of the *epiotic* and *opisthotic* bones. In possessing these elements of the skull, in so large and distinct a form, *Menobranchus* differs from all *Amphibia*, save *Proteus* and the extinct Labyrinthodonts. The parietal bones are separate from the frontals, and send, as is usual in the *Urodela*, a long process forwards on each side of the latter. In *Menobranchus*, this process is extremely long, reaching the olfactory foramen, the posterior margin of which it bounds. There are no nasal nor prefrontal bones, nor any distinct alisphenoidal, orbito-sphenoidal, or ethmoidal ossifications; of the maxilla, nothing but a rudiment appears, and this is sometimes absent. There are no jugal or quadrato-jugal ossifications. A palato-pterygoid plate, bearing teeth on its expanded palatine portion, extends from the antorbital process to the inner face of the suspensorium, which, as stated above, has a mere tubercle in the place of a pterygoid process. The vomers are long, bear teeth along their outer edges, and diverge backwards so as to leave an interspace between their inner edges. Posteriorly, they articulate with the anterior ends of the palato-pterygoids.

The squamosal is a long, slender, curved bone, devoid of any zygomatic process, which extends from the articular end of the suspensorium, along its outer edge, to the outer side of the epiotic. From its posterior margin it sends down a short process over the stapedial ligament.

The parasphenoid is a broad thin plate of bone, which extends from near the junction of the vomers to the occipital foramen. The distal end of the suspensorium is incompletely ossified, as a quadrate bone; and a dentary and a splenial element, both dentigerous, lie the former

external to and below, the latter internal to, Meckel's cartilage.

The skull of *Proteus* is, in its general characters, similar to that of *Menobranchus*, but is more extensively ossified.

In *Siren*, the skull, which has the same elongated form and forwardly directed suspensoria as in *Menobranchus* and *Proteus*, possesses, in the epiotic region, two strong crests, which project backwards beyond the level of the occipital condyles, but are otherwise very different from the epiotics of the latter genera. The "exoccipitals" and prootics are completely fused together, even in half-grown specimens, a mere rim of cartilage being left around the fenestra ovalis. The lateral walls of the skull present ossifications extending from the exits of the orbito-nasal nerves, forwards to the mesethmoid, or internasal portion of the trabeculæ, and completely encircling the olfactory foramina. But these ossifications remain distinct for a considerable time, if they ever coalesce. Each, therefore, represents half of the sphen-ethmoid of the Frog.

The flat and wide parasphenoid extends forwards to the space left by the divergence of the vomers. On the roof of the skull, each broad parietal sends forward a prolongation along the outer edge of the frontal, which reaches the antorbital process. The premaxillæ have very long ascending processes, which lie upon the mesethmoid, and are received between the ends of the frontal bones. Between these ascending processes one or two elongated ossifications are situated. These were termed "nasals" by Cuvier, but their position does not accord with this determination. The horizontal, or oral, portions of the premaxillæ, on the other hand, are very short and edentulous, each being coated by a thin plate of horny substance. The maxillæ are rudimentary or absent. The vomers are two, flat, oval, bony plates, the ventral aspect of which is beset with parallel rows of teeth set in obliquely-disposed curved lines, the convexities of the curves being turned inwards and backwards. The vomers are in contact anteriorly, but diverge posteriorly. The posterior extremity of each abuts upon a plate of similar form, but much smaller, and bearing fewer series of teeth, which lies on the ventral side of the origin of the antorbital process, and represents the palatine bone. The aperture of the posterior nares lies just opposite, and external to, the junction of these two bones.

The suspensorium is short, thick, and completely cartilaginous. Dorsally and internally, it is attached by a stout pedicle to the trabecula in front of the auditory capsule, while its dorsal and posterior face lies against the truncated anterior face of the pro-otic. The angle formed where this face joins the outer face represents the otic process of *Menobranchus*. There is no pterygoid process, nor any trace of a pterygoid bone. Just above the suspensorium, and seemingly connected with it, there proceeds from the anterior face of the pro-otic region of the skull, a strong, triangular, forwardly-directed cartilaginous process. From the free anterior end of this, a band of fibrous tissue passes, and, encircling the eye, is attached to the antorbital process. The squamosal is a slender curved bone, extending from the epiotic ridge to the articular end of the suspensorium, where it is widest. It exhibits only a rudiment of the well-marked process which extends towards the stapes in *Menobranchus* and *Proteus*. The mandible presents a dentary, an angular, and a dentigerous splenial element; and the proximal end of Meckel's cartilage is ossified, giving rise to a dense nodular *articulare*. The dentary is toothless, and supports the inferior horny beak.

The cornu of the hyoid is very stout, and its ventral moiety is ossified. The much thicker dorsal moiety is cartilaginous, and its recurved dorsal end extends beyond the extremity of the skull. At a considerable distance below its apex, a strong short ligament proceeds from its anterior face to the stapes. A broad sheet of ligamentous fibres further unites the hyoid with the lateral walls of the ear capsule, and with the posterior face of the suspensorium (hyo-suspensorial ligament); and a slender ligament (mandibulo-hyoid) proceeds from near the insertion of the hyo-stapedial ligament to the angle of the mandible. There are two basibranchials, both ossified, the posterior ending in short radiating processes; two cerato-branchials and four epibranchials.

In *Amphiuma*, the suspensoria are very little inclined forwards, and their long axes make nearly a right angle with that of the skull. The portion of the skull which lies behind a line joining the articular ends of the *ossa quadrata* is very much shorter than the region in front of it. Moreover, although the epiotic processes are prominent, the occipital condyles project far beyond them. One bone represents the exoccipital, epiotic, and opisthotic on each side. The pro-otic is large, and gives rise to the anterior moiety of a strongly-marked temporal ridge. Its exposed surface presents two fossæ, divided by a nearly vertical linear elevation. The large parietals form the posterior portion of the temporal ridge, and diverge anteriorly, to be continued forwards, on each side of the frontals, to the sphen-ethmoid. The frontals, in like manner, diverge in front to receive a median ossification, which is continuous with the coalesced median processes of the premaxillæ. The anterior half of each frontal is rugose, as are the exposed surfaces of the sphen-ethmoid and of the nasal bones, and the integument is firmly adherent to these rugosities. The nasals are broad and triangular. The truncated base of each lies over the nasal aperture; the inner edge articulates with the ascending process of the premaxilla; the outer edge joins first the maxilla, and then the sphen-ethmoid. The premaxillæ are so thoroughly ankylosed that no trace of their primitive distinctness is to be seen. The large maxillæ extend back for half the length of the skull, are firmly united with the adjacent bones, and are connected by dense ligament with the extremity of the quadrate bone. The greatly elongated vomers diverge but little; nevertheless, they come in contact only by their anterior extremities. In the rest of their extent they are separated, in front, by a median ossification representing the anterior part of the sphen-ethmoid, and, behind, by the anterior forked prolongation of the parasphenoid which embraces this ossification. The rest of the parasphenoid is broad and flat; it widens a little, in front of the auditory capsules, so as to form a rudiment of the "guard" in the frog's skull.

The osseous pterygoid is a curved plate of bone, convex inwards and concave outwards, which articulates posteriorly with the quadrate, and, in front, stops short, at little more than half the distance from its posterior end to the internal nostril. The cartilaginous pterygoid process of the suspensorium extends some way beyond it, and, widening, is attached by ligament to the maxilla. Posteriorly, the cartilaginous pterygoid is traceable, as a comparatively narrow band, on the inner side of the bony pterygoid, to the pedicle of the suspensorium, which is attached in front of the fenestra ovalis, and above the rudimentary "guard" of the parasphenoid. An ascending process passes from it between the orbito-nasal and the other divisions of the trigeminal. The otic process of the suspensorium, which is articulated with the outer face of the auditory capsule, is cartilaginous; but the rest of the suspensorium is ossified as a quadrate bone. This is, as usual, clamped to the skull by the squamosal, which is broad and expanded above, and narrow below. Behind, the suspensorium is directly articu-

lated with the styliform projection of the centre of the stapes. A very strong hyo-suspensorial ligament passes from near the distal end of the suspensorium to the cornu of the hyoid. The mandibulo-hyoid ligament is much weaker. The hyoidean apparatus presents a median basi-hyal, connected by a rounded hypo-hyal on each side, with a long and curved cerato-hyal, which is almost completely ossified. The first basibranchial is elongated and cartilaginous—the second is absent. The first branchial arch is a single elongated bone, representing the similarly coalesced cerato-branchial and epibranchial in *Menopoma*. The second cerato-branchial is small and cartilaginous. The three posterior epibranchials are simple curved cartilages; and the single branchial cleft is placed between the third and fourth epibranchials.

The skulls of the four genera, *Menobranchus*, *Proteus*, *Siren*, and *Amphiuma*, now described, resemble one another, and differ from those of other *Amphibia*, in their elongated form; and, especially, in the relative narrowness of the facial region in front of the orbits, which, as the case of *Amphiuma* shows, arises, not from any want of development of the maxillary bones, when they exist, but from their taking a direction which but slightly diverges from parallelism with the axis of the skull. Moreover, they all possess well-marked epiotic prominences. *Amphiuma* differs widely from the other three, in the great size of its maxillary bones, in the absence of palatine bones, in the projection of the occipital condyles beyond the epiotic processes, in the ankylosis of the premaxillæ, in the presence of well-developed nasal bones, in the coalescence of the first cerato-branchial with the first epibranchial, and in the transverse direction of the suspensorium.

In most of those respects, in which *Amphiuma* differs from *Menobranchus*, *Proteus*, and *Siren*, it approaches the Salamanders; especially if we take such forms as *Anaides* into account. On the other hand, in the entire absence of a palatine bone, and in the fusion of the first cerato-branchial with its epibranchial, it agrees with *Menopoma* and *Cryptobranchus*.

In *Menopoma*, the skull has a broadly-rounded snout, and its posterior contour slopes forwards and outwards (without being interrupted by conspicuous epiotic prominences), in the manner characteristic of the higher *Urodela*. The small pro-otics are separated from the exoccipitals (which also represent the epiotics and episthotics), by a wide cartilaginous interspace, in which the fenestra ovalis is situated. The parietal sends a process forwards, along the outer edge of the frontal, between it and the orbito-sphenoid. This meets a curved flat bone, which bounds the orbit anteriorly and internally, and articulates with an ascending process of the maxillary bone. It may therefore be regarded as a prefronto-lachrymal. The frontals unite in a long median suture, and then, diverging, embrace the nasal bones, and articulate externally with the fore part of the ascending process of the maxillary bone, which is thus received between the frontal and the prefronto-lachrymal. The very broad parasphenoid extends from the exoccipitals to the vomers, with which it unites by a denticulated squamous suture. The wide vomers are united by a median suture, and expand in front, ending in arched edges, close behind which the teeth are set. The premaxillæ are separate and small, articulate with the arched edges of the vomers, and send up strong ascending processes to the dorsal face of the skull, where they firmly unite with the nasals. The squamosal is a flattened prismatic bone, as broad at one end as at the other, which articulates with the parietal externally, and with the quadrate internally. Like the suspensorium, which it covers, it stands out at right angles with the axis of the skull. There is no palatine bone. The pterygoid is broader and more square than in any other Amphibian, in consequence of the great expansion of its internal process, which articulates by its whole length with the parasphenoid. The anterior process ends in a free pointed cartilage, directed outwards and forwards, and united with the maxilla by ligament, as in the higher *Urodela*. The external process extends to the articular end of the quadrate, as usual, and is continued thence along the cartilaginous suspensorium to its attached end.

The chondrocranium forms a complete ring of cartilage round the occipital foramen, continuous at the sides with the auditory capsules. From these the trabeculæ are continued forwards, as in *Menobranchus*, leaving a very wide ventral fontanelle. At the anterior end of this they unite and form the mesethmoid, from which roof and floor plates of the nasal capsules are continued. The suspensorium is connected by a pedicle with the trabecula, in front of the auditory capsule, and gives off a broad ascending process, which becomes ossified continuously with the pterygoid, over the orbito-nasal nerve. A stout otic process is articulated with a facet on the antero-external region of the periotic capsule, and is further connected with it by ligamentous fibres. The quadrate ossification involves a small portion of the articular end of the suspensorium; it thence extends upwards, on the dorsal aspect of the suspensorium, gradually becoming more slender, and nearly reaches the point at which the otic process of the suspensorium articulates with the periotic cartilage.

The osseous skull of *Cryptobranchus* is extremely like that of *Menopoma*.

In *Menopoma* the hyo-branchial apparatus presents the same general structure as that of *Siredon*, except that the second basibranchial seems to be wanting, while the first is very broad and rounded; at the same time, the epibranchial and the cerato-branchial of the first arch are represented by only one continuous cartilage.

In *Cryptobranchus*,[1] however, a considerable reduction has taken place, the two posterior pairs of branchial arches present in *Menopoma* having disappeared. The second arch still presents a division into cerato-branchial and epibranchial, but the dorsal end of the latter is closely united with that of the preceding arch. It is interesting to observe, however, that the modification thus effected is quite different from that which occurs in the Salamanders, in which, in the adult state, the first branchial arch retains its two segments; while the second, reduced to its cerato-branchial, is applied against the first, at the junction of the cerato- and epi-branchial; and the second basibranchial persists as the *ossiculum thyroideum* of Von Siebold.

Menopoma and *Cryptobranchus* further differ from the proper Salamanders in having the vomerine teeth disposed along the anterior edges of the expanded vomers. Unfortunately nothing is known of the larvæ of these forms, but it would seem as if, in them, the primitive vomers enlarge by extension of ossification behind, and not in front of, the originally existent teeth.

In the remaining *Urodela*, the Salamanders proper, the skull has the broadly-arched snout and the shelving posterior contour of *Menopoma*, but the vomers and pterygoids are very different.

The structure of the skull in these animals will be best understood by commencing with that of *Siredon*, which, though perennobranchiate under ordinary circumstances, is totally unlike the other so-called *Perennibranchiata* in cranial structure, and is, in fact, to all intents and purposes a larval Salamander.

An ossification on each side of the occipital foramen represents the exoccipitals, epiotics, and episthotics. In front of each of these

[1] See Hyrtl, "*Cryptobranchus japonicus*, Schediasma anatomicum," tab. iii.

is a pro-otic, and an orbito-sphenoid. The latter is sometimes united with its fellow of the opposite side.[1] The skull is roofed in by pairs of parietal, frontal, prefronto-lachrymal, and nasal bones. The maxillæ are short, and are united with the ends of the suspensorium only by fibrous tissue. There is a very broad and flat parasphenoid, which extends from the inferior margin of the occipital foramen, and ends, anteriorly, by a wide, irregularly convex edge, which does not reach the vomers. The latter bones are elongated and curved, and their long axes diverge posteriorly, as in *Menobranchus;* but their anterior ends are far apart, and they lie, separated by the whole breadth of the parasphenoid, and between that bone and the premaxilla and maxilla, adherent to the ventral face of the subnasal process of the chondrocranium.

The short palatine bones are situated immediately behind, and on the inner side of, the posterior nares, but their somewhat tapering, external and posterior, ends do not articulate directly with the pterygoids. The latter are triradiate bones, with an inner process which passes towards the base of the skull; an outer, which runs down the suspensorium; and a long anterior process, which gradually diminishes in breadth forwards, and is connected only by ligament with the palatine. Three ossifications embrace Meckel's cartilage. The dentary covers its outer face throughout its whole length. The angular lies on the inner face of its posterior two-thirds, and the small dentigerous splenial is also applied to its inner face between the angular and the dentary. The chondrocranium is in much the same condition as that of *Menopoma.* There is a broad basicranial cartilage situated between the auditory capsules, and passing, at the sides and above, into a complete occipital arch. But, in front, the trabeculæ, though they have increased in vertical height, remain united by fibrous tissue only, both in the floor and in the roof of the skull, which thus presents two great "fontanelles" when the parasphenoid, parietals, and frontals are removed. In front, they coalesce, each giving off, as it does so, a flat antorbital process, which is expanded at its outer end, where it supports the maxilla. Below, this process gives attachment to the palatine. By their coalescence, the trabeculæ give rise to a broad internasal septum (or mesethmoid cartilage), and they expand, on each side, below, into subnasal plates, which are separated, anteriorly, by a wide notch in the middle line. The curved outer edges of these plates give attachment to the premaxillæ and maxillæ, and they answer to the præ-nasal processes of the chondrocranium of the frog. Between the posterior edge of each of these and the anterior edge of the corresponding antorbital process, the posterior nostril is situated; and the inferior surface of the subnasal plate gives attachment to the vomer. Superiorly, the mesethmoid cartilage expands into a very thin (alinasal) plate, which roofs in each nasal chamber, and supports the prefronto-lachrymal and nasal bones.

The suspensorium is connected, above and internally, with the trabecula of its side by a pedicle; and it has an ascending process which lies over the orbito-nasal nerve (which is therefore included between the pedicle and the ascending process) immediately after its exit from the skull. Posteriorly and superiorly, it gives off an otic process, which is articulated with the outer and front part of the auditory capsule; while, inferiorly and externally, it furnishes an articular surface to the mandible. The pterygoid process has the form of a style tapering forwards, and nearly reaching the antorbital process, with which it is connected, however, only by ligamentous fibres. The posterior moiety of Meckel's cartilage is very stout as far as the coronoid process, and then tapers rapidly to its free, pointed, symphysial extremity.

The hyoidean and branchial apparatus is entirely fibrous and cartilaginous, none of its parts having undergone ossification. Each cornu of the hyoid is connected with the upper and posterior face of the suspensorium, and with the angle of the mandible, by ligamentous fibres—the hyosuspensorial and mandibulo-suspensorial ligaments. The cornua are not subdivided, and are united in the median ventral line by ligament. A triangular first basibranchial extends back from their junction, and is succeeded by a second, as in *Menobranchus;* but this second basibranchial is not ossified. Two cerato-branchials are attached to the posterior extremity of the first basibranchial on each side, and the anterior is, as usual, followed by a long and strong epibranchial, which supports the anterior gill. The posterior cerato-branchial supports the second epibranchial directly, and the third and fourth epibranchials indirectly.

The interesting observations of Professor A. Duméril have shown that, under certain conditions, the ordinarily perenni-branchiate *Siredon* passes into the caduci-branchiate *Amblystoma;* and this metamorphosis is accompanied by some very interesting modifications in the structure of the cranium, especially in the vomerine, palatine, and pterygoid regions. Ossification extends forwards from the vomers beneath the præ-nasal processes, so that the series of teeth, which originally lay along the anterior margins of these bones, come to be situated at their posterior edges. At the same tim they take up a direction at right angles to the axis of the skull, instead of being greatly inclined to that axis, as they are in *Siredon,* and the two sets of vomerine teeth thus form a single transverse row. Moreover, the anterior process of the pterygoid moves outwards until it comes into contact with the inner face of the maxilla. The one end of the palatine remaining attached to the vomer, the other swings outwards, in correspondence with the change of position of the pterygoid, and thus becomes directed transversely to the axis of the skull, immediately behind the posterior nostril, its teeth continuing the transverse line of the teeth of the vomers. Salamanders with the teeth thus disposed have been termed "lechriodont." The maxillary bones are larger than in *Siredon,* but the jugal arch remains ligamentous. The dorsal ends of the cornua of the hyoid retain their ligamentous connection with the suspensorium, and the ventral ends with the anterior basibranchial. The first cerato-branchial and epibranchial persist, and retain their articulation with one another. The second cerato-branchial remains, but its dorsal or outer end becomes attached to the preceding, and all the three posterior epibranchials disappear. The second basibranchial becomes detached as a Y-shaped piece, which lies in the middle line, in front of the larynx.

In all the other Salamanders, the vomers, in the adult, present the same enlargement of the part in front of the teeth, at the expense of the region behind them, as in *Amblystoma.* But the teeth rarely offer the same disposition. More commonly they form two series, inclined to one another at a more or less acute angle, open forwards, and supported upon bony plates, which appear like prolongations of the vomers, extending backwards on the ventral face of the parasphenoid. This "mecodont" arrangement is strikingly exemplified by *Salamandra maculosa,* and still more remarkably by *Plethodon* and *Anaides,* where these longitudinal series of teeth beneath the parasphenoid are commonly termed "sphenoidal" teeth. Dugès[2] and other observers, however, have shown that, in larval *Salamandræ* and *Tritones,* the vomerine and palato-pterygoid apparatus have, at first, the same disposition as in *Siredon;* and Dugès has described the process by which the palatine bones, becoming detached from the pterygoids, which rotate outwards, ankylose with the vomers, taking up a position beneath the parasphenoid, and more or less parallel with the axis of the skull; and it can hardly be doubted that the so-called "sphenoidal" dentigerous plates of other genera of *Salamandrida* have the same origin. If this conclusion be correct, it indicates a very curious morphological difference between the "mecodont" and "lechriodont" *Salamandrida.*

In all the *Salamandrida* the parietal bones send long processes forwards on each side of the frontals. The parasphenoid is a broad flat plate. Very often the premaxillæ are ankylosed into one bone, and the bones of the periotic capsule coalesce. In some cases there are epiotic processes or ridges. Maxillæ are always present, and the snout is usually broadly arched. Nasal bones, distinct from the prefronto-lachrymals, are usually present.

In the genus *Anaides* the skull is comparatively long and narrow, and the muzzle is less arched than usual. The single premaxilla, and the two well-developed maxillæ, follow the semicircular curve of the broad subnasal plates, to the edges of which they are attached. The hinder free extremities of the maxillæ are curved upwards, and the jugal arch is represented only by ligament. Thus far the skull is salamandrine; as it is also in the presence of distinct nasal and prefronto-lachrymal bones, in the disposition of the vomerine and so-called "sphenoidal" teeth, in the absence of an apparent palatine bone, and in the manner in which the pterygoid is produced into a long process, which becomes connected with the inner face of the maxilla. But, in the well-marked downward and forward inclination of the suspensorium, and in the strong crests into which the epiotic processes are developed, the skull of *Anaides* is very like that of *Siren.*

In the skull of *Epicrium glutinosum* (Fig. 14), which may be selected as an example of the PEROMELA, the strong occipital condyles are continued into two ossifications, which rise on to the roof of the skull, where they unite in a short suture, and, spreading out so as to embrace the parietals, are continued over the auditory apparatus, as far as the squamosal and the quadrate bones. Ventrally, no indication of any suture between these bones and the broad parasphenoid is visible; laterally, they pass forward into a continuous ossification, which constitutes the side walls of the auditory capsule, and, in front of this, is perforated by the wide foramen for the trigeminal nerve, and enters largely into the lateral wall of the cranial cavity. The parietal bone rests on the dorsal edge of this lateral ossification, which terminates, anteriorly, by an irregularly

[1] See Friedrich and Gegenbaur—"Der Schädel des Axolotl (*Siredon pisciformis*)" in the *Berichte der Königlichen Zootomischen Anstalt zu Würzburg,* 1849. This memoir contains an excellent account of the chondrocranium of the Axolotl.

[2] *Recherches,* pp. 172, 173, pl. xiv. fig. 89. Rusconi, *Observations Anatomiques sur la Sirène,* pl. vi. figs. 3 and 10.

excavated border, between which and the posterior margin of the sphen-ethmoid the cranial wall is unossified. Throughout its whole

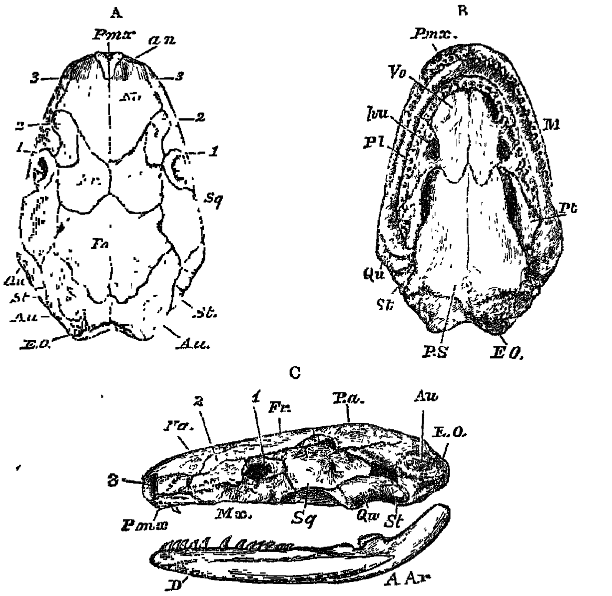


Fig. 14.—The skull of *Epicrium glutinosum*. A, dorsal; B, ventral; C, lateral, view. The letters have the same signification as before.

extent, this large ossification, which represents the exoccipitals, the elements of the periotic capsule, and the alisphenoids, is firmly ankylosed with the parasphenoid. There is a well-developed sphen-ethmoid, similar in its general characters to that of the frog. It is very closely united, if not ankylosed, with the vomers and premaxillæ. The roof of the skull is completed by two parietals, two frontals, and two large nasals, which unite in a long suture, except in front, where, for a short distance, they are separated by the ascending processes of the premaxillæ. The dentigerous oral processes of these bones are short, and unite by suture with the maxillæ. These send up broad plates which lie in front of and below the orbit, on the sides of the face. The canal for the suborbital tentacle perforates the maxilla in front of the orbit. Posteriorly, the maxilla unites with the squamosal, which is a broad plate firmly fixed to the quadrate, but somewhat loosely united with the frontal and parietal and with the complex occipito-otic bone. A small crescentic post-orbital bone (denoted by 1 in Fig. 14) articulates with the maxillary and squamosal, and with another bone (2), which answers very nearly to the prefrontal of a reptile. Between the nasal bone and the premaxilla, above and below, and the maxilla behind, a small bone (3) is fitted. The quadrate bone is represented by the ossification of the distal end of the suspensorium, which is inclined a little backwards. The stapes is large and well ossified. Two distinct ossifications, an angulo-articular and a dentary, are discernible in the mandible; and the second short row of teeth, inside those of the dentary, seems to indicate the existence of a splenial element.

In the Labyrinthodonta the skull presents the extremes of form which are met with among the *Amphibia*, from the elongation observable in *Archegosaurus*, to the short and broad form of *Metopias* and *Brachyops*. The chief characters by which the labyrinthodont cranium differs from that of its existing allies are the following:—

The occipital condyles in some genera remained long, if not permanently, cartilaginous; and one or two supra-occipital ossifications (probably membrane bones) very generally occur. The epiotics are prominent, and appear to remain permanently separate from the adjacent bones. In front of them, and articulated with the outer edges of the parietal and frontal, are two bones, which are commonly identified with the "squamosal" and "post-frontal" of the higher Vertebrata. The "post-frontal" articulates anteriorly with a large "prefrontal" bone, which bounds the dorsal and anterior contour of the orbit. The outer edges of the "squamosal" and "post-frontal" articulate with two bones, termed the "post-orbital" and the "supra-temporal." The post-orbital lies in front of the other, and contributes to the posterior margin of the orbit,—the rest of the contour of which, between the post-orbital and the prefrontal, is usually completed by a large jugal. Articulated, dorsally and internally, with the "supra-temporal," and, anteriorly, with the jugal, is a "quadrato-jugal," which sometimes extends into the articular surface for the lower jaw, and in some cases, at any rate, overlaid a quadrate ossification. There are long paired nasals, between the anterior ends of which the ascending processes of the premaxillæ are received; and between these bones, the unusually long maxillæ, and the prefrontals, distinct "lachrymal" ossifications occur.

The vomers are large, meet in a long median suture, and bear teeth. The palatine bones, also dentigerous, bound the posterior nares in front, and are elongated antero-posteriorly.

The mandible presents a dentary (probably including a splenial) element, an angular and an articular ossification.

Those surfaces of the cranial bones which were covered by the skin are usually rugose, and sculptured much in the same way as those of the crocodiles, and they frequently present symmetrically-disposed grooves, the so-called "mucous canals," which, very probably, lodged sensory apparatuses resembling the similarly-named structures in fishes—the homologues of which are found in existing *Urodela*.

The hyoid is unknown, and what appears to be traces of a branchial apparatus have been observed only in young specimens of *Archegosaurus*. Hence it is probable, not only that no known Labyrinthodonts were perennibranchiate, but that the air-breathing condition supervened early in the course of their development.

The Labyrinthodonts doubtless possessed a well-developed chondrocranium, but such a structure would necessarily perish in the course of fossilisation. The singular resemblance of the labyrinthodont skull to that of the *Peromela*, in the arrangement of the bones which bound the cavity of the mouth, and the disposition of the teeth upon them, suggests a comparison of the other cranial bones in the two groups. Starting from the nasals of *Epicrium*, which may be safely identified with those of the Labyrinthodonts, the bone marked (2) in *Epicrium* corresponds very closely with the labyrinthodont "prefrontal;" and that numbered (1), with the "post-orbital." No. 3 in *Epicrium*, in some respects answers to the so-called "lachrymal" of the Labyrinthodonts; while the maxilla of the Cæcilian may be taken to represent both maxilla and jugal of the Labyrinthodont. But if this be so, the squamosal of *Epicrium* corresponds with the supra-temporal of the Labyrinthodont; and a question arises as to the true nature of the "squamosal" and "post-frontal" of the latter.[1]

The Limbs.—The pectoral arch in the *Amphibia* is distinguishable into a scapular, a coracoidal, and a præcoracoidal region, although the extent to which these parts of the primitive cartilaginous arch become separately ossified varies very much in the different members of the group.

In *Proteus*, *Menobranchus*, *Cryptobranchus*, and *Menopoma*, ossification occurs only in the scapular region. In *Siren* and *Amphiuma* an additional broad coracoidal ossification occurs, but it does not meet the scapular ossification in the glenoidal cavity. The junction, however, takes place in *Siredon* and the Salamanders. In none of the *Urodela* does any ossification appear in or upon the præcoracoidal or supra-scapular cartilage.

A supra-scapular ossification exists in all known *Anura*. All but *Microps* and *Hylædactylus*[2] have a præcoracoid, which acquires a sheath of bony matter. The glenoidal cavity is bounded by the præcoracoid, coracoid, and scapula; and in some cases (*e.g.*, *Dactylethra*) the ossified ends of the three unite and give rise to a triradiate suture in the glenoidal cavity, just as the pubis, ischium, and ilium of most Vertebrata unite in the acetabulum. In *Systoma gibbosum*, contrary to the usual rule, the præcoracoid is far broader than the coracoid (Parker).

In the higher *Anura*, a median piece, of very variable size, form, and consistency, extends forwards from the junction of the præcoracoids. Mr Parker considers it to be an outgrowth from these, and terms it the *omosternum*.

The long bones, both in the fore and hind limbs, consist of an axis of cartilage, sheathed in, and more or less replaced by, a diaphysis of membrane bone. The extremities of the cartilages frequently undergo calcification, and are thus converted into epiphyses. A strong crest characterises the humerus in many male *Anura*. In the latter, the radius and ulna coalesce into one bone, while in all other *Amphibia* they remain distinct.

In *Siredon*, *Cryptobranchus*, and *Menopoma*, the carpus contains eight separate cartilages, of which three—the *radiale*, *intermedium*, and *ulnare*—form a proximal row; and four *distalia*, a distal row. Between these two series lies a single *centrale*.

In *Menobranchus*, there are only six carpal cartilages—the ulnare and intermedium, and the radiale and radial distale, respectively, having apparently, as Gegenbaur suggests, coalesced.

In *Amphiuma didactylum*, the number of carpal cartilages is reduced to four, and in *Proteus* to three. In both these cases the two largest cartilages form a proximal row.

[1] On the structure of the skull, as of whatever else is known of the organisation of the Labyrinthodonts, the reader will find full, excellently arranged, and well-digested information in the "Report of the Committee of the British Association on the Labyrinthodonts of the Coal Measures," drawn up by Mr Miall, *British Association Reports*, 1873.

[2] Parker *On the Shoulder Girdle*, p. 67.

The *Salamandrida* usually have seven carpal elements. In the proximal row there are two—a radiale and a coalesced intermedium and ulnare. There is a single centrale and four distalia. These are variously ossified until, in *Triton cristatus* and *alpestris*, all are ossified.

No urodele amphibian has more than four digits in the manus, and the number may be reduced to three, or even two (*Amphiuma didactylum*). When four digits are present the number of the phalanges is usually 2, 2, 3, 2.

Among the *Anura*, Dugès and Gegenbaur have shown that *Bombinator* and *Pelobates* have eight distinct carpal bones—two in the proximal row (radiale, intermedium-ulnare), five in the distal, and one between these two rows. This last, which is the centrale, lies on the radial side of the manus, and articulates with the three radial distalia, much as the navicular bone articulates with the three cuneiformia in the mammalian tarsus. In *Rana esculenta*, there are also two bones in the proximal row, and the centrale lies on the radial side of the carpus. But there are only three bones in the distal row; one large, on the ulnar side, which bears the third, fourth, and fifth metacarpals, and two small ossicles on the radial side, which articulate with the first and second metacarpals.

There are five digits in the manus of the *Anura*; but the pollex is rudimentary, being represented only by a cartilaginous or more or less ossified style. The second and third digits usually have two phalanges each, and the fourth and fifth, three (2, 2, 3, 3).

The pectoral arch of the Labyrinthodonts is best known in *Archegosaurus*, where it presents three ossified elements, which probably answer to the coracoid, præcoracoid, and scapula. The bones of the fore-limb in the Labyrinthodonts are always weak relatively to the size of the body. There appear to have been five digits, the carpus remaining unossified.

In *Proteus*, *Menobranchus*, and *Amphiuma*, the pelvic arch is not connected with any distinctly modified sacral vertebra, and the ilium is very small. The pubes and ischia are represented by broad cartilaginous plates, which unite, and may become fused together in the middle line.

In *Menobranchus*, the pubic portion of the pelvis is continued forwards into a broad triangular median process. In *Siredon*, *Menopoma*, *Cryptobranchus*, and the Salamanders, there is a similar median process, reminding one of the omosternum in the pectoral arch of the *Anura*. It becomes bifurcated anteriorly. The ilium is always ossified; and there are ischial ossifications in all but *Proteus*. On the other hand, the pubic region always remains cartilaginous in the *Urodela*.

Hyrtl has shown that *Cryptobranchus* has no proper knee-joint, the femur being united with the tibia and fibula by a solid fibrous mass; and that, in *Menopoma*, the cavity of the knee-joint is very small.

The tibia and fibula in the *Urodela* are always separate, and the proximal elements of the tarsus are not elongated. The greatest number of tarsal elements is found in *Cryptobranchus* and *Menopoma*, which, according to Hyrtl, have three cartilages in the proximal, and five in the distal, row, while two are central. In *Siredon*, the tarsus completely resembles the carpus, but there is one more distal cartilage. The tarsus therefore consists of three proximal cartilages (*tibiale*, *intermedium*, *fibulare*), one central (*centrale*), and five distal (*distalia*). In the Salamanders, there is usually the same number and disposition of the tarsal cartilages; but more or fewer are ossified, and it is interesting to remark that the two fibular distalia sometimes become united into a "cuboid."

Menobranchus has two (or three) proximal, one central, and three distal tarsal cartilages; *Amphiuma*, three proximal and two distal; *Proteus*, two cartilages on the fibular, and one on the tibial side.

Siredon, *Cryptobranchus*, *Menopoma*, and most Salamanders have five digits in the pes; *Menobranchus*, four; *Amphiuma*, three; and *Proteus*, two. The number of the phalanges in the pentadactyle foot is usually 2, 2, 3, 3, 2. In *Siredon*, Hyrtl found 1, 2, 3, 4, 2.

In the *Anura*, the ilium is greatly elongated, and the pubes and ischia are flattened, discoidal, and applied together by their inner surfaces. The ilium and the ischium, alone, become completely ossified, and there is no præpubic process.

The tibia and fibula coalesce into one bone. Two elongated bones form a proximal row in the tarsus, and are commonly united by their epiphysial ends (*e.g.*, *Rana*; they remain separate in *Bombinator*). In *Rana esculenta*, the distal confluent ends of these bones (which possibly answer to the astragalus and calcaneum) present a transversely elongated articular surface, which is convex from the dorsal to the plantar side. Between this and the proximal end of the second and third metatarsals lies a discoidal, more or less calcified, cartilage. The convex distal face of this cartilage articulates with these two metatarsals. From its fibular side a strong ligamentous band passes to the proximal end of the fifth metatarsal, and a fibrous plate to the fibular and plantar edge of the fourth metatarsal, so that the band and plate are interposed between these metatarsals and the coalesced astragalus and calcaneum. On the tibial side of the discoidal cartilage lies another, which is elongated from the dorsal to the plantar side, and concave proximally, to articulate with the tibial side of the distal end of the coalesced astragalus and calcaneum. The inner or tibial face of this cartilage articulates with the proximal end of the elongated first joint of the *calcar*. Its distal end is connected by a strong band of ligamentous fibres, within which a nodule of cartilage may be enclosed, with the proximal ends of the first and second metatarsals. The second joint of the *calcar* has the form of an ungual phalanx.

In *Bufo* and *Bombinator*, according to Gegenbaur, the *calcar* consists of only a single piece.

The pelvic arch of the Labyrinthodonts appears to have contained a well-ossified pubic element, in which respect it differs from that of all other *Amphibia*. The hind-limb, like the fore-limb, was relatively weak. The tibia and fibula are distinct. In the few cases in which the pes is preserved it is pentadactyle, with a short cartilaginous tarsus.

The Integumentary Organs.—In all recent *Amphibia*, the integument is remarkable for the great abundance of simple follicular glands which are distributed through it, and are sometimes all of one kind (*e.g.*, *Proteus*), though in other cases two sorts of such glands can be distinguished (*Rana*). In many *Anura* and *Urodela*, these glandular structures attain a greater complication of structure, especially near the angle of the jaw, and constitute what are termed the "parotoid" glands. In some cases, the secretion of these glands is extremely acrid and irritating. In some *Urodela* (*Proteus* and *Siredon*), and in the tadpole, the epidermis becomes modified in relation with the termination of sensory nerves, in the head and along the body, in the region of the nerve of the lateral line, and gives rise to sensory organs of the same nature as those which are found in the lateral line and the so-called mucous sacs and canals of fishes.[1]

In a few *Anura*, ossification takes place in the dorsal integument, and this process may go so far as to give rise to bony plates, which may become closely connected with the spines of the subjacent vertebræ (*Brachycephalus*, *Ceratophrys*). In the majority of the *Peromela*, oval, cycloid scales are imbedded in the transverse folds of the integument, and constitute another point of resemblance between the members of this group and the Labyrinthodonts. But the rows of scales are not confined to the ventral surface, and the scales themselves differ in structure from those of the Labyrinthodonts.

In the *Urodela* and *Anura*, the epidermis is periodically exuviated.

The Alimentary Organs.—The *teeth* of the recent *Amphibia* vary a good deal in form. In the *Urodela*, they are usually conical and pointed; frequently more or less curved; sometimes, as in *Anaides*, lancet-shaped. *Siren* has the surfaces of the vomers and palatines covered with parallel series of small *dents en brosse*. In *Ceratophrys*, the bases of the teeth are slightly grooved longitudinally. In *Archegosaurus*, similar grooves are more marked, and give rise to folds of the wall of the tooth. These, extending inwards and ramifying, give rise to the complicated or "labyrinthic" structure exhibited by transverse sections of the teeth of the typical Labyrinthodonts. Very generally, the teeth become ankylosed with the subjacent bones, and are replaced by others developed at their bases. In the Labyrinthodonts, some of the anterior teeth frequently become much larger than the rest. The *Anura* are remarkable for the total absence of teeth in the mandibles, in all but one or two genera, while many have no premaxillary or maxillary teeth. The Toads have no teeth in the upper jaw. *Pipa* is altogether edentulous. *Siren* alone presents plates of horn upon the gingivel surfaces of the premaxillæ and of the dentary elements of the mandible.

Teeth may be developed upon the premaxillæ and maxillæ, the palatines, and the dentary and the splenial elements of the mandible; but they do not occur elsewhere,—the so-called sphenoidal teeth of some Salamanders being really borne, as has been seen, on the peculiarly modified palatines.

The buccal cavity is usually spacious, and the widely-separated posterior nares open into the anterior part of it. In the lower *Urodela*, the branchial clefts lie at the sides of the pharynx, and the median aperture of the glottis is situated far back. In the *Urodela*, and some *Anura*, there are no Eustachian passages; but, in most *Anura*, these passages have the form of wide recesses leading out of the pharynx. In *Pipa* and *Dactylethra* alone, the "recesses" are converted into Eustachian "tubes," which open by a common

[1] *Recherches sur les organs sensitifs, qui se trouvent dans l'epiderme du Protée et de l'Axolotl*, by E. Bugnion. Lausanne, 1873.

median aperture; this is relatively wider in *Dactylethra.* Two grooves in the mucous membrane of the roof of the mouth pass from the Eustachian to the posterior nasal apertures, and enclose a lyrate space, in these genera.

The tongue is rudimentary in the lower *Urodela;* but, in the Salamanders, it may be free, fleshy, and even mushroom-shaped. In *Pipa* and *Dactylethra,* no trace of a tongue is to be observed. In *Rana,* as in most *Anura,* the anterior end of the tongue is comparatively small and little elevated above the mucous membrane of the floor of the mouth, but the posterior end is produced into a free fleshy mass, bifurcated at its extremity. It is this free end which is thrown forward in the act of prehension, the tongue turning on its anterior end as on a hinge. *Rhinophrynus* is the only Anuran in which the anterior end of the tongue alone is free.

In the males of many *Anura* the mucous membrane of the mouth is produced outwards, on each side, between the mandible and the hyoid, into a sac, which becomes filled with air, and gives rise to a conspicuous projection of the integument of the throat. In some cases these two sacs coalesce into one.

Salivary glands have not been discovered in any *Amphibia.*

Except in the *Peromela,* the gullet is short. It passes into an elongated stomach, the long axis of which coincides with that of the body in the *Urodela* and *Peromela,* but becomes oblique, or transverse, in the *Anura.* The intestine is never very long, and, consequently, its convolutions are few and simple. There is always a marked distinction between the small and the large intestine. The latter opens into a cloaca, which receives the ducts of the urinary and genital apparatus. The stomach and intestine are enclosed in peritoneum, and suspended to the roof of the abdominal cavity by a mesenteric fold. The liver is always provided with a gall-bladder. It is distinctly bilobed in most *Anura;* and, in *Pipa* and *Dactylethra,* the two lobes are completely separate, the gall-bladder being attached to the right lobe. In the *Peromela,* the liver has an exceptional form, being divided into a great number of small lobes, arranged in a longitudinal series so as to overlap one another.

A pancreas is always present; but sometimes, as in *Rana,* it is small, and its glandular substance surrounds the hepatic duct. The spleen, enclosed in the mesentery, is elongated in the *Urodela* and *Peromela,* rounded in the *Anura.*

The Organs of Circulation.—The heart is contained within a pericardium, the walls of which generally exhibit numerous scattered pigment cells, and though delicate in the fresh state, are apt to become tough and almost pergamentaceous in spirit specimens. The heart (if we apply that name to the whole apparatus enclosed within the pericardium, except the venæ cavæ), presents a series of five segments, to which, enumerating them from behind forwards, the following terms may be applied:—1, The *sinus venosus;* 2, the *atrium;* 3, the *ventriculus;* 4, the *pylangium* (from πυλών, a gateway, and ἀγγεῖον, a vessel); and 5, the *synangium. Atrium* here denotes the auricular division of the heart, comprising the right and left auricles. *Pylangium* and *synangium,* together, are the equivalents of that portion of the heart which lies between the ventricle and the anterior wall of the pericardium, and which has been variously named *bulbus, cavus,* and *truncus, arteriosus.*

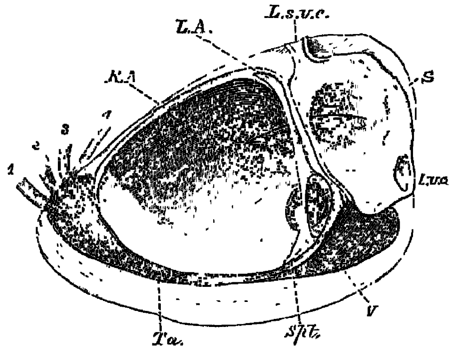


FIG. 15.—The heart of *Siredon mexicanus.* Lateral view of the heart contained within the pericardium, the left wall of the sinus venosus and of the auricles being removed; *S.* sinus venosus; *I. v. c.* inferior vena cava; *L. s. v. c.* left superior vena cava; *L.A.* left auricle; *R. A.* right auricle; *Spt.* septum auriculorum; *V.* ventricle; *T. a.* truncus arteriosus; 1, 2, 3, 4, the aortic arches. The arrow traverses the sinu-auricular aperture. The auriculo-ventricular aperture lies to the right of the arch formed by the free edge of the septum.

These five segments of the heart are so arranged, that the sinus and atrium lie on the dorsal and posterior aspect of the organ, while the others occupy its ventral and anterior region. Viewed sideways, in fact, the heart has the shape of a ⋦, of which the sinus and atrium occupy the upper, and the other segments the lower half. But it also always presents, more or less, a lateral flexure, between its anterior and posterior points of adherence to the middle line of the pericardium; so that, viewed from above, it approximates the form of an N, of which the right half is represented by the synangium, pylangium, and ventricle, and the left half by the atrium and sinus. The pylangium, in fact, always arises from the right side of the ventricle, while a large part of the atrium and of the sinus very often lies to the left of the ventricle, the auriculo-ventricular aperture of the ventricle looking to the left side and forwards.

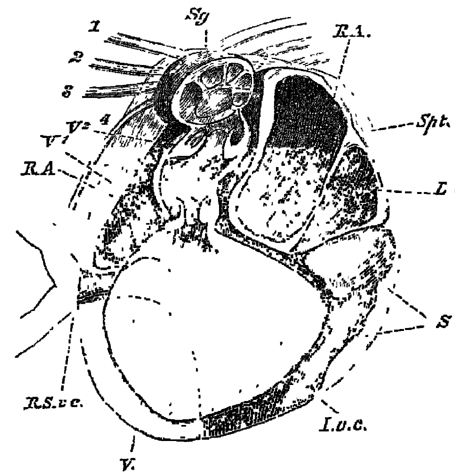


FIG. 16.—Ventral view of the same heart contained in the pericardium. *R.s.v.c.* right superior vena cava. The pylangium laid open to show the two transverse rows of valves, V^1, V^2. The commencement of the synangium (*Sg.*), cut across.

There is an interesting difference to be observed in the relative position of these segments of the heart in the lower and the higher *Amphibia.* In *Siredon,* for example, the greater part of the sinus lies completely behind the ventricle, and the sinu-auricular aperture is situated on the posterior face of the atrium, on a level with the posterior part of the ventricle; but, in the Frogs, the sinus lies altogether above the ventricle, without sensibly projecting behind it, and the sinu-auricular opening lies in the dorsal face of the atrium, in front of the level of the auriculo-ventricular aperture. In other words, the segments of the heart have a less marked vertical flexure in the lower, than in the higher *Amphibia,* and more nearly approach the condition of the embryonic heart. In correspondence with this, the superior cavæ traverse the pericardium to enter the sinus near its posterior end in *Siredon,* but about its middle in the Frog.

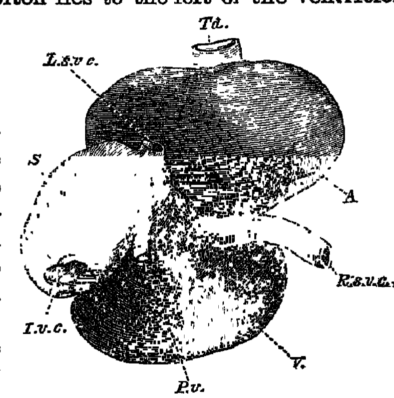


FIG. 17.—Posterior view of the same heart, removed from the pericardium; *P.v.* pulmonary vein.

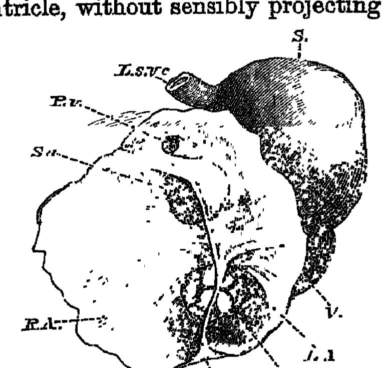


FIG. 18.—The atrium of the same heart laid open and its walls spread out, so as to show the opening of the pulmonary vein, *P.v.*, and the sinu-auricular aperture, *S.a.*

The *sinus venosus* is a thin walled sac, which is relatively largest in the lower *Amphibia* and smallest in the Frogs. Anteriorly, it usually receives, on each side, one of the two superior venæ cavæ; posteriorly, the single vena cava

inferior opens into it. But, in some cases (as in *Menobranchus* and *Pipa*, according to Meyer) the inferior vena cava divides into two branches, each of which coalesces with the superior vena cava of its side before opening into the sinus. The superior cavæ may open into the sinus immediately after they have traversed the pericardium, as in *Menobranchus*; or, they may be short trunks, as in the Frogs; or, as in *Siredon* and the Salamanders, the right cava may be long and the left short.

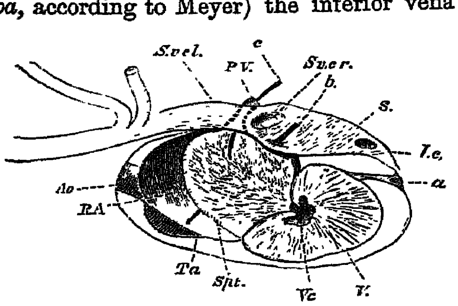


FIG. 19.—The Heart of *Rana esculenta*.—Lateral view of the heart contained within the pericardium. (The heart has been carefully drawn to scale *in situ*, and the parts shown by dissection put in as if the organ were transparent.) *S.* sinus venosus; *I.c.* inferior vena cava; *S.v.c.l.* left superior cava; *S.v.c.r.* opening of the right superior cava; *P.V.* pulmonary vein (its dotted contour is seen through the left superior cava); *c*, style introduced into the pulmonary vein and passing into the left auricle; *b*, style introduced into the sinu-auricular aperture and passing into the right auricle (*R.A.*), where its end is visible to the right of the septum, *Spt.* *Vc.* ventricular cavity. *T.a.* truncus arteriosus. *Ao.* aortic arch; *a*, ligament passing from the wall of the pericardium to the ventricle.

The sinu-auricular aperture, by which the sinus and the right auricle communicate, is small, relatively to the size of these two cavities, and has an oval form. Its lips may be slightly prolonged towards the cavity of the auricle, but do not give rise to very definite sinu-auricular valves.

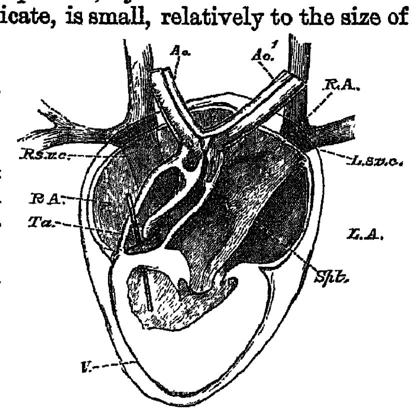


FIG. 20.—Ventral view of the heart of *Rana esculenta*, obtained in the same way. A style is passed through the aperture which leads from the ventricle into the pylangium; *L.A.* left auricle; *Ao.* Ao^1. aortic arches; *R. s. v. c.* right, and *L. s. v. c.* left superior cava.

The *auricular* segment of the heart, or *atrium*, is always more or less bi-lobed, the *truncus arteriosus* being embraced by the two lobes, one of which projects on its right side and the other on the left. The right and left lobes are equal in *Proteus*; both lobes are large and sacculated in *Siren*; in *Menobranchus*, the left lobe seems to be large, in *Epicrium*, the right; but many of these differences are probably accidental. In the Bullfrog (*Rana pipiens*) the two lobes of the atrial segment of the heart completely envelop the *truncus arteriosus*, and become united together by fibrous tissue, which connects their walls on the ventral side of the *truncus*. The *atrium* is usually divided into two cavities, of which the left is smaller than the right, by a septum, which extends from the left wall of the *atrium* towards the auriculo-ventricular aperture. The cavity of the auricular segment thus becomes divided into a smaller, left, auricle, which lies behind and to the left of the septum, and a larger, right, auricle, to the right and in front of the septum. In the Frogs, the *septum auriculorum* is a complete partition, containing muscular fibres, and the septal branches, with their ganglia, of the cardiac nerves of the pneumogastric. It divides the auriculo-ventricular aperture, passing from one auriculo-ventricular valve to the other, and ending between them by a free edge, which might almost be said to lie in the cavity of the ventricle (Fig. 23).

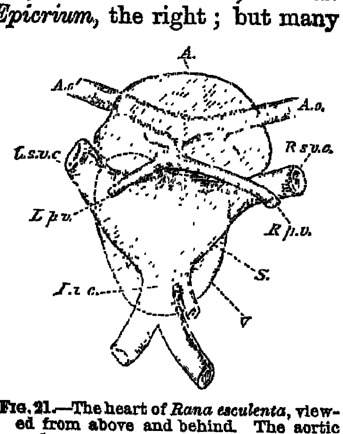


FIG. 21.—The heart of *Rana esculenta*, viewed from above and behind. The aortic arches seen through the auricles. *L.p.v.*, *R.p.v.* left and right pulmonary veins.

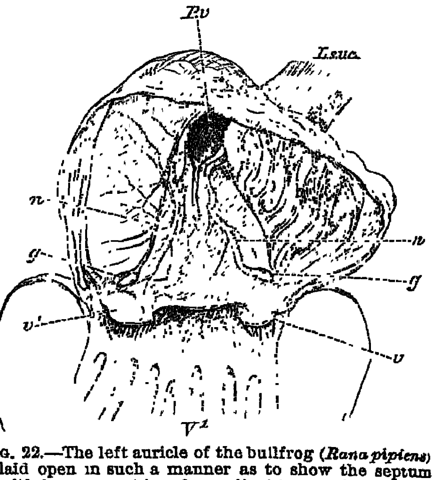


FIG. 22.—The left auricle of the bullfrog (*Rana pipiens*) laid open in such a manner as to show the septum with its nerves (*n*) and ganglia (*g*), and the manner in which it descends upon the free surfaces of the auriculo-ventricular valves, V^1, V^2. *P.v.* opening of the pulmonary vein; *L.s.v.c.* left superior vena cava; *V.* ventricular cavity.

In *Lissotriton punctatus*, and in *Siredon*, the septum, still complete, ends in the cavity of the auricular segment by a free edge, which arches over the auriculo-ventricular aperture. In *Menobranchus*, the septum is reduced to little more than a wide-meshed network of branched muscular bands, and, in *Proteus*, the existence of a septum is doubtful.

The auriculo-ventricular aperture is always situated at the left side of the posterior end of the auricular segment, where the latter joins the ventricle. In *Rana esculenta* and *pipiens* it possesses distinct, though short, membraneous valves, the free edges of which, directed towards the ventricular cavity, are kept down by fine tendinous filaments.

The common trunk, formed by the union of the two pulmonary veins, runs over the dorsal wall of the *sinus venosus*, passes between the two superior cavæ, and, usually dilating, opens into the cavity of the left auricle, close to the sinu-auricular aperture; and, in fact, separated from it only by the septum, which continues the direction of the right wall of the pulmonary vein.

The *ventricular* segment always has thick walls and a comparatively small cavity, which lies in the anterior half or base of the ventricle, and takes a direction from left to right, or from the auriculo-ventricular aperture to that of the *truncus arteriosus*. In consequence of the loose and spongy texture of the greater part of the thickness of the ventricular wall, it must be recollected that its apparent cavity by no means represents its capacity.

The *truncus arteriosus* of *Menobranchus* is subcylindrical, in that half which is nearest the ventricle, but, in the other half, has a dilated and ovoid form. The latter, in reality, consists of the origins of the aortic arches, closely united together (*synangium*), while the former subdivision is the gateway between the ventricle and the great vessels, or the *pylangium*. It presents two transverse rows of semilunar valves, three in each row; the lower or posterior row being close to the opening of communication between the pylangium and the ventricle, while the other row is near the anterior end of the pylangium.

In *Siredon* (Figs. 15 and 16) there is the same division into a pylangium proper and a large oval bulb-like synangium, formed by the united aortic arches. Three valves in a transverse row are situated at each end of the pylangium. An oblique ridge projects from the dorsal wall of the pylangium, beginning low on the left side, and gradually increasing in size, until it passes into the dorsal valve of the anterior row. There is a small space in front of the anterior row of valves, into which projects the posterior

free end of an oblique, but nearly horizontal septum, which divides the cavity of the synangium. From this thick partition thinner septa radiate to the walls of the synangium, which they thus divide into five longitudinal canals, of which that which lies to the right is twice as large as any of the others. In fact, it also becomes subdivided, further forwards, by a longitudinal septum, and then there are six canals answering to the six aortic arches which spring from the synangium, where it reaches the anterior end of the pericardium. According to Hyrtl's account, the pylangium of *Cryptobranchus* has a very similar structure; but the synangium is completely split into two trunks, each of which contains three canals.

This leads to the structure of the *truncus arteriosus* observed in the Frogs, which consists almost wholly of the pylangium. Three thick semilunar valves are placed at the ventricular end of this region, and three others, also of unequal dimensions, at its synangial end. A longitudinal ridge, with a rounded, free, ventral edge, projects from the dorsal wall of the pylangium. It is thicker anteriorly than posteriorly, and is directed obliquely, so that its anterior end passes into the right anterior valve, while its posterior extremity is close to the left posterior valve. The anterior valves of the pylangium (v^2) are much larger than the posterior valves; and, of the three anterior valves, that which lies on the dorsal side is the smallest. Immediately beyond it is situated the aperture (p), which leads into the pulmonary trunks. In front of the pulmonary aperture is a wide cavity, whence the two great aortic trunks (Ao, Ao^1) spring. A tongue-like projection springs from the dorsal wall, and divides the cavity imperfectly. On the ventral side of the base of this tongue are the two openings (Ca) which lead into the carotid trunks. The three trunks—carotid, aortic, and pulmonary—pass out of the pericardium together, so closely united that they appear one. It is only at some distance beyond the pericardium that they separate,—the anterior ending in the *rete mirabile*, which has received the name of the "carotid gland;" the middle becoming the arch of the aorta; the posterior, the pulmo-cutaneous artery.[1]

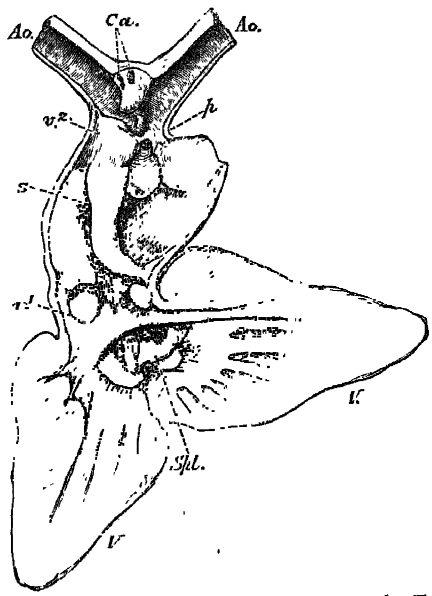


FIG. 23.—The heart of *Rana pipiens*. The ventricle (*V.*), the truncus arteriosus, and the aortic trunks (*Ao.*) are laid open from the ventral side. *Spt.* free edge of the septum auriculorum; v^1. semilunar valves at the ventricular end of the pylangium; v^2. valves at its synangial end; *S*, the septum of the pylangium; *p*, the aperture of the pulmonary trunks; *Ca*, the apertures of the carotid trunks.

In the *Peromela* (*e.g.* *Epicrium*), the heart presents many singular peculiarities (Fig. 24). In the first place, it is moved back to a distance which is relatively far greater than in any other *Amphibia* and in most lizards. Next, it is extremely elongated, and the *truncus arteriosus* is relatively more prolonged than any other part of the heart. But the relative proportions of the pylangium and synangium are the reverse of those which obtain in the *Anura*. The two transverse rows of valves which mark the boundaries of the pylangium are situated close to one another, near the origin of the *truncus*, all the rest of which is made up of the synangium. A longitudinal partition, at first, divides the cavity of the synangium into two unequal passages; but, towards its anterior end, it contains four equal canals. Having reached the anterior extremity of the pericardium, the synangium divides, and the two pairs of canals become independent, but closely united, trunks, which run, on each side of the trachea, to about the level of the glottis. Here the two trunks join, and pass into the single arch of the aorta, which turns sharply back beneath the vertebral column. The carotid artery is given off from the junction of the two trunks with the single dorsal aortic arch. Shortly before the two trunks join, that upon the dorsal side gives off the pulmonary artery. A single pulmonary vein opens into the left auricle; and it is worthy of notice, that the auricles and sinus are situated as far forwards on the dorsal aspect of the heart as in the Frogs.

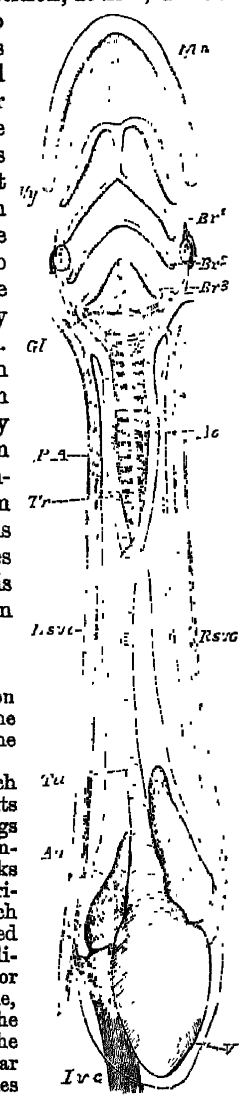


FIG. 24.—Ventral view of the head and trunk of *Epicrium glutinosum*. *Mn.* mandible; *Hy.* hyoid; Br^1, Br^2, Br^3, branchial arches; *Gl.* glottis; *Tr.* trachea; *I.v.c.* inferior vena cava; *V,* ventricle; *Au.* auricles; *R.s.v.c.*, *L.s.v.c.* right and left superior cavæ, *T.a.* truncus arteriosus; *Ao.* left aortic arch; *P.A.* right pulmonary artery. The pericardium (lightly shaded) extends as far as the bifurcation of the synangium.

As regards the number and destination of the great vessels which arise from the synangium, great differences obtain in the different groups of the *Amphibia*.

In the perennibranchiate *Urodela*, each of the three, or four, branchial arches has its appropriate aortic trunk, which springs mediately, or immediately, from the synangium. The three anterior aortic trunks supply the gills, but are not wholly distributed to them; so that the trunks which unite to form the dorsal aorta are derived partly from the gills and partly come directly from the ventral aorta. The anterior aortic arch gives off, on its ventral side, a hyomandibular artery to the walls of the oral cavity, which appears to represent the remains of the hyoidean and mandibular aortic arches, while, dorsally, it supplies the internal carotid. The pulmonary artery is given off from the fourth aortic arch, or from the common trunk, which is formed by the union of this with those which precede it.

In *Cryptobranchus*, according to Hyrtl, three trunks are given off on each side from the synangium. The most anterior corresponds with the hyomandibular artery of the perennibranchiate forms. The second belongs to the first branchial arch. It gives off no branch, but unites with the third and largest vessel to form a common trunk, which unites with its fellow beneath the vertebral column, and gives rise to the dorsal aorta. The posterior aortic arch gives off the pulmonary artery (which supplies a branch to the alimentary canal). From the common trunk a maxillary and an internal carotid artery are supplied; while a third branch passes to the ventral side of the atlas, and, turning backwards, passes between the transverse process of the second and succeeding vertebræ as a collateral vertebral artery.

In *Salamandra*, there are four aortic arches. The most anterior of these belongs to the first branchial arch. It gives off a hyomandibular branch, then breaks up into a *rete mirabile*, whence the internal carotid artery is continued, and is connected by a mere *ductus Botalli* with the second arch. The second and third arches give off no branches; but, along with the slender *ductus Botalli* of the fourth arch, coalesce into the trunk which unites with its fellow to form the dorsal aorta. The fourth arch gives off the

[1] The structure of the heart in the *Amphibia* has been recently discussed with great ability, by M. Armand Sabatier in his *Études sur le cœur* Montpellier, 1873.

pulmonary artery, and a smaller dorsal cutaneous branch (Hyrtl). The pulmonary artery gives twigs to the stomach.

It is clear that the posterior trunk of *Cryptobranchus* represents the second, third, and fourth aortic arches of *Salamandra;* and that the first aortic arch of *Salamandra* answers to the first and second trunks which spring from the synangium of *Cryptobranchus.*

In the *Anura* there are apparently only two aortic arches; but, as has already been observed, each of them is divided into three canals. The anterior canal ends in a *rete mirabile,* whence the internal carotid artery proceeds, and it gives off the hyomandibular or lingual artery. It therefore answers to the first arch of the Salamanders. The second or middle canal is the largest, and passes into a trunk which runs along the sides of the gullet; and curving backwards, unites with that of the opposite side in the dorsal aorta. The third canal ends in a trunk which divides into the pulmonary and the great cutaneous arteries, which latter is distributed to the dorsal integument. It answers to the third and fourth arches in the Salamanders.

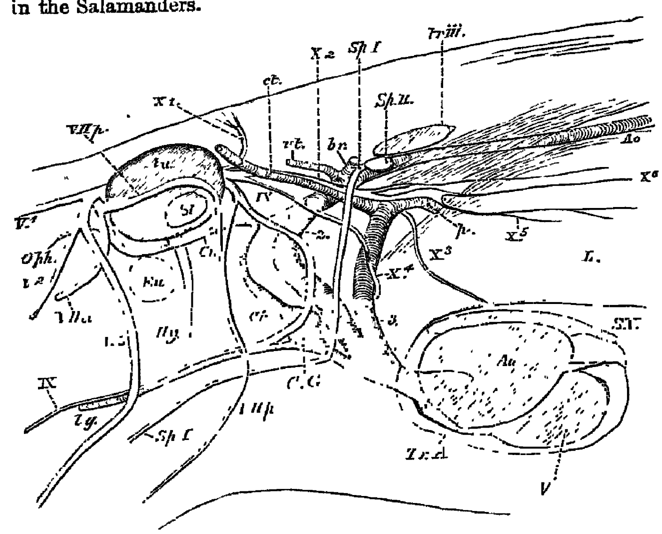


FIG. 25.—The heart, great arterial trunks, and the adjacent principal nerves of *Rana esculenta*, drawn to scale. The positions of the auditory capsule (*Au.*), Eustachian tube (*Eu.*), and hyoidean cornu (*Hy.*), are indicated diagrammatically. *L*, root of the left lung; *S.V.* sinus venosus; *vt.* ventricle, *Au.* auricle; *Tr. A.* truncus arteriosus; *C.G.* carotid gland; *lg.* lingual artery; *Cr.* carotid artery; *Oph.* ophthalmic artery. 2. Left arch of the aorta, passing through the muscular diaphragm to the aorta (*Ao.*) beneath; *tr. iii.* the transverse process of the third vertebra, *br.* the brachial artery. 3. Pulmo-cutaneous artery; *ct.* its cutaneous, *p.* its pulmonary division. Nerves:—V[1], V[2], V[3], first, second, and third divisions of the trigeminal; VII*a*, VII*p*, anterior and posterior divisions of the portio dura; IX., the glossopharyngeal; X[1], the cutaneous branch of the vagus; X[2], the visceral trunk, giving off X[3], the cardiac, X[5], the pulmonic, and X[6], the gastric branches; X[4], the laryngeal branch. *Sp.I.* the first spinal (hypoglossal) nerve; *Sp.II.* the cut trunk of the second spinal nerve.

In the *Peromela* (*Epicrium*) the two aortic trunks which spring from the *truncus arteriosus* would seem to correspond with the second and third of the frog, the first having become absorbed into the second. This is a point which can be cleared up satisfactorily only by the study of development; but it is obvious that the heart and its arches have undergone greater changes in this group than in any of the others.

With respect to the venous system, it is worthy of notice that the blood returning from the hinder part of the body and the posterior extremities is, in part, carried to the kidneys, and in part poured into a vein which runs in the anterior wall of the abdominal cavity,—the *anterior abdominal vein.* Of the branches in which this vein terminates anteriorly, one communicates with the portal vein, and one is distributed to the liver directly. In the *Anura,* venous radicles in the integument covering the back of the head and shoulders, unite to form a great cutaneous vein, which passes backwards, perforates the external oblique muscle, and then turning abruptly forwards, ends in the subclavian vein. This vein carries away a large part of the blood of the cutaneous artery, which accompanies it in a great part of its course.

The *lymphatic system* has been most carefully studied in the frog, where it consists of (1.) widely-distributed lymphatic capillaries, and sinuses which ensheath the blood-vessels; (2.) subcutaneous lymph sacs; (3.) a large subvertebral *cisterna,* enclosed between the diverging lamellæ of the mesentery, and placed in communication with the peritoneal cavity by minute openings or stomata; (4.) four lymph hearts, two situated close to the transverse process of the third vertebra and two at the sides of the coccygeal style. These hearts pump the lymph into the adjacent veins. As the two pairs of lymph hearts have been discovered in *Triton* and *Salamandra* as well as in *Rana*, it is probable that they are present in the *Urodela* generally. No *Amphibia* possess lymphatic glands.

The *Thymus gland* in the *Urodela* lies behind the angle of the mandible (*Triton, Salamandra*), or close to the dorsal ends of the branchial arches (*Proteus, Menobranchus, Siredon, Amphiuma, Menopoma*). In the *Peromela* it has the same position as in the abranchiate *Urodela.* In the tadpole the thymus occupies a place similar to that which it possesses in the branchiate *Urodela.* In the adult frog it is to be found just behind the suspensorium. The *Thyroid gland,* usually double, but single (according to Leydig) in *Proteus,* always lies in the immediate vicinity of the lingual vessels.[1]

The Respiratory Organs.—The glottis in the *Amphibia* is situated in the middle line of the floor of the pharynx. In the perennibranchiate *Urodela,* it is a very small longitudinal slit leading into a narrow passage, which widens into a chamber into which the elongated pulmonary sacs open. The *Urodela* and the *Peromela* present mere cartilaginous rudiments of a larynx; but, in the *Anura,* this structure attains a great development, and becomes the instrument of the powerful voice with which many of these animals are provided. The larynx is lodged in the angle between the two thyro-hyals, with which it is closely connected. The chief part of the larynx is an annular cricoid cartilage, with which two arytænoid cartilages are articulated. Membranous folds, or freely projecting cartilaginous processes of the arytænoid cartilages (*Pipa*), play the part of vocal ligaments. In *Pipa* the larynx is extensively ossified. In *Proteus,* the lungs are long tubes, dilated at their posterior blind ends, and fixed to the dorsal walls of the abdominal cavity by folds of the peritoneum. In *Triton* they are somewhat wider sacs, but, in both, the inner surfaces of the pulmonary sacs are smooth. In *Siren* and *Salamandra,* the walls of the sacs become cellular, and in *Amphiuma, Menopoma, Cryptobranchus,* and the *Anura,* the cellulation acquires a considerable development.

In *Amphiuma, Menopoma, Cryptobranchus,* and in the *Peromela,* there is a distinct trachea, which is of great length in the *Peromela.* In *Pipa* and *Dactylethra* there is no trachea, but each lung is connected with the laryngeal cavity by a bronchus.

The Renal Organs.—The kidney is a more or less elongated organ—longer in the *Urodela* and *Peromela,* shorter in the *Anura*—which lies on each side of the vertebral column, its posterior end being close to, or even extending back on the dorsal side of, the cloaca.

In the female the efferent ducts of each kidney unite into a longer or shorter common trunk, which appears always to open into the cloaca by an aperture distinct from that of the oviduct, though the contrary statement is very generally received.[2] In *Rana esculenta,* there can be no doubt as to the distinctness of the minute urinary apertures from the large and conspicuous oviducal openings, close to which they are situated. Hyrtl says of *Cryptobranchus*—"Ureter . . . . super latera cloacæ descendens in collum allantoidis exoneratur" (*op. cit.*, p. 84).

In the male *Amphibia,* on the other hand, there is a longer or shorter duct common to both the renal and the genital products, which opens into the cloaca. In the *Urodela,* the duct is continued forwards along the outer side of the kidney to the anterior end of the ab-

[1] See Leydig, *Anatomisch-histologische Untersuchungen über Fische und Reptilien,* 1853.

[2] See, for example, Stannius, *Handbuch der Amphibien,* pp. 250, 251. On the other side, comp. Milne-Edwards, *Leçons* t. vii. p. 336.

dominal cavity, and clearly represents the Wolffian duct of the embryo. Both the urinary tubuli and the *vasa efferentia* of the testis open into this duct. In *Cryptobranchus* the kidney is divided by a constriction into two portions—a slender, anterior, and a much thicker and longer, posterior, division. From the latter the efferent urinary canals proceed, and, curving outwards and backwards, join the posterior part of the Wolffian duct. The former is traversed by the *vasa efferentia* of the testes, which pass from its outer edge to the anterior portion of the Wolffian duct, so that it resembles an epididymis.[1]

In *Proteus*, according to Leydig, the anterior end of the Wolffian duct is infundibuliform and open; the *vasa efferentia* of the testes open into the anterior moiety of the duct, the renal ducts, into its posterior moiety. The numerous arcuated renal ducts of the Salamanders and Tritons unite together, and open into the Wolffian duct near its cloacal end. The Wolffian duct persists in *Bombinator igneus* and *Discoglossus pictus*[2]; but, in most *Anura*, it becomes obliterated for the greater part of its extent, and the same canals serve to convey both the urinary and the spermatic fluids to the persistent cloacal end of the Wolffian duct, which ordinarily receives the name of ureter. The urinary bladder is always large, and is often bifurcated anteriorly.

The Nervous System.—The amphibian brain is remarkable for the rudimentary condition of the cerebellum, which has the form of a mere band arching over the anterior part of the fourth ventricle. The mesencephalon is divided above, more or less distinctly, into two optic lobes. The cerebral hemispheres are always relatively large, subcylindrical in the *Urodela*, but wider behind than in front in the *Anura*, and they are generally closely united together by their inner faces.

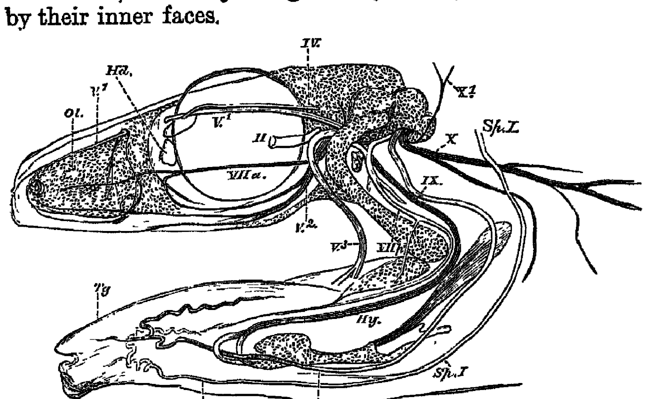


FIG. 26.—Diagram of the chief cranial nerves of *Rana esculenta*. II. optic, IV. pathetic; V¹, orbito-nasal; V², superior maxillary; V³, inferior maxillary; VIIa. VIIp. anterior and posterior divisions of the portio dura; IX. the glosso-pharyngeal; X. the pneumogastric; XI, its dorsal branch. *Sp. I.* The first spinal nerve (hypoglossal). *Ol.* olfactory nerve; *Tg.* tongue; *Hy.* cornu of the hyoid; *Hd.* Harderian gland.

Ten pairs of cranial nerves are always found—viz., 1, The olfactory; 2, optic; 3, oculomotor; 4, pathetic; 5, trigeminal; 6, abducens; 7, portio dura; 8, auditory; 9, glossopharyngeal; 10, pneumogastric. The hypoglossal is always an extra-cranial nerve.

1. The *olfactory* is usually a rounded cord, not dilated at its anterior end. Fischer has observed it to arise by two roots in *Pipa*.

2. The *optic* nerves are attached, as usual, to the floor of the thalamencephalon. Fischer[3] found no chiasma in *Siredon* or *Menobranchus*. Dr Humphrey found none in *Cryptobranchus*; but sections of the brain are needful before the actual absence of the chiasma can be considered to be satisfactorily proved.

3. The *oculomotor* nerve remains distinct from the trigeminal in most *Amphibia*, but its branch to the superior *rectus* muscle appears to coalesce with the orbito-nasal division of the fifth in *Salamandra terrestris* (Fischer).

4. The *pathetic* nerve remains distinct in *Siredon* and *Cryptobranchus*, and in the *Anura*; but in *Salamandra terrestris*, Fischer found that the superior oblique muscle was supplied by a branch from the orbito-nasal, with which, therefore, the pathetic had probably coalesced.

5. The *trigeminal* gives rise, as usual, to a Gasserian ganglion; and this ganglion remains distinct from that of the seventh nerve in all the *Urodela*, though united with it by a commissural band, which appears to answer to the *nervus petrosus superficialis minor* of the higher *Vertebrata*. In the *Anura*, on the contrary, the two ganglia are closely approximated (*Pelobates*, *Bombinator*)[4], or confounded together (*Rana*, *Hyla*, *Bufo*) in the adult, though they are distinct in the tadpole. The orbito-nasal, or first division of the trigeminal, is always separated from the second and third divisions by the ascending process of the suspensorium, when this structure is present. It supplies the tentacles of the *Peromela*. In the tadpole, and in some *Urodela*, a cutaneous branch to the dorsum of the head is given off from the fifth.

6. The *abducens* is distinct from the trigeminal in *Salamandra* and *Bufo*, but coalesces with the Gasserian ganglion in *Rana*, *Pipa*, and most *Anura*.

7 and 8. The *portio dura* and *portio mollis* arise by a common trunk, from which the *portio dura* soon separates, and either forms a distinct ganglion, as in the *Urodela* and *Peromela*, or fuses with the trigeminal.

9. The ganglion of the *glossopharyngeal* nerve appears to coalesce with that of the vagus, and the roots of the two nerves pass out of the same foramen in all the *Amphibia* except *Siren*, where, according to Fischer (*op. cit.*, p. 147), the nerve leaves the skull by a distinct aperture, close in front of that for the pneumogastric, and forms a ganglion of its own.

10. The *vagus* or *pneumogastric*, in the perennibranchiate *Amphibia*, supplies the second and third branchia, and the *cucullaris* muscle; gives off cutaneous, laryngeal, cardiac, pulmonic, and gastric branches, and sometimes as many as three cutaneous branches, one of which runs along the junction of the dorsal and ventral muscles to the hinder part of the body. These lateral nerves of the pneumogastric exist also in *Menopoma*, *Amphiuma*, and *Triton*, and in tadpoles; but appear to be absent in *Salamandra terrestris* and in the adult *Anura* (Fischer, *l.c.*) These, however, possess a cutaneous branch of the vagus, which accompanies the cutaneous branch of the pulmo-cutaneous artery, and is distributed more or less widely to the dorsal integument of the head and trunk.

Fischer considers that a fine nerve, arising lower down than the vagus, and distributed to the abductors of the head in *Pipa*, is to be regarded as an *accessorius*. But, seeing that, in the *Amphibia* generally, the motor nerves of the larynx, and, where a *cucullaris* exists, the nerves of that muscle also, are supplied from the pneumogastric, the question of the presence or absence of an *accessorius* seems to reduce itself to this: Does the pneumogastric receive nerve fibres arising from the sides of the *medulla oblongata* and spinal cord between the roots of the spinal nerves? And, as it certainly does not, the *accessorius*, as it exists in the higher *Vertebrata*, must be admitted to be absent in *Amphibia*.

In most *Amphibia*, the first cervical nerve has the dis-

[1] Schmidt, Goddard, and Van der Hoeven, *Aanteekningen over de Anatomie van den Cryptobranchus japonicus*.

[2] According to Von Wittich. "Beiträge zur morphologischen und histologischen Entwickelung der Harn und Geschlechtswerkzeuge der nackten Amphibien," *Zeitschrift für Wissenschaftliche Zoologie*, bd. iv.

[3] *Anatomische Abhandlungen*, p. 123, *et seq.*

[4] According to Stannius, *Handbuch*, p. 150.

tribution of the hypoglossal; in *Menobranchus*, however, the corresponding nervous supply is furnished by the second and third cervical nerves,—the first spinal nerve, in this genus, perforating the sides of the body of the atlas, and being distributed to a muscle which passes from this vertebra to the occiput (Fischer, *l.c.*, p. 158). In *Pipa* the hypoglossal is furnished by the second cervical nerve; in *Salamandra*, by the first and second. There is no trace of any suboccipital nerve in the *Amphibia;* and as, in the absence of this nerve, the first spinal would appear to answer to the second cervical of the higher *Vertebrata*, the fact that it takes the place of the hypoglossal becomes very perplexing.

In the *Anura* (*Rana*) the sympathetic is represented by a double chain of ganglia, situated at the sides of the aorta, and receiving branches from the anterior divisions of the spinal nerves. It appears to be continued in the skull by commissural cords which pass forwards on the inner side of the auditory capsule, and connect the ganglion of the vagus with that of the trigeminal.

The Organs of the Higher Senses.—The nasal sacs are elongated in *Proteus*, *Menobranchus*, and *Siren*, and not covered by nasal bones or alinasal cartilages. In the other *Amphibia* they are broader, and enclosed by cranial cartilages and ossifications. The olfactory mucous membrane is variously folded; and, in *Rana*, some of these folds are supported by ingrowths of the anterior cartilaginous wall of the nasal chamber.

In *Proteus* the eye is completely hidden by the continuation of the unaltered integument over it, and the organ of vision is almost as much obscured in the *Peromela*. In the other perennibranchiate *Urodela*, and in *Pipa*, the integument covering the eye forms a transparent cornea, but there are no eyelids. The abranchiate *Urodela* have an upper and a lower lid; and, in the higher *Anura*, the lower lid becomes transparent, and is usually regarded as a *membrana nictitans*, as it is provided with a peculiar motor apparatus. In the *Anura*, the eye possesses not only the ordinary four *recti* muscles and the two *obliqui*, but there is a *retractor bulbi*. The Frogs and probably other *Anura*, possess a Harderian gland; but no lachrymal gland has been observed. The sclerotic may be chondrified, but it is not ossified. There is no pecten.

With regard to the organ of hearing, the membranous labyrinth is enclosed between the pro-otic bone, in front, and the representatives of the opisthotic and epiotic (usually confounded with the exoccipital), behind. The *fenestra ovalis* always occupies a space in the line of junction of the pro-otic with the posterior ossification, whether it be occupied by a broad unossified space, as in *Menopoma*, or the two bones be ankylosed together, as in *Siren*, *Triton*, and old Frogs. The stapes is more or less ossified, and its outer face is frequently provided with a styliform appendage, in the *Urodela*. In the *Urodela* (which have no tympanic cavity), a ligament passes from the stapes to the suspensorium, and there is no *columella auris*. The like absence of *columella auris* and of a tympanum obtains in several *Anura*. Dugès states that the columella is wanting in *Bombinator* and *Pelobates*[1] (*Recherches*, p. 41), and the absence of the *columella auris*, as of the tympanum and Eustachian tubes, has since been noticed in *Telmatobius*, *Phryniscus*, *Atelopus varius*, and *Brachycephalus ephippium* (Stannius, *op. cit.*, p. 61). In the higher *Anura*, there is a complete tympanum, with Eustachian tubes, and a *columella auris*, which extends from the stapes to the *membrana tympani*. The tympanic membrane is either quite similar to the rest of the integument or markedly different from it. In some genera (*e.g. Rana*), the tympanic membrane is set in a frame of cartilage. In *Pipa* and *Dactylethra*, the Eustachian tubes, as already remarked, have a common opening, and the columella is very peculiar. Recent investigations make it probable that the *Amphibia* possess a rudimentary cochlea.[2] Whether the opening, which in the Frogs has been described as a *fenestra rotunda*, is really of that nature, is doubtful.

The Reproductive Organs.—The ovaria and testes are attached to the dorsal wall of the abdominal cavity, in the immediate vicinity of the kidneys, by the mesoarial and mesorchial folds of the peritoneum, which invest them.

The ovaria, when fully developed, become hollow, and in the *Anura* their internal cavities may be divided by septa.

The oviducts are long, usually more or less convoluted, tubes, which open posteriorly into the cloaca; while, anteriorly, their funnel-shaped apertures lie in the anterior part of the abdomen, sometimes, as in the Frogs, as far forward as the root of the lung. Their walls are glandular, and secrete a viscid substance which invests the ova in their passage down the oviduct.

In the male *Urodela*, the persistent Wolffian duct, already mentioned, occupies the position of the oviduct in the female, and the *vasa efferentia*, after traversing the kidney, open into it. This duct persists in *Bombinator igneus* and *Discoglossus pictus;* but in the male *Anura*, in general, the greater part of it is obliterated, only so much remaining as plays the part of ureter and *vas deferens*. In the *Urodela* accessory glands open into the cloaca, and in *Triton* there is a rudimentary copulatory papilla. Some female *Urodela* are provided with *receptacula seminis*. In the terrestrial Salamanders and in the anurous *Rhinoderma Gayi* the young are developed within the dilated uterine terminations of the oviducts. In *Pipa* the eggs are deposited on the back of the female, and the integument grows up round each, and encloses it in a cell, in which it undergoes its development. In some tree-frogs (*Nototrema* and *Opisthodelphys*) the eggs are received into a sort of marsupial pouch formed by an up-growth of the margins of the dorsal integument, which, when complete, has a small posterior aperture. On the other hand, it is the male *Alytes obstetricans* which twists the strings of eggs laid by the female round his hind-legs, and, thus cross-gartered, retires into seclusion until the young are ready to be hatched, when he resorts to the water in which the tadpoles are to perform their further metamorphoses.

Development of the Amphibia.—The yelk of the ovum undergoes complete division, in which respect the *Amphibia* agree with the *Pharyngobranchii*, *Marsipobranchii*, and *Mammalia*, and differ from other *Vertebrata;* though it must be remembered that the process of yelk division in the *Ganoidei* and *Dipnoi* is not yet known.

Except in some viviparous species, the embryo, when hatched, is pisciform and apodal; and three pairs of external gills, which become more or less branched, are developed from the first, second, and third branchial arches. In the larval *Triton* a very singular elongated appendage makes its appearance on each side of the head, in front of the branchiæ;[3] and in the tadpole two eminences of the ventral integument, with glandular terminal faces, are developed—one on each side of the middle line, behind the mouth. The larvæ of *Dactylethra* have two long tentacles attached near the angle of the mouth. An opercular fold of the integument grows back from each hyoidean arch, and the two are connected by a free fold of the subgular integument. The limbs make their appearance as buds from the sides of the body, the anterior pair appearing first. The anterior limbs attain a considerable size before the posterior pair are developed in *Triton;* but, in the Frogs, the posterior limbs grow much faster than the anterior, which long remain inconspicuous and hidden.

In the Urodele larvæ, teeth are very early developed in the premaxillary, maxillary, vomerine, palatine, splenial, and dentary

[1] *Pelobates*, however, has an extremely minute, ossified, *columella auris*.

[2] See Hasse, *Die vergleichende Anatomie des häutigen Gehörorganes*, Leipsic, 1873.

[3] The larval *Siredon* has no such hyoidean (?) appendage.

regions; and, indeed, in *Triton* and *Siredon*, the teeth precede the corresponding bones, which arise by the ossification of the mucous membrane about the bases of the teeth; and there are no labial cartilages, and no horny labial papillæ, or beak-like armature of the jaw. The abdomen is slender, in accordance with the brevity of the intestine, and the little animal is altogether carnivorous.

In the *Anura*, on the other hand, teeth are not developed until a later stage. A pair of cartilages appear in the roof of the mouth in front of the ends of the trabeculæ ("*rostraux supérieurs*," Dugès; "upper labials," Parker), and another pair opposite them ("*rostraux inférieurs*," Dugès; "lower labials," Parker); and the epithelium of the mucous membrane covering them becomes converted into an upper and a lower brown horny toothed plate, having some resemblance to the beaks of a Chelonian. The curtain-like lips, which surround the oral aperture, are also beset with horny papillæ, which call to mind the corneous teeth of the Marsipobranchii. The abdomen is swollen and almost globular, and lodges a long and spirally-coiled intestine. The animal is herbivorous, though it does not despise animal food, even in the shape of the weaker members of its own family.

The space allotted to this article does not allow the details of the development of the *Amphibia* to be even sketched; but attention may be directed to one or two of the more important points.

The skull presents some singular differences in the course of its development in the *Urodela* (*Triton*, *Siredon*) and the *Anura* (*Rana*, *Alytes*) respectively. In the former, the mandibular and trabecular arches become connected only at their dorsal ends, by the pedicle of the mandibular arch; the pterygoid arch is developed late; and the mandibular arch appears to give rise to no orbital process. In the latter, the mandibular and trabecular arches not only unite at their dorsal ends by the pedicle, but, at a very early period, the mandibular arch is united with the antorbital process of the trabecula; and the pterygoid grows *pari passu* with the subsequent divergence of the mandibular and the trabecular arches. A large orbital process is developed from the mandibular arch.

In the *Urodela*, the hyoidean and branchial apparatus consists, at first, of elongated cartilaginous hyoidean cornua, united with a median chondrification, which represents the basihyal and basibranchial pieces, to which last two cerato-branchials are attached. The first cerato-branchial is continued dorsally into the first epibranchial, while the second cerato-branchial supports the other three epibranchials. As the development of the *Triton* proceeds, the hyoidean arch becomes connected with the suspensorium, and with the stapes, by ligament. The second basi-branchial ossifies, detaches itself from the first, and lies as a forked bone in front of the larynx; and only the two cerato-branchials, with the first epibranchial, remain—the rest of the branchial apparatus disappearing.

In the *Anura*, the hyoidean arches are, at an early period, very thick, and relatively short, and are articulated with the suspensoria. A relatively broad and short cartilage represents the basihyal and basibranchial, and at the sides of this are two very broad cartilages, which correspond with the two cerato-branchials, inasmuch as their dorsal edges bear the four epibranchial cartilages. As the tadpole grows older, the hyo-branchial apparatus becomes more like that of the Urodele larva, the hyoid arch elongating into a slender rod, and the two cerato-branchials becoming distinct. The basibranchial region of the median cartilage, which unites the cerato-branchials ventrally, becomes forked, and the processes which form the fork ossify and become the thyro-hyals, which therefore would seem to correspond with the *os ypsiloides* of the *Urodela*. Finally, the extreme dorsal end of the hyoidean arch detaches itself from the suspensorium, and enters into close union with the periotic capsule, from the outer wall of which the *columella auris* is developed.[1]

The Distribution of the Amphibia.—Darwin has pointed out (*Origin of Species*, p. 350) that *Amphibia* are met with on no islands but New Zealand, New Caledonia, the Andaman Islands, and perhaps the Solomon Islands and the Seychelles. "This general absence of frogs, toads, and newts in so many true oceanic islands cannot be accounted for by their physical conditions; indeed, it seems that these are peculiarly fitted for those animals, for frogs have been introduced into Madeira, the Azores, and Mauritius, and have multiplied so as to become a nuisance. But as these animals and their spawn are immediately killed (with the exception, so far as is known, of one Indian species) by sea-water, there would be great difficulty in their transportal across the sea, and therefore we can see why they do not exist in strictly oceanic islands."

Leaving the oceanic islands aside, the distribution of the *Amphibia* is world-wide, but the different groups are very remarkably localised.

The *Urodela*, for example, are limited not only to the arctogæal province, but to the temperate parts of that province; and, in curious correspondence with the Ganoid fishes, their headquarters are in North America. *Siren*, *Menobranchus*, *Amphiuma*, *Menopoma*, *Dicamptodon*, *Heredia*, *Anaides*, *Desmognathus*, *Batrachoseps*, *Hemidactylus*, and *Plethodon* are exclusively North American; and the majority of species of *Amblystoma* and *Spelerpes* appertain to that region,—*Amblystoma* being represented in North Asia, and *Spelerpes* in the circum-Mediterranean area. *Triton* alone is spread over the whole temperate arctogæal area. *Salamandra*, *Pleurodeles*, *Bradybates*, *Chioglossa*, and *Salamandrina* are confined to Europe and North Africa. The singular *Salamandra atra* is limited to the Swiss and Austrian Alps, *Proteus* to Carniola and Carinthia. Four genera—*Ellipsoglossa*, *Isodactylium*, *Onychodactylus*, and *Ranodon*—are confined to North Asia; and *Cryptobranchus*, if it be a distinct genus, is limited to Japan.

If the distribution of the *Urodela* calls to mind that of the Ganoid fishes, that of the *Peromela* is rather comparable to the distribution of the Tapirs. Of the four genera, *Siphonops* and *Rhinatrema* are exclusively inhabitants of the hotter part of the Austro-Columbian province—as are the great number of the species of *Cæcilia*; but the remaining species of that genus are East Indian, and *Epicrium* is confined to Java and Ceylon.

In strong contrast with the foregoing, the *Anura*[2] are of world-wide distribution, being abundantly represented in all the great provinces. A great preponderance of the genera and species, however, are Austro-Columbian, the *Anura* having their headquarters in South America, as markedly as the *Urodela* have theirs in the northern division of that continent. North America, in fact, is poor in *Anura*, having only three peculiar genera, viz., *Scaphiopus*, *Acris*, and *Pseudacris*; while the rest of northern Arctogæa has five, viz., *Pelodytes*, *Discoglossus*, *Alytes*, *Pelobates*, and *Bombinator*.

The genus *Rana* itself, however, is characteristically arctogæal, having only a single species in the Mexican border-land of Austro-Columbia, and none in Australia. *Rana esculenta* extends from France to China and Japan, and from North Europe to Tunis. *Rana temporaria* covers even a larger area, as it occurs in the British Islands and in North America, as well as in North Asia and Japan.

The Austro-Columbian region not only presents the greatest number of species, but among them are some of the most singular forms, such as *Pseudis*, *Ceratophrys*, *Brachycephalus*, *Rhinoderma*, *Engystoma*, *Otilophus*, *Nototrema*, *Opisthodelphys*, *Rhinophrynus*, and *Pipa*; in which respect the South American *Anura* run parallel with the birds of the same region. And, as is seen in other cases, the nearest allies of many of these singular forms are to be found in Ultra-Saharal (Æthiopic) Africa, *e.g.*, *Hemisus* (*Brachycephalus*), *Breviceps* (*Engystoma*), *Dactylethra* (*Pipa*). It is remarkable that *Pseudophryne*, which is closely allied with the Æthiopic *Hemisus* and the Austro-Columbian *Brachycephalus*; and *Chelydobatrachus*, which is similarly related to the Æthiopic *Breviceps* and the Austro-Columbian *Engystoma*, are Australian.

The Australian region is remarkable for the absence of the genera *Rana* and *Bufo*, which occur everywhere else; and for the occurrence of *Cystignathus*, which is an Austro-Columbian, North American, and Æthiopian form, but does not occur in India. If it were not for its tree-frogs, Australia would be poorer in *Anura* than Europe is.

These *Anura*, modified for arboreal life, or "tree-frogs," are represented in all the distributional provinces—the genus *Hyla* having its chief seat in Austro-Columbia, and extending thence over North America, Europe, North Africa, Western and Eastern Asia, and Australia, but not into India or Ultra-Saharal Africa, in which other forms of the same group are met with.

The British Islands possess the following species of *Amphibia*:—*Rana temporaria*, *Bufo vulgaris*, *B. calamita*, *Triton cristatus*, *T. Bibronii*, *Lissotriton punctatus*, *L. palmipes*.

Geological Distribution.—No fossil *Peromela* are known. *Anura* occur in the Miocene deposits of France and Germany. The best preserved forms belong to the genera *Palæobatrachus* and *Latonia*, and occur in the schists of Œningen along with their tadpoles. They possess maxillary teeth, and present no important differences from existing *Anura*, except that, in *Palæobatrachus*, the sacral vertebra has coalesced with the two preceding vertebræ, while, in existing forms, only one of the præ-sacral vertebræ is known to become confluent with the sacral. *Urodela* also occur in the same Miocene deposits. Of these the famous *Andrias Scheuchzeri* is very closely allied to *Menopoma* and *Cryptobranchus*, while other forms appear to be generically identical with *Triton* and *Salamandra*. The singular genus *Orthophysis* presents a good deal of resemblance to *Proteus*, but appears to have possessed no limbs.

The older Cainozoic and the upper and middle Mesozoic formations have yielded no *Amphibia*. A doubtful form, *Rhinosaurus*,

[1] See the Memoirs of Dugès and Parker, already cited, for the details of these metamorphoses. The account given by Mr Parker of the modifications of the dorsal extremity of the hyoidean arch, however, does not accord with the results of the present writer's later investigations. No coalescence of the hyoidean with the mandibular arch takes place; and the "supra-hyo-mandibular" has nothing to do with the *columella auris*.

[2] See Dr Günther's valuable *Catalogue of the Batrachia salientia*.

occurs in the Lias of Simbirsk. In the earliest Mesozoic deposits—the Trias,—and in the later Palæozoic—the Permian and the Carboniferous formations, *Amphibia* occur, sometimes in great abundance. In the Trias, they have been found in greatest numbers in Germany, while the Carboniferous formations have furnished the largest supply in the British Islands, Germany, and North America. It is interesting to observe that the last-named region has recently yielded elongated apodal forms, allied to the *Ophiderpeton* of the Kilkenny coal measures.

Ætiology of the Amphibia.—In taking a general survey of the relations of the different great divisions of the *Amphibia*, the most striking fact is their singular distinctness and isolation from one another. None of the *Peromela* present the slightest indication of an approximation towards the *Anura* or the *Urodela*.

It may be suggested that the incompleteness of the jugal arch in *Breviceps*, *Pipa*, and *Dactylethra;* the absence or rudimentary condition of the palatine bones in *Breviceps*, *Bombinator*, and *Alytes;* the rudimentary condition of the tympanum, and the absence, or reduction to a rudiment, of the *columella auris*, in so many forms; the presence of rudimentary ribs attached to some of the anterior vertebræ of *Bombinator* and *Alytes;* the presence of mandibular teeth in *Hemiphractus* and *Grypiscus;* and the peculiar spermatozoa of *Bombinator*, are so many indications of an approach towards the type of structure observed in the higher *Urodela*.

But, without underestimating the force of these considerations, it must be admitted that they count for very little, when we take into consideration the fixity of the number of the vertebræ, and of the characters of the pelvis and of the limbs, in the *Anura*.

It is to be regretted that nothing is known of the development of any of the *Peromela;* of any of the *Urodela*, except *Salamandra*, *Triton*, and *Siredon* (*Amblystoma*); and of more than a few of the *Anura*. Among the lower forms of this division, the development of *Alytes* and *Pelobates* has been studied thoroughly by Vogt[1] and Van Bambeke;[2] and the more advanced conditions of the tadpole of *Dactylethra* are known. So far as these observations go, however, they tend to show that the larvæ of all the *Anura* possess the horny beak, which distinguishes them from those of the *Urodela*.

If we assume, as the fundamental similarities between the different divisions of the *Amphibia* lead us to do, that they have resulted from the modification of some one primitive form, the problem, at present seemingly insoluble, presents itself, whether these differences in structure and habit of the larvæ of the *Urodela* and *Anura* indicate that the caudate ancestor of the *Anura* was already different from the ancestor of the *Urodela*, or whether they result from modifications which have taken place in the larvæ of the *Anura*, since that group came into existence.

In view of this problem, *Siren* possesses a particular interest. Its horny jaw-sheaths might be compared to those of the Anuran tadpole, and it might be regarded as showing the way by which the Anuran became differentiated from the caudate original stock. But the horny sheaths in *Siren* rest directly upon the premaxillæ and the dentaries, and not on labial cartilages; and as to its habits of life, *Siren* appears to be eminently carnivorous (Duméril et Bibron, *Erpétologie Générale*, i. 196). As has been already stated, no fossil remains of *Peromela* are known, but *Urodela* and *Anura* occur in some abundance, and, in certain cases, in an excellent state of preservation, as far back as the middle of the Tertiary epoch. Now, these fossils show that the Anurous and Urodelous types of organisation were, at that time, thoroughly differentiated from one another. *Palæobatrachus*, with its three vertebræ ankylosed into a sacrum, is, in fact, a singularly modified frog; while among the *Urodela*, the *Salamandrida*, the *Menopomida*, and very possibly the *Proteida*, are severally represented. The young of the Miocene *Anura* were tadpoles so similar in form to those of the existing frogs and toads, that there is no reason to doubt their resembling them in other respects.

There can be little question, then, that the Anurous and the Urodelous types must have been represented before the Tertiary epoch; but here their history breaks off, no amphibian belonging to any living groups having been discovered in Mesozoic or older strata, as far as the Lias.

From the Trias to the Carboniferous formations, inclusively, the fresh-water deposits abound in *Amphibia*. But all these, so far as we have any positive knowledge, are referable to the Labyrinthodont type. No Labyrinthodont presents the slightest approximation towards the *Anura;* but elongated and apodal, as well as salamandroid forms occur; and in their cranial structure, no less than in the presence of scale-like dermal ossifications, they approach the *Peromela*. In regard to their possible relations with the *Urodela*, it is interesting to observe that in some Labyrinthodonts, at any rate,[3] the manus has the five digits, one of which, at least, is lost in all the *Urodela*, and the pelvis appears to have had a distinct and completely ossified pubic element, which has also disappeared in all existing *Amphibia* (Miall, *Report, l.c.*)

The Labyrinthodonts present a few characters—such as the paired supra-occipital ossifications and the complications of the folds of their teeth—by which they approach the Ganoid fishes more than any other *Vertebrata;* and it is worthy of notice that the lowest Labyrinthodonts, such as *Archegosaurus*, present no approximation to the cranial characters of the lower *Urodela*, and show no evidence of the largely-developed branchial apparatus which is so characteristic of the latter.

Thus, if upon such slender evidence as exists, it is justifiable to speculate at all concerning the "phylogeny" of the *Amphibia*, the most probable conclusion appears to be that the *Labyrinthodonta*, the *Urodela*, and the *Anura* diverged from one another at a very early period of geological history; while, possibly, the *Peromela* are the last remnants of the peromelous modification of the Labyrinthodont type.

With respect to the origin of the amphibian stock itself, the following considerations appear to be of fundamental importance:—1. The early stages of development of the *Amphibia* do not resemble those of any known Ganoid, Telostean, or Elasmobranch fish, and are similar to the corresponding stages of the *Marsipobranchii*. 2. The skull of the lowest *Urodela* has, in some respects, advanced but little beyond the Marsipobranch stage. In the higher *Urodela* there are numerous points of resemblance with the Ganoids. The skull of the tadpole, on the other hand, has much in common with that of *Chimæra* (as Müller has pointed out), and with that of the *Dipnoi*, while the chondrocranium of the adult frog has many singular affinities with that of the *Elasmobranchii*, and particularly of the Rays. 3. The only *Vertebrata*, besides the *Amphibia*, which have transitory external gills are the *Elasmobranchii*, the *Dipnoi*, and perhaps some Ganoids. 4. The only fishes in which the cerebellum is rudimentary are the *Marsipobranchii* and *Ganoidei*. 5. The only fishes in which the amphibian and embryonic connection between the male reproductive organs and the renal efferent ducts is observed are the Ganoids. 6. The only fishes which have a "pylangium," with valves disposed as in the *Amphibia*, are the Ganoids, Elasmobranchs, and *Dipnoi*. 7. The only fishes which possess morphological (*Polypterus*) or functional (*Dipnoi*) lungs are the Ganoids and *Dipnoi*. The conclusions suggested by these facts appear to be that the *Amphibia* took their origin from some primordial form common to them, the *Elasmobranchii*, the *Ganoidei*, and the *Dipnoi;* and that the main distinction by which their earliest forms were marked off from those of the other groups, was the development of that pentadactyle type of limb, which is common to all the higher *Vertebrata*. And seeing that the Elasmobranch, Ganoid, and Dipnous types were fully differentiated from one another in the Devonian epoch, it is reasonable to believe that the existence of the *Amphibia*, as a group, dates back at least as far as that remote period of the earth's history.

Taxonomic Synopsis of the Amphibia.

I. The Urodela.

A. Branchiæ persistent throughout life. (*Perennibranchiata.*)

1. *Trachystomata.*—Skull elongated; præmaxillæ and dentary piece of the mandible provided with horny plates; premaxillæ not ankylosed; no nasal bones, but ossifications between the ascending processes of the premaxillæ; maxillæ rudimentary or absent; palatines small, oval, and beset with "*dents en brosse;*" pterygoid absent; four persistent branchial arches; pelvic arch and limbs absent.
Siren.

2. *Proteida.*—Skull elongated; premaxillæ and dentaries dentigerous; maxillæ rudimentary or absent; premaxillæ not ankylosed; no nasal bones; palatines bearing a single row of teeth, and coalescent with the pterygoids; three persistent branchial arches; both the pectoral and the pelvic arches and limbs developed.
Proteus, Menobranchus.

B. Branchiæ caducous; gill-clefts persistent. (*Derotremata.*)

3. *Amphiumida.*—Skull elongated; premaxillæ and dentaries dentigerous; maxillæ large; premaxillæ ankylosed; large nasal bones; palatines absent; pterygoid present, elongated; a basihyal cartilage; four persistent branchial arches; both the pectoral and the pelvic limbs developed, though very small.
Amphiuma.

[1] Vogt, *Untersuchungen über die Entwickelungsgeschichte der Geburtshelferkröte* (*Alytes obstetricans*), 1842.

[2] Van Bambeke, "Recherches sur le développement du Pelobate brun," *Mém. de l'Acad. de Belgique*, 1868.

[3] "Description of the Vertebrate Remains from the Jarrow Colliery," by Prof. Huxley, F.R.S., *Transactions of the Royal Irish Academy*, vol. xxiv. 1867, pl. xix. fig. 2.

4. *Menopomida.*—Skull broad; premaxillæ and dentaries dentigerous; maxillæ large: premaxillæ not ankylosed; large nasal bones; palatines absent; pterygoid present and very broad; a basihyal cartilage; persistent branchial arches may be reduced to the first and second; the cerato-hyal and epibranchial are confluent in the first, distinct in the second branchial arch; both pectoral and pelvic limbs well developed.

Menopoma, Cryptobranchus.

C. Branchiæ caducous, and gill-clefts closed in the adult condition. (*Myctodera.*)

5. *Salamandrida.*—Skull broad; premaxillæ and dentaries dentigerous; maxillæ large; premaxillæ separate or ankylosed; nasal bones present, and usually large; palatines present in the young state, and situated as in the *Trachystomata* and *Proteidea*, but changing their relations in the adult; pterygoids present; the first and second branchial arches persistent,—the first two-jointed, the second a single piece.

[The latest writer on the classification of the *Urodela*, Professor Strauch ("Revision der Salamandrinen-gattungen," *Mém. de l'Acad. Imp. des Sciences de St Petersbourg*, se. vii. tome xvi.), divides the *Salamandrida* into two tribes,—*Mecodonta* and *Lechriodonta*; the first comprising all those species, the vomero-palatine teeth of which are disposed along the inner edges of two backwardly diverging processes of the bones, and therefore form two longitudinal series divergent posteriorly; and the second, those which have the teeth disposed along the posterior edges of the vomero-palatine bones, which are sometimes truncated posteriorly, sometimes produced into a longer or shorter median process, and on which, therefore, the teeth are either directed transversely, or form two oblique series, more or less rapidly converging backwards.]

a. Mecodonta—

Salamandra, Pleurodeles, Bradybates, Triton, Chioglossa, Salamandrina.

b. Lechriodonta—

Ellipsoglossa, Isodactylium, Onychodactylus, Amblystoma, Ranodon, Dicamptodon, Plethodon, Desmognathus, Anaides, Hemidactylium, Heredia, Spelerpes, Batrachoseps.

II. The Anura.

[For the classification of the *Anura*, consult Dr Günther's valuable *Catalogue of the Batrachia salientia*; Mr Cope's papers in the *Natural History Review*, 1865, and in the *Journal of the Academy of Natural Science of Philadelphia*, N.S., vol. vi.; and Mr Mivart's essay "On the Classification of the Anurous Batrachians," in the *Proceedings of the Zoological Society*, 1869. Far more minute investigation of the structure of the *Anura* than has yet been carried out seems to be requisite before their classification can be placed upon more than a provisional footing. The phases through which the Frog passes in the course of its development, show that those *Anura* which are devoid of a tympanic cavity are of a more embryonic character than those which possess one. The arboreal habit is so evidently adaptive, that it can hardly be regarded as a safe basis for classification. Even *Rana temporaria*, at a year old, will climb up the vertical side of a glass vessel, flattening out the ends of its toes, and applying its belly against the surface of the glass, like a Tree-frog.]

A. The tympanic cavity, with its Eustachian passage of communication with the mouth, may be present or absent. When present, the oral apertures of the Eustachian tubes are separate, and the pterygoid bones do not furnish a floor to them.

a. No teeth in the premaxillæ or maxillæ; tongue free, either in front or behind, but usually behind.

α. No tympanic cavity. Eustachian recesses sometimes present.

Rhinophrynus (1), *Phryniscus, Pseudophryne, Brachycephalus* (2), *Hemisus* (3), *Microhyla.*

β. A tympanic cavity and Eustachian tubes.

Hylaplesia, Kalophrynus, Bufo, Otilophus, Peltaphryne, Pseudobufo, Schismaderma, Xenorhina (4), *Engystoma* (4), *Diplopelma* (4), *Cacopus* (*Systoma*) (4), *Glyphoglossus* (4), *Callula* (4), *Brachymerus* (4), *Adenomera* (4), *Pachybatrachus* (?), *Breviceps, Chelydobatrachus, Hypopachus, Rhinoderma, Atelopus, Copea, Paludicola.*

(1) Tongue free in front. (2) Dorsal dermal ossifications. (3) Tongue retractile. (4) No præcoracoids.

b. Teeth in the premaxillæ and maxillæ; the tongue may be fixed by its whole circumference, but is usually free behind.

α. No tympanic cavity; Eustachian recesses sometimes present.

Bombinator (1), *Pelobates, Didocus, Alsodes, Telmatobius, Cacobus, Liopelma.*

β. A tympanic cavity and Eustachian tubes.

Plectromantis, Alytes (1), *Scaphiopus, Hyperolius, Helioporus, Nattereria, Phyllomedusa, Pelodryas, Chirodryas, Hyla, Hylella, Otolygon, Pseudacris, Pohlia, Litoria, Triprion, Opisthodelphys, Trachycephalus, Nototrema, Ixalus, Megalixalus, Hylarana, Leptomantis, Hylambates, Platymantis, Cornufer, Hemimantis, Rhacophorus, Chiromantis, Polypedates, Theloderma, Rappia, Acris, Leiyla, Elosia, Epirhexis, Phyllobates, Hylodes, Crossodactylus, Strabomantis, Calostethus, Rana, Odontophrynus, Dicroglossus, Oxyglossus, Phrynobatrachus, Hoplobatrachus, Phrynoglossus, Clinotarsus, Pseudis, Pithecopsis, Mixophyes, Pyxicephalus, Ceratophrys* (2), *Zachænus, Platyplectrum, Neobatrachus, Cyclorhamphus, Limnodynastes, Crinia, Eusophleus, Pleurodema, Leiuperus, Hylorhina, Limnocharis, Cystignathus, Hemiphractus* (3), *Chiroleptes, Calyptocephalus, Cryptotis* (4), *Asterophrys* (4), *Xenophrys* (4), *Megalophrys* (4), *Nannophrys* (4), *Pelodytes, Leptobrachium, Discoglossus* (1), *Zaphrissa* (1), *Latonia* (1), *Palæobatrachus, Arthroleptis, Grypiscus* (3).

(1) Opisthocœlian verteoræ; rudimentary ribs attached to the anterior vertebræ. (2) Dorsal dermal ossifications. (3) Mandibular teeth. (4) Opisthocœlian vertebræ.

B. The Eustachian tubes of the well-developed tympanic cavity have a common median aperture in the roof of the mouth, and the pterygoid bones extend beneath and form a floor to them. The tongue is wanting. The lungs are attached to bronchial tubes; and the vertebræ are opisthocœlous.

a. No teeth.

Pipa.

b. Teeth in the premaxillæ and maxillæ.

Dactylethra.

III. The Peromela.

a. With a tentaculiferous fossa on the fore part of the face.

Cæcilia, Siphonops (1), *Epicrium.*

b. With no tentaculiferous fossa.

Rhinatrema.

(1) *Siphonops annulatus* has no scales

IV. The Labyrinthodonta.

Amphibamus, Anthracosaurus, Apateon, Archegosaurus,† Baphetes,* Batrachiderpeton, Bothriceps,† Brachydectes, Brachyops,* Capitosaurus,* Chalcosaurus,* Cocytinus, Colosteus,† Dasyceps,* Dendrerpeton,* Dictyocephalus, Dolichosoma, Erpetocephalus,* Eupelor,* Eurythorax,* Gonioglyptus,* Hylerpeton, Hylonomus, Ichthyerpeton,* Ichthyocampsa, Kerater peton,* Labyrinthodon,* Lepidotosaurus, Lepterpeton,* Leptophractus, Loxomma,* Mastodonsaurus,* Melosaurus,* Metopias,* Micropholis,* Molgophis,† Œstocephalus* (?) † *Ophiderpeton,† Osteophorus,* Pachygonia,* Pariostegus, Pholiderpeton,* Phlegethontior,† Pteroplax, Ptyonius,† Raniceps,† Rhinosaurus, Sauropleura,* Trematosaurus,† Tuditanus,† Urocordylus,† Xestorrhytias,* Zygosaurus.**

[A satisfactory grouping of these genera has not yet been effected; and it is possible that some of the forms here enumerated may not be true Labyrinthodonts. To those about the truly Labyrinthodont character of which there seems no doubt a * or a † is attached—the † denoting the serpentiform genera. *Batrachiderpeton, Pariostegus,* and *Pteroplax* are remarkable for the incompleteness of the jugal arch, and some other characters by which they appear to represent the *Proteidea*. The true position of *Hylerpeton* and *Hylonomus* is still doubtful.] (T. H. H.)

AMPHICTYONY, in *Greek Antiquity*, was an association of several tribes for the purpose of protecting some temple common to them all, and for maintaining worship within it. The members were called ἀμφικτίονες or ἀμφικτύονες, a word which means "the dwellers around." The second form of the word Benfey supposes to have arisen from a digammated ἀμφικτίϝονες. Out of the name the Athenians, according to their habit, easily discovered the founder of the Delphic Amphictyony, with which they were connected; and hence in later times, by an inverse process, the name was derived from Amphictyon, one of the fabulous kings of Attica.

Similar religious confederations existed in Greece at a very early period, and there is reason to believe that at their stated assemblies they discussed questions of international law and matters affecting their political union as well as religious subjects. Gradually, however, the political influence of the Amphictyonies died away. As states of great power stood on an equality with insignificant tribes in the number of votes, they naturally prevented the settlement of important political matters in such an assembly. Accordingly, during the flourishing period of Greek history the Amphictyonies almost disappear. They are not mentioned in Thucydides and Xenophon. But they appear again in vigour in the time of Philip, and become engines by which political parties, under pretence of religious zeal for the interests of the gods, wreak their vengeance on their rivals and antagonists.

This is especially true of the Amphictyony of Delphi, the most important of all these associations. Though we know better about this confederation than about any other, yet many particulars are hidden in obscurity, and considerable doubts gather around others of which we know something. The Amphictyony existed in very early times, and Æschines states that it arose when the temple at Delphi was first built. It is more likely, however, that it was originally connected with Thermopylæ and the temple of Demeter Amphictyonis which was there. The Amphictyony consisted of a union of twelve tribes, each of which had a right to two votes. These tribes were for the most part Thessalian or bordering on Thessaly; and it is probable that the others, as the Dorians and Ionians, gained admission in consequence of colonies that came to them from Thessaly.

There are nine lists of the tribes that constituted the Delphic Amphictyony in the classical writers and in inscriptions. Of these only one is complete, and the rest differ from each other in some particulars. The one that is complete was found on a Delphic stone containing a decree of the Amphictyonic council in regard to money due to the Delphic treasury. On this stone are given the votes of each tribe, and the final decision of the council in harmony with the majority of votes for one of the opinions held. The list is as follows:—The Delphians, two votes; Thessalians, two votes; Phocians, two votes; Dorians from Metropolis, one vote; the Dorians from Peloponnesus, one vote; the Athenians, one vote; the Eubœans, one vote; the Bœotians, two votes; the Achæan Phthiots, two votes; the Malians, one vote; the Œteans, one vote; the Dolopians, one vote; the Perrhæbians, one vote; the Magnetes, two votes; the Ænianes, two votes; the Locri Hypocnemidii, one vote; the Locri Hesperii, one vote. The exact date of the decree recorded on the Delphic stone is matter of dispute, but the most probable conjecture places it about the year 130 B.C. We have therefore clear testimony as to the constitution of the Amphictyonic council at this date; and, starting from this, we can form some idea of the changes which took place in the members of the council. It is generally believed that no change took place in the tribes forming the league till the time of the second sacred war, 345 B.C. Of these tribes Æschines gives us a list, with the omission of one. They are the Thessalians, Bœotians, Dorians, Ionians, Perrhæbians, Magnetes, Locri, Œteans, Phthiots, Malians, Phocians; and there can be little doubt that it is the Dolopians who have been by some mistake omitted. The confusions in some of the other lists have arisen probably from the ignorance of transcribers, who did not know that the Ænianes and Œteans lived close to each other, and were often comprehended under the same name, and who made two tribes of the Achæan Phthiots, Achæans and Phthiots. Æschines says that all these tribes had equal right of voting; but the inscription on the Delphic stone shows that the two votes of one tribe might be divided among two different portions of it. At the conclusion of the Phocian war the Phocians were excluded, and the Macedonians received their votes; and the vote of the Lacedæmonians was given to the other Doric tribes of Peloponnesus. The Delphians also obtained votes, either at this time or after the third sacred war, 338 B.C., by some of the smaller tribes that had two votes being restricted to one. In the same way, and also by the exclusion of the Locri Ozolæ, the Ætolians secured a place in the council in 338 B.C., and gradually took possession of a great number of votes. The Phocians were restored to their place in 279 B.C., on account of their gallant resistance to the Gauls. Finally, the Ætolians and Macedonians were excluded from the council, and the constitution of the council as given in the Delphic stone was formed. The last change mentioned in classical writers is detailed by Pausanias, but the passage is evidently corrupt. Augustus wished to give votes to Nicopolis, and for this purpose so altered the constitution of the council as to make the votes thirty in number.

The objects of the league are distinctly expressed in the oath which the Amphictyons had to take, and which is preserved in Æschines's oration "De Falsa Legatione." This oath bound the Amphictyons not to destroy any of the Amphictyonic towns, not to turn away its running waters either in time of war or in time of peace; and if any one should attempt to rob the temple of Delphi (the common centre of the confederacy), to employ their hands, feet, tongue, and their whole power to bring him to punishment. The humanising influence which this and other enactments of the confederacy were intended to exercise, is perceptible in the part relating to war. The framer of the law evidently regarded war only as an unavoidable means of settling disputes between two states; but it was to be carried on only for the purpose of bringing the dispute to a decision, and not for destruction and devastation. Another enactment probably was that the inhabitants of a conquered city should not be sold as slaves. But the chief care of the Amphictyons appears to have been to watch over the temple, to punish those who were guilty of a crime against it, and to reward those who did anything to increase its splendour and glory.

There is difficulty in determining how often the Amphictyons met. But the most likely inference from the somewhat indefinite statements of ancient writers is, that they went twice every year both to Delphi and Thermopylæ, in spring and in autumn. There is also some difficulty in determining the relative positions of the two sets of officials named in connection with the Amphictyony, the Hieromnemones and the Pylagoroi or Pylagorai. But there can scarcely be a doubt that the Hieromnemon was the principal official. There were as many Hieromnemones as there were votes; and the Hieromnemones were alone entitled to vote. The assembly proper consisted therefore only of the Hieromnemones. It is most likely that the Hieromnemones were elected annually by lot. In the case of the smaller states it is probable that the right to elect

went round by turns, while the more important states sent their representatives every year. There might be several Pylagoroi from each state. Æschines mentions that there were on one occasion three from Athens. They were elected by vote. Their function seems to have been to advise with the Hieromnemon, to address the assembly when anything relating to their own state was discussed, and to bring all their influence to bear on the assembly on behalf of their own state. The office of Hieromnemon remained in high honour till a late period. When the Dionysiac theatre in Athens was excavated in 1862, a chair of honour was found with the inscription ἱερομνήμονος, and as it is certain that dramatic exhibitions took place in this theatre in the time of the Antonines, the office of Hieromnemon must have existed at that period.

The meetings, however, were attended not only by the deputies, but by thousands of others who flocked to Delphi or Thermopylæ for religious and mercantile purposes, or only for the sake of amusement. This occasioned popular meetings (ἐκκλησίαι) distinct from those of the regular deputies. But we cannot suppose that all the Greeks indiscriminately were allowed to take part in those popular assemblies, which must have consisted of visitors from the states which were members of the Amphictyony.

Wise and humane as were the objects of the Amphictyons, yet wherever they actively interfered in the affairs of Greece during the historical period, we find that they were more powerful for evil than for good; and the holy wars which were carried on by them in the defence of the Delphic temple and the honour of its god, contributed not a little to the demoralisation of the Greeks.

The very first time that the Amphictyons interfered in the affairs of Greece we find them acting in direct opposition to the spirit of their institution. We allude to the Crissæan or first sacred war, which broke out in 594, and lasted till 585 B.C. The inhabitants of Crissa (or Cirrha), on the Corinthian Gulf, were charged with extortion and violence towards the strangers who landed at their port, or passed through their territory on their way to Delphi. For this the Amphictyons declared war against Crissa, and it was vigorously carried on by the Thessalians and Cleisthenes, the tyrant of Sicyon. They even pretended to have the sanction of Apollo to dedicate the Crissæans and their territory to the god, to enslave them, and make their land a waste for ever. The war is said to have been terminated by a stratagem of Solon, who poisoned the waters of the river Pleistos, from which the town was supplied. When the town was taken, the vow of the Amphictyons was literally carried into effect: Crissa was razed to the ground, its harbour choked up, and its fertile plain changed into a wilderness. Such was the terrible vengeance taken by a body of confederates, whose original object was to prevent those very things which they now perpetrated to uphold the honour of the deity presiding over them. The second sacred war, which likewise lasted for ten years, from 355 to 346 B.C., was carried on with unparalleled exasperation for all that period, and nearly all the Greeks took part in it. The Thebans had set their hearts upon conquering Phocis, but screened their designs behind a charge preferred against the Locrians, alleging that they had robbed the temple of Delphi, because they had taken into cultivation a tract of land belonging to the Delphic temple. The Amphictyonic council, before which the charge was brought, condemned the Phocians to pay a heavy fine, and to destroy the crops of the sacred fields. No sooner was this verdict pronounced than the Thebans, Thessalians, Locrians, and Œteans took up arms to execute it. The Phocians were joined by Athens and Sparta, and took possession of the temple of Delphi and its treasures, which they were obliged to employ in defraying the expenses of the war. The war was carried on with unexampled cruelty, for even the surrender of the dead for burial was refused, and all Phocian captives were put to death. This war also afforded Philip of Macedonia an opportunity to interfere in the affairs of Greece. Being invited by the Thessalians to co-operate with them against the Phocians, Philip and his Macedonians acted as the champions of the god, and defeated the Phocians in a bloody battle near Magnesia. Three thousand captive Phocians were put to death. The latter, however, remained undaunted until at length they were compelled by treachery to surrender. The Amphictyons now excluded them for ever from the league, their arms and horses were to be delivered up, their towns to be destroyed, and the people were henceforth to live in small villages, and to pay annually to the god sixty talents (about £15,000) until the temple should be completely indemnified. Macedonian and Theban troops carried the judgment into execution; twenty-two towns disappeared from the face of the earth, and the otherwise fertile country remained for many years a wilderness. A third sacred war was decreed against the town of Amphissa, because its inhabitants had taken into cultivation the plain of Crissa; but in reality the war was brought about by the venal creatures who endeavoured to promote the ambitious schemes of Philip of Macedon, who was bent upon making himself master of Greece. This war broke out in 338 B.C., and its unfortunate consequences led to the catastrophe which deprived Greece of her independence in the battle of Chæronea. Such is a brief outline of the history of the Delphic Amphictyony, which not only itself violated its first principles, but is not known to have ever raised its voice to condemn the wanton destruction of other Amphictyonic towns, such as Platææ and Thebes.

There were many other confederations of a similar kind, some of which, however, do not bear the name of Amphictyonies in the authorities from which we derive our information regarding them. The following were among the most noted:—

1. The *Amphictyony of Calauria*, an island near Trœzen, consisted of the seven states of Hermione, Epidaurus, Ægina, Athens, Prasiæ, Nauplia, and the Minyan Orchomenos. These states took part in the sacrifices which were offered up in the temple of Poseidon, situated on the island. Sparta and Argos displaced Nauplia and Prasiæ when these lost their independence. It is difficult to see what object could unite states so widely apart. Some suppose that the tribes forming the league were originally Ionian; others, that they all were interested in the defence of seaports against inland states.

2. *Amphictyony of Onchestos*, in the territory of Haliartus in Bœotia, was likewise connected with the temple of Poseidon. As at all other Amphictyonies, the meetings of the members were celebrated with various religious rites, solemnities, and public games. We do not know the nations that constituted this league.

3. *Amphictyony of Amarynthos*, in Eubœa, connected with the temple of Artemis. We know that the two towns of Eretria and Chalcis were members of it, and that there existed an ancient treaty by which these two cities pledged themselves not to use against each other any missiles thrown from afar.

4. *Amphictyony of Delos*, connected with the temple of Apollo, was a league formed among the inhabitants of the Cyclades and the Ionians in the neighbourhood. Its institution was ascribed to Theseus. The solemnities connected with its meetings gradually fell into disuse, until they were revived and increased in 426 B.C., when the island of Delos was purified by the Athenians. The Athenians, after this time, regularly sent an annual embassy to Delos, and

they also retained for themselves the superintendence of the temple and the administration of its treasures.

AMPHION, in *Greek Mythology*, the son of Zeus by Antiope, and the husband of Niobe, was a musician of such wonderful power, that at the sounds of his lyre the stones began to move, and formed themselves into walls around Thebes, after his conquest of that city. He was killed by Apollo for assaulting his temple; or, as some report, he destroyed himself in despair at the slaughter of his children by that god. The famous Farnese bull, discovered in 1546, represents Amphion punishing Dirce for her treatment of his mother. There are four other mythical personages of this name.

AMPHIOXUS, a species of fish, differing widely from all other known animals. See LANCELET.

AMPHIPOLIS, a city of Macedonia, situated on the east bank of the river Strymon, about three miles from the sea. It was originally a Thracian town, known as the Ἐννέα ὁδοί (Nine Roads), and was colonised by the Athenians in 437 B.C., two previous attempts (497 and 465 B.C.) having been unsuccessful. In 424 B.C. it surrendered to the Lacedæmonians without resistance, and the Athenians never afterwards recovered possession of it. For his failure to prevent this disaster Thucydides was banished from Athens. The site of Amphipolis is occupied by the modern *Jeni Keui.*

AMPHISBÆNA (from ἀμφίς, on both sides, and βαίνω, to go), a genus of animals, found only in South America and the West Indies, which, though they have the general appearance of snakes or worms, belong to the order *Lacertilia,* or Lizards. The best known species are the sooty or dusky amphisbæna (*A. fuliginosa*), and the rarer *A. alba.* The body of the amphisbæna, from 18 to 24 inches long, is of nearly the same thickness throughout. The head is small, and there can scarcely be said to be a tail, the vent being close to the extremity of the body. The animal lives mostly underground, burrowing in soft earth, and feeds on ants and other small animals. From its appearance, and the ease with which it moves backwards, the popular belief in the countries where it prevails has been that the amphisbæna has two heads, and that when the body is cut in two the parts seek each other out and reunite. From this has arisen another popular error, which attributes extraordinary curative properties to its flesh when dried and pulverised.

AMPHITHEATRE (from ἀμφί and θέατρον) denotes a theatre in which the spectators were placed "all round" the stage. Though the word is of Greek formation, the thing itself is distinctively Roman, being designed for those cruel shows of gladiators and wild beasts in which that people took great pleasure, and which in modern times are only represented by the barbarous bull-fights still popular in Spain.

In the present article we do not enter on the consideration of the spectacles themselves, but shall confine ourselves to the buildings, which were devised to allow as large a number of spectators as possible to enjoy the sight of the show. In a dramatic representation it is necessary that the actors should be heard, and also that their faces should be seen, and the audience has therefore to be arranged in a semicircle in front of them; but when men fought with other men or with beasts, they could be seen equally well from all sides.

In Italy, combats of gladiators at first took place in the forums, where temporary wooden scaffoldings were erected for the spectators; and Vitruvius gives this as the reason why in that country the forums were in the shape of a parallelogram instead of being squares as in Greece. Wild beasts were also hunted in the circus. But towards the end of the Roman republic, when the shows increased both in frequency and in costliness as the city grew in power, special buildings began to be provided for them; and when the consolidation of peace under the empire had secured great material prosperity for the provinces, such as they had never enjoyed when separated into small states and often at war with each other, the example of the capital was followed by many other towns in the West; so that nearly a hundred amphitheatres have been identified, either by the existence of their ruins or by being mentioned by old writers. There were even a few in the East, although such cruel games were quite alien to the elegance and refinement of the Hellenic mind.

From their being so admirably adapted for enabling the greatest possible number of people to behold a spectacle, it is natural to suppose that they would be occasionally used for purposes different from those usually intended by them; and accordingly Suetonius relates how Caligula had an impertinent poet burnt alive in the amphitheatre, and how Titus ordered the informers, after having been whipped in the forum, to be led through the arena, apparently that they might be exposed to the execrations of the people. Criminals were also sometimes exposed in them to be devoured by wild beasts, and many of the Christian martyrs died in this way.

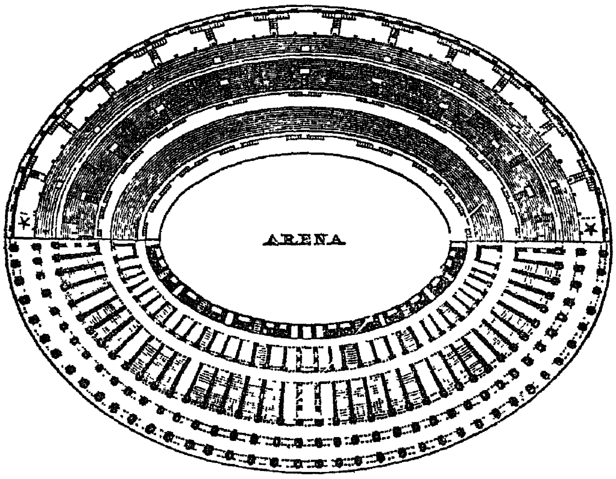
The first amphitheatre was that constructed, 59 B.C., by C. Scribonius Curio. The only author by whom it is described is Pliny, whose account of it rather taxes our credulity. He tells that Scribonius built two wooden theatres, which were placed back to back, and that after the dramatic representations were finished, they were turned round, with all the spectators in them, so as to make one circular theatre, in the centre of which gladiators fought. And this was repeated more than once. Thirteen years later, Cæsar built (also of wood) the first regular amphitheatre, and exhibited wild beasts in it; and sixteen years after, C. Statilius Taurus built the first one of stone, which was burnt in the great fire of Rome during the reign of Nero. Probably the outside walls only were of stone.

Several others were constructed under the early emperors, but they were entirely superseded and eclipsed by that of Vespasian and Titus, the vast ruins of which strike the traveller with awe. Set on fire by lightning under the emperor Macrinus, it was restored by Alexander Severus, the shows during the interval being held (as of old) in the circus. The latest record of its being used is in the 6th century, when Cassiodorus was present; but Bede in the 8th century speaks of the edifice as still entire. During the Middle Ages many of the stones of this, as of many other ancient buildings, were carried away for building purposes; and among the plunderers we regret to have to reckon the great Michel Angelo, who worked up a large number of its stones into a palace for one of the Roman noble families. As, however, the Colosseum had been the scene of many of the Christian martyrdoms, Benedict XIV., whose name ought never to be mentioned without an expression of admiration and gratitude for his enlightened patronage of learning and antiquities, took advantage of this to consecrate the interior by the erection of crosses and oratories, thereby preserving it from further depredations. Of late years considerable excavations have been made to examine its substructures. Its name is variously written, but on the whole it would seem that the most correct orthography is Colosseum (not Coliseum), and that it is derived from its colossal size, which far surpassed any former edifice of the sort. Many of its minor arrangements are uncertain, but the main features and general plan are sufficiently intelligible.

The external elevation of the Colosseum consisted of four stages, each adorned with engaged columns of the three orders of Greek architecture. The lowest three were arcaded, having each eighty columns and as many arches. Those of the basement story served as entrances; seventy-

six being numbered and allotted to the general body of spectators, while four, at the extremities of the axes of the ellipse, were the principal entrances. The higher arcades had a low parapet with (apparently) a statue in each arch, and gave light and air to the passages which surrounded the building. The openings of the arcades above the principal entrances were larger than the rest, and were adorned with figures of chariots. The highest stage was much more solid, being composed of a continuous wall of masonry, only pierced by forty small square windows. The object of this may have been to obtain the necessary solidity and weight for steadying the poles which supported the awning, and must have had to carry a severe inward strain. The alternate arcades were ornamented with metal shields. There was also a series of brackets to support the poles on which the awning was stretched.

The interior may be naturally divided into the *arena* and the *cavea*, with their respective appendages.



The *arena* was the portion assigned to the combatants, and derived its name from the sand with which it was strewn, to absorb the blood and prevent it from becoming slippery. Some of the emperors showed their prodigality by substituting precious powders, and even gold dust, for sand. The *arena* was generally of the same shape as the amphitheatre itself, and was separated from the spectators by a wall built perfectly smooth, that the wild beasts might not by any possibility climb it. At Rome it was faced inside with polished marble, but at Pompeii it was simply painted. For further security, it was surrounded by a metal railing or network, and the arena was sometimes surrounded also by a ditch (*euripus*), especially on account of the elephants. Connected with the arena were the dens from which the beasts came, and the rooms where the gladiators met before the show began. In spite of the excavations which have been made, it is not very easy to understand how all the effects described by ancient authors were produced; for after the regular shows were over, the arena was sometimes filled with water, and sea-fights were exhibited with ships.

The part assigned to the spectators was called *cavea.* In the different amphitheatres whose ruins have been examined, there are some differences in the arrangements, but the general features are nearly the same in all. The *cavea* was divided into several galleries, concentric with the outer walls, and therefore, like them, of an elliptic form. The place of honour was the lowest of these, nearest to the arena, and called the *podium.* The divisions in it were larger, so as to be able to contain movable seats. At Rome it was here that the emperor sat, his seat bearing the name of *suggestum.* The senators, principal magistrates, vestal virgins, the provider (*editor*) of the show, and other persons of note, occupied the rest of the *podium.* At Nismes, besides the high officials of the town, the *podium* had places assigned to the principal guilds, whose names are still seen inscribed upon it, with the number of places reserved for each. In the Colosseum there were three *mœniana* or galleries above the *podium,* separated from each other by terraces (*prœcinctiones*) and walls (*baltei*). The lowest was appropriated to the equestrian order. Numerous passages (*vomitoria*) and small stairs gave access to them; while long covered corridors, behind and below them, served for shelter in the event of rain. At Pompeii each place was numbered, and elsewhere their extent is defined by little marks cut in the stone. The spectators were admitted by tickets (*tesseræ*), and order preserved by a staff of officers appointed for the purpose.

The height of the Colosseum is given as from 160 to 180 feet. The seats in the interior do not rise higher than the level of the third order of the exterior, that is, about half the entire height of the building; and this apparent excess of height beyond what was made available, has led some to suppose that there were upper seats and galleries, of which no trace now exists. The height, however, appears to have been necessary for the ventilation of the building. When such enormous crowds were packed closely together for several hours at a time on an Italian summer day, with an awning drawn over them, the atmosphere would have become quite pestilential if there had not been a considerable space overhead, and at least one range of open arcades, unencumbered by any galleries to prevent the free circulation of air. Scented liquids were at times squirted over the spectators from concealed tubes; but no aroma would have compensated for the want of air, which the arcade all round the building, above the highest spectators, would supply. There may also have been another series of openings serving the same purpose between the top of the wall and the edge of the awning, which was supported upon poles. It has been calculated that the Colosseum contained 87,000 places, and that besides these, 15,000 more spectators could be admitted. The greatest length is about 612 feet, and the length of the shortest axis of the ellipse about 515 feet. The dimensions of the arena are variously stated by different writers, some making it 247 feet by 150, and others 281 by 176.

With regard to the provincial amphitheatres, Maffei, in his account of that of Verona, appears to have unduly restricted their number, with the object of exalting the honour of the one he describes. Besides the Colosseum, he would hardly allow any ruins to be entitled to this name except those at Verona and Capua. But subsequent writers have not followed him in this rigorism; and Friedländer, who is the latest and most complete authority on the subject, gives the measurements and description of fifty-two. Naturally, the early ones would be of wood, like that erected by Atilius at Fidenæ in the time of Tiberius, which gave way while shows were being exhibited, on which occason 50,000 persons were killed or injured. One at Placentia is also mentioned, which is said to have been the most spacious then in Italy, and to have been burned in the wars between Otho and Vitellius by the inhabitants of a neighbouring town whose envy it had excited. Such disasters, coupled with the growing scarcity of wood and the greater facilities for quarrying stone, would naturally lead to the construction of more solid buildings. At the same time, the progress of this improvement must have been slow, and the building of at least the great majority of the provincial amphitheatres of stone may be ascribed to the period between the reign of Vespasian and that of Constantine, when the establishment of Christianity threw a discredit on the cruel and bloody shows for which these vast structures were designed. Hadrian is especially commemorated for the numerous

buildings he caused to be erected almost everywhere, and this is mentioned in connection with games being held.

In constructing many of the amphitheatres in the provincial towns, advantage was taken of the natural slope of a hill to lessen the labour of construction; and in some cases a narrow ravine between two hills allowed of both sides being formed on the natural slopes, and of the stream at their feet being dammed up for combats on the water. The conformation of the ground and the caprices of local authorities have produced slight minor differences of plan, but the general description of the Colosseum will suffice for all. For details regarding others the reader may consult, in addition to other authorities, the descriptions given in this work of the different towns where their remains are still found. Here it may be sufficient to name that at Pompeii, which is probably better known to most persons by the graphic description in Lord Lytton's novel than by any of the illustrated accounts that have been published of that wonderful town; that at Verona, which served as a basis to Maffei's careful investigation of the whole subject; those at Capua and Pozzuoli, which almost rival the Colosseum in dimensions; those at Nismes, Arles, and Frejus in France; that at Italica, near Seville in Spain, remarkable for the thickness of its walls and the strength of its masonry—leading Florez to remark that its ruin is due not to the injuries of time and the weather, but to the hand of man; that at the ancient Thysdrus, in the province of Carthage, now called *El-Djemm*, which alone resembles the Colosseum in having five galleries or corridors in the first storey; and that at Pola in Istria, whose external shell—the internal fittings, which were probably all of wood, having quite disappeared—forms a striking object as seen from the sea.

A very fair summary of the whole subject will be found in Smith's *Dictionary of Classical Antiquities;* and a much more minute and elaborate account, by C. Thierry, with good illustrations, in the *Dictionnaire des Antiquités* of Daremberg and Saglio, which has the further advantage of giving numerous references to larger works on the subject,—its chief defect being one too common in French books, the almost complete ignoring of everything published in this country, where Taylor and Cresy's *Architectural Antiquities of Rome*, of which a second edition has recently appeared, is entitled to special mention. Nor does it notice that treasure of information about Spanish history and antiquities, the *España Sagrada*, where (vol. xii. p. 228) will be found the most careful account of the amphitheatre at Italica, with several drawings. The following table, abridged from Friedländer's *Darstellung aus der Sittengeschichte Roms* (1865, 2d ed. 1867), gives the dimensions, in English feet, of a few of the principal amphitheatres that have been examined:—

	Entire Building.		Arena.	
	Greater Axis.	Shorter Axis.	Greater Axis.	Shorter Axis.
	Feet.	Feet.	Feet.	Feet.
Puzzuoli,	626½	475	367	216
Rome (Colosseum),	616	510½	281	176
Falerii,	586½	348	...	...
Capua,	557	458	250	150
Julia Cæsarea,	551	289	459	197
Italica (Seville),	513	439½	...	...
Verona,	505½	403	248	145½
Tarraco,	486	390	277	181
Thysdrus,	457	392	253½	188
Pola,	452	369½	230	147
Arles,	448	352	228	129
Pompeii,	445	341	218½	115
Tours,	443	393½	223	98½
Nismes,	433½	332½	227	126½

(G. H. F.)

AMPHITRITE, in *Greek Mythology*, the supreme goddess of the sea, and as such the wife of Poseidon (Neptune), but, unlike him, so entirely confined in her authority to the sea and the creatures in it, that not only was her name (from ἀμφὶ-τρίω, the same root as τρύω) sometimes used as an equivalent for that element, but she was never associated with her husband either for purposes of worship or in works of art, except when he was to be distinctly regarded as the god who controlled the sea, though generally his functions extended to the whole watery element. She was one of the nereids, and distinguishable from the others only by her queenly attributes. It was said that Neptune saw her first dancing at Naxus among the other nereids, and carried her off. But in another version of the myth, she then fled from him to the farthest ends of the sea, where the dolphin of Neptune found her out. In works of art she is represented either enthroned beside him, or driving with him in a chariot drawn by hippocamps or other fabulous creatures of the deep, and attended by tritons and nereids.

AMPHORA (from ἀμφί and φέρω), a large vessel used by the ancient Greeks and Romans for preserving wine, oil, fruits, &c., and so named from its usually having an ear or handle on each side of the neck, whence it was also called *diota*. It was commonly made of earthenware, but sometimes of stone, glass, or even more costly materials; its usual form was tall and narrow, diminishing below to a point. A number of specimens of the various kinds of amphoræ are to be seen in the Elgin collection in the British Museum. Homer and Sophocles mention amphoræ used as cinerary urns; and a discovery made in 1825 at Salona shows that they were sometimes used as coffins. The amphora was divided lengthwise to receive the corpse, then closed and deposited in the earth, thus preserving the skeletons entire (Steinbüchel, *Alterthum*, p. 67). The amphora was a standard measure of capacity among both Greeks and Romans. The Attic amphora contained nearly nine gallons, and the Roman amphora about six.

AMPLITUDE, in *Astronomy*, is the amount of deviation towards the north or south of a celestial object from the true east at rising, and the true west at setting. For the fixed stars it is constant; for the sun and planets it varies with the declination. At the equinoxes the sun rises exactly in the east, and sets in the west point,—the amplitude then is zero; at the solstices it amounts at London to 39° 44′.

AMPTHILL, a small neatly-built market town in Bedfordshire, situated about 8 miles south of Bedford. Besides the old parish church, it contains various dissenting chapels, a county court-house, a savings bank, several schools, and an almshouse. Near the town is Ampthill house, a mansion of the late Lord Holland, containing a valuable collection of paintings, a library, and a museum. The site of the old castle in which Catherine of Aragon resided while her divorce from Henry VIII. was pending, is marked by a cross within the grounds. The district is chiefly agricultural, but in Ampthill there is a large brewery, and a considerable amount of straw-plaiting and lace-making. Population in 1871, 2220.

AMPULLA, a Latin word denoting a small jar or flask for holding liquids. In mediæval church Latin it usually signifies the vessels that contained the consecrated oils, of which the three principal—for the catechumens, for the sick, and for confirmation—were hallowed by the bishop on the Thursday before Easter. The word has passed into our language in connection with the coronation of the kings of England, and occurs repeatedly in the coronation service. Thus, in that used for Queen Victoria, we read:—"The anthem being concluded, the Dean of Westminster, taking the *ampulla* and spoon from off the altar, holdeth them

ready, pouring some of the holy oil into the spoon, and with it the archbishop anointeth the Queen in the form of a cross. . . . Then the Dean of Westminster layeth the *ampulla* and spoon upon the altar." Gildas mentions its use as established among the Britons in his time, and St Columba is said to have employed it in the coronation of King Aidan. The most celebrated ampulla in history is that known as *la sainte ampoule* at Rheims, from which the kings of France were anointed. According to the legend, which gained for itself a secure place in the national belief, it had been brought from heaven by an angel for the coronation of Clovis, and at one period the kings of France claimed precedence over all other sovereigns on account of it. It seems, however, that Pepin in the 8th century was the first French king who was anointed, and this in connection with his baptism rather than his coronation. (See the preface to the 3d volume of Maskell's *Monumenta Ritualia* and the authorities there referred to.)

AMRÁOTÍ, a district and city of India, in the commissionership of East Berar, within the Haidarábád assigned districts. The district lies between 20° 23′ and 21° 7′ N. lat., and between 77° 24′ and 78° 13′ E. long. It is bounded on the N. by the Elichpur district; on the E. by the Wardhá river, separating it from the central provinces; on the S. by the Básim and Wún districts; and on the W. by Akolá district. The area is estimated at 2566 square miles, but the survey has not yet been completed. The population in 1867 was returned at 407,276 souls, which, taking the area as given above, would show an average density of 158 persons per square mile; number of males, 212,575; females, 194,701; the proportion of males to the total population being 52·19 per cent. The district consists of an extensive plain, about 800 feet above sea-level, the general flatness being only broken by a small chain of hills, running in a north-westerly direction, between Amráotí and Chándor, with an average height of from 400 to 500 feet above the level of the lowlands. Four towns are returned as containing a population exceeding 5000 souls—namely, Amráotí, population 23,410; Karinjá, a considerable commercial town, population 11,750; Badnerá, a town on the Great Indian Peninsula Railway, which intersects the district, population 6876; Kolápur, population 6169.

AMRITSAR, a division, district, and city of British India, under the jurisdiction of the Lieutenant-Governor of the Panjáb. The Amritsar Division comprises the districts of Amritsar, Siálkot, and Gurdáspur. It is bounded on the N.E. by the Himálayas; on the S.W. by the Gujránwálá and Lahor districts; on the N.W. by the river Chenáb; and on the S.E. by the river Biás. The total population of the division is returned at 2,743,880 souls, divided into the following classes:—Hindus, 659,905; Mahometans, 1,401,290; Sikhs, 352,885; others, 329,800. The number of males was returned at 1,512,480, and the females at 1,231,400, the proportion of males to the entire population of the division being 55 per cent.

Amritsar District lies between 30° 40′ and 32° 10′ N. lat., and between 74° 40′ and 75° 40′ E. long. It is bounded on the N.W. by the river Rávi, on the S.E. by the river Biás, on the N.E. by the district of Gurdáspur, and on the S.W. by the district of Lahor. Amritsar district is a nearly level plain, with a very slight slope from east to west. The banks of the Biás are high, and on this side of the district well-water is not found except at 50 feet below the surface; while towards the Rávi wells are less than 20 feet in depth. The only stream passing through the district is the Kirní or Sakí, which takes its rise in a marsh in the Gurdáspur district, and after traversing part of the district empties itself into the Rávi. Numerous canals intersect the district, affording ample means of irrigation. The Sind, Panjáb, and Dehli Railway, and Grand Trunk Road, which runs parallel with it, afford the principal means of land communication and traffic. Total population of Amritsar district, 832,750, divided into the following classes:—Hindus, 138,027; Mahometans, 377,135; Sikhs, 223,219; others, 94,369. The males number 465,074, and the females 367,676; the proportion of males to the total population being 55·84 per cent. The principal tribes and castes in point of numbers are as follow:—(1.) Játs, viz., Hindus and Sikhs, 189,065; Mahometans, 65,964: total, 255,029. (2.) Bráhmans, 43,846. (3.) Kshattriyas, 39,892. (4.) Káshmirís, 37,456. (5.) Arorás, 29,103. The total agricultural population is returned at 417,747. Area of the district, 2036·23 square miles, or 1,303,188 acres, of which 927,730 acres are under cultivation, 178,939 acres are cultivable, but not actually under tillage, and 196,519 acres are uncultivable and waste. This result gives 1·56 acres (of which 1·11 acres are cultivated and ·21 cultivable) per head of the population, or 3·12 acres (2·22 cultivated and ·42 cultivable) per head of the agricultural population.

The principal agricultural products of Amritsar are wheat, barley, and grain for the spring crop; and rice, joár (spiked millet), Indian corn, moth (*Phaseolus aconitifolius*), and másh (*Phaseolus radiatus*) for the autumn crop. The current settlement of the district expires in 1875-76. Five towns are returned as containing a population of upwards of 5000 souls—namely, Amritsar, population 135,813; Jandrálá, 6975; Majíthá, 6600; Rám Dás, 5855; Bundálá, 5287. Of the foregoing towns Amritsar has been constituted a first-class, and Jandrálá, Majíthá, and Rám Dás third-class municipalities. Besides the regularly-constituted municipalities, however, a municipal income is also realised at the following ten places:—Tarn Táran, Fathiábád, Govindwal, Naushahrá Pannian, Verowal, Jalálábád, Attarí, Chamiárí, Vanniki, and Bhallar. Municipal revenue is in all cases levied by means of octroi duties, supplemented in some instances by house rates and other direct taxation. The total revenue of Amritsar district in 1871–72 amounted to £113,785, of which £85,727, 18s., or 75 per cent., was derived from the land. The other principal items of revenue were as follows:—Distilleries, £3677, 14s.; drugs and opium, £3548, 6s.; income tax, £1724, 8s; stamps, £13,621, 18s.; local rates levied under the provisions of Act 20 of 1871, £5208, 10s. The staple manufacture of Amritsar is woollen shawls, in imitation of those of Káshmír. The value of this manufacture in 1871–72 was estimated at £91,742.

Amritsar City, the divisional headquarters and capital of the district of the same name, is situated in 31° 40′ N. lat. and 74° 45′ E. long. It lies at an equal distance between the Biás and Rávi rivers, is about 8 miles in circumference, and forms at once the great trading centre of the Panjáb, and a celebrated seat of the Sikh religion and learning. The following description of the town is extracted from *Thornton's Gazetteer* (ed. 1862):—

"Amritsar owes its importance to a taláo or reservoir which Rám Dás, the fourth guru or spiritual guide of the Sikhs, caused to be made here in 1581, and which he termed Amrita Saras, or the Fount of Immortality. It thenceforward became a place of pilgrimage. Nearly two centuries afterwards, Ahmad Sháh, the founder of the Durání empire, alarmed and enraged at the progress of the Sikhs, blew up the shrine with gunpowder, filled up the holy tank, and caused kine to be slaughtered upon the site, thus desecrating the spot. On his return to Kabul, the Sikhs repaired the shrine and reservoir, and commenced the overthrow of Mahometan sway in Hindustán. The sacred tank is a square of 150 paces, containing a great body of water, pure as crystal, notwithstanding the multitudes that bathe in it, and supplied apparently by natural springs. In the middle, on a small island, is a temple of Hari or Vishnu; and on the bank a diminutive structure, where the founder, Rám Dás, is said to have spent his life in a sitting posture. The temple on the island is richly adorned with gold and other costly embellishments, and in it sits the sovereign guru of the Sikhs to receive the presents and homage of his followers. There are five or six hundred akális or priests attached to the temple, who have erected for themselves good houses from the contributions of the visitors. Amritsar is a very populous and extensive place. The streets are narrow, but the houses in general are tolerably lofty, and built of burnt brick. On the whole, Amritsar may claim some little architectural

superiority over the towns of Hindustán. Besides considerable manufactures of shawls and silks in imitation of the Káshmír fabric, Amritsar carries on a very extensive transit trade, as well as considerable monetary transactions, with Hindustán and Central Asia. Provision is made for an ample supply of water to the town from the Bárí Doáb canal. A striking object at Amritsar is the huge fortress of Govindgarh, built by Ranjit Sinh in 1809, ostensibly to protect the pilgrims visiting the place, but in reality to overawe their vast and dangerous assemblage."

Amritsar was the first mission station of the Church of England in the Panjáb. The census of 1868 gives a population within municipal limits of 43,931. The total population, however, of the city and suburbs is returned at 135,813, of whom 3477 are agriculturists, the rest being engaged in trade or other non-agricultural pursuits. The town has been constituted a first-class municipality, the affairs of which are conducted by a committee of twenty-eight members. The municipal income is derived from octroi duties, local taxes, house tax, &c., and amounted in 1871–72 to £19,800, or 9s. per head of the population within municipal limits. Since the opening of the Panjáb railway Amritsar has rapidly become the great centre of trade in that province. Its position on the line and the enterprise of its merchants promise also to give it the command of the trade *viâ* Leh to Central Asia, which is now (1874) being opened up. It is the chief *entrepôt* in the Panjáb for Manchester goods, in return for which it exports to other parts of India food-grains, the local manufactures in imitation of the Káshmír fabrics, and the costly shawls and stuffs which form the staple of the Káshmír trade.

AMRU-IBN-EL-ASS, or 'Amr, one of the most famous of the first race of Saracen leaders, was descended of Aasi, of the tribe of Koreish. In his youth he wrote satirical verses against the person and doctrine of Mahomet. His zeal in opposing the new religion prompted him to undertake an embassy to the king of Ethiopia, in order to stimulate him against the converts whom he had taken under his protection, but he returned a convert to the Mahometan faith, and, along with Khaled, joined the fugitive prophet at Medina. When Abu-Bekr resolved to make a new attack upon Syria, he entrusted Amru with a high command. In this he was so successful that he rose to the elevated station of chief in Irak, when Khaled requested the attendance of all the Arabian generals before Damascus. During the caliphate of Omar he also served in Palestine under Abu-Obeïdah, taking the command in the siege of Cæsarea, which yielded to him in July 638 A.D. After the death of Obeïdah, Amru assumed the chief command in Syria, in which he was confirmed by the caliph, notwithstanding the opposition of Othman. Soon afterwards (639) he led an army of 4000 Arabs into Egypt. During the progress of his march a messenger from Omar arrived with a letter containing directions to return, if he should receive this letter in the territories of Syria; but if he should receive it in those of Egypt, he might advance, and all needful assistance would be instantly sent to him. The contents of the letter were not made known to his officers until he was assured that the army was on Egyptian soil, so that the expedition might be continued under the sanction of Omar's orders. Having taken Pharma, he advanced to Misrah, the ancient *Memphis*, and besieged it for seven months. Although numerous reinforcements arrived, he would have found it very difficult to storm the place previous to the inundation of the Nile, but for a treacherous lessening of the forces of the citadel, which was consequently taken by storm; and the Greeks who remained there were either made prisoners or put to the sword. On the same spot Amru erected a city named Fostat, the ruins of which are known by the name of Old Cairo. Amru pursued the Greeks to Alexandria, and after an obstinate and bloody siege of fourteen months, the city was taken, 640 A.D. To Amru has generally been attributed the burning of the famous Alexandrian library, by command of the caliph Omar. But with this act of barbarism, so inconsistent with the character of Omar and his general, he is for the first time charged by Abul-Faragius, a Christian writer, who lived six centuries later. It is highly probable that few of the 700,000 volumes collected by the Ptolemies remained at the time of the Arab conquest, when we consider the various calamities of Alexandria from the time of Cæsar to those of Caracalla and Diocletian, and the disgraceful pillage of the library in 389 A.D. under the rule of a Christian bishop, Theophilus (see Gibbon, c. 51). Amru died 663 A.D. In a pathetic oration to his children on his death-bed he bitterly lamented his youthful offence in satirising the prophet, although Mahomet had forgiven him, and had frequently affirmed that "there was no Mussulman more sincere and steadfast in the faith than Amru."

AMRU-EL-KAIS, an Arabian poet, contemporary with Mahomet. He wrote one of the seven *Moallakat* (Suspended), or poems, composed before the promulgation of Mahometanism, which derived their name from the fact that they were suspended in the Kaaba at Mecca. He was hostile to the claims of the prophet, and wrote verses against him. It is said that his death was occasioned by his wearing a poisoned shirt presented to him by the Greek emperor Heraclius, to whom he had gone to ask aid against the Beni-Asad, his own tribe. The story is, however, discredited by Abulfeda. The *Moallakat* of Amru, in the original text, was published by Lette at Leyden in 1848, and an English translation by Sir William Jones appeared in 1782. The edition of Hengstenberg (Bonn, 1823) contains a Latin version. Another edition, by Arnold, appeared at Leipsic in 1850. The edition of Baron MacGuckin Slane (Paris, 1837) includes the miscellaneous poems, a translation, notes, and a life of the poet.

AMSANCTI (or AMPSANCTI) VALLIS, a valley with a small sulphureous lake and cavern in the territory of the Hirpini, or Principato Ultra (east of Naples), about four miles from the town of Frigento (Cicero, Pliny), or eight from Gesualdo. The spot can most easily be visited by railway from Ariano, on the Naples and Benevento line. It is described by Virgil (*Æn.* vii. 563–71) as an outlet from a cave giving access to the infernal regions :—

> "Hic specus horrendum, sævi spiracula Ditis,
> Monstratur, ruptoque ingens Acheronte vorago
> Pestiferas aperit fauces; quis condita Erinnys,
> Invisum numen, terras cœlumque levabat."

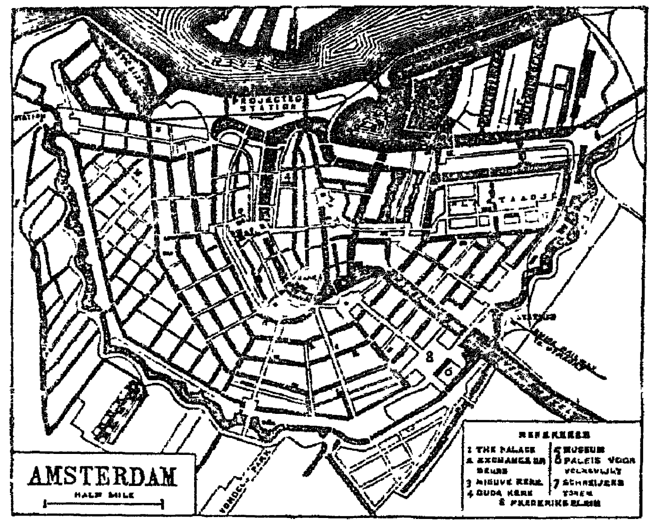
The modern name is *Le Mofete*, after the goddess Mephitis, who, according to Pliny (*N.H.* ii. 95), had a temple here, of which there are no remains. The lake is considered by Dr C. T. Ramage (who made a special visit to it) as of volcanic character, and appears to lie on the edge of a crater-shaped valley. "The water," he says, "had a dark, pitchy appearance, and was thrown up occasionally in several places to the height of 4 or 5 feet. At the edge (of the crater) we were possibly 40 feet above the water, and we did not dare to descend, as the exhalations of sulphur were so strong that we should have been suffocated long before we reached the water. . . . In fact, the whole of this country seems to be volcanic, and is constantly subject to earthquakes." (See *Nooks and Byways of Italy*, by C. T. Ramage, LL.D., 1868; *Swinburne's Travels*, vol. i., Murray's *Handbook for South Italy*, 1873.)

AMSDORF, Nicolaus, a Protestant reformer of the 16th century, was born, Dec. 3, 1483, at Gross-Zschopa, near Wurzen, on the Mulde. He was educated at Leipsic, and then at Wittenberg, where he was one of the first who matriculated (1502) in the recently-founded university. He soon obtained various academical honours, and became

professor of theology in 1511. He joined Luther at the very beginning of his great struggle (1517); continued all along one of his most admiring and determined supporters; was with him at the Leipsic conference (1519), and the Diet of Worms (1521); and was in the secret of his Wartburg seclusion. He assisted the first efforts of the Reformation at Magdeburg (1524), at Goslar (1531), and at Einbeck (1534); took an active part in the debates at Schmalkald (1537), where he defended the use of the sacrament by the unbelieving; and (1539) spoke out strongly against the bigamy of the Elector of Hesse. After the death of the Count Palatine, bishop of Naumburg-Zeiz, he was installed there (Jan. 20, 1542), though in opposition to the chapter, by the elector of Saxony and Luther. His position was a painful one, and he longed to get back to Magdeburg, but was persuaded by Luther to stay. After Luther's death (1546) and the battle of Mühlberg (1547) he had to yield to his rival Pflug, and retire to the protection of the young duke of Weimar. Here he took part in founding Jena university (1548); opposed the "Augsburg Interim" (1548); superintended the publication of the Jena edition of Luther's works; and debated on the freedom of the will, original sin, and, more noticeably, on the Christian value of good works, in regard to which he held that they were not only useless, but prejudicial. He urged the separation of the High Lutheran party from Melanchthon (1557), got the Saxon dukes to oppose the Frankfurt Recess (1558), and continued to fight for the purity of Lutheran doctrine. He died at Eisenach, May 14, 1565, and was buried in the high church there, where his effigy shows a well-knit frame and sharp-cut features. He was a man of strong will, of great aptitude for controversy, and considerable learning, and thus exercised a decided influence on the Reformation. Many letters and other short productions of his pen are extant in MS., especially five thick volumes of *Amsdorfiana*, in the Weimar library. A small sect, which adopted his opinion on good works, was called after him; but it is now of mere historical interest.

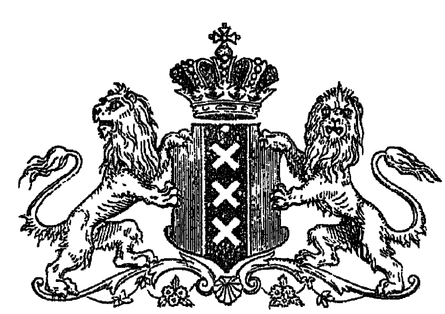
AMSLER, Samuel, one of the most distinguished of modern engravers, was born at Schinznach, in the canton of Aargau, in 1791. He studied his art under Lips and Hess, and from 1816 pursued it in Italy, and chiefly at Rome, till in 1829 he succeeded his former master Hess as professor of copper engraving in the Munich academy. The works he designed and engraved are remarkable for the grace of the figures, and for the wonderful skill with which he retains and expresses the characteristics of the original paintings and statues. He was a passionate admirer of Raphael, and had great success in reproducing his works. Amsler's principal engravings are—"The Triumphal March of Alexander the Great," and a full-length "Christ," after the sculptures of Thorwaldsen and Dannecker; the "Burial of Christ," and two "Madonnas," after the pictures of Raphael; and the "Triumph of Religion in the Arts," after Overbeck, his last work, on which he spent six years. He died May 18, 1849.

AMSTERDAM, or Amsteldam, formerly called *Amstelredam*, capital of the Netherlands, situated in the province of North Holland, is built somewhat in the form of a half-moon, on the Y or Ij, an arm of the Zuyder Zee, in 52° 22′ N. lat., and 4° 53′ E. long. The name Amsterdam means "the dam or dyke of the Amstel," from a river so called which passes in a north-easterly direction through the city,—the "dam" referring to the extensive and costly system of embankments, canals, and sluices necessary to secure this low-lying city against the encroachments of the tide. Towards the land Amsterdam was at one time surrounded by a fosse or canal, and regularly fortified; but its ramparts have been demolished, and the twenty-eight bastions that formed part of the defences are now used as promenades, or covered with buildings. Within the city, four canals—the Prinsen Gracht, Keizer's Gracht, Heeren



Gracht, and the Singel—extend, in the form of polygonal crescents, nearly parallel to each other and to the former fosse; while numerous smaller canals intersect the city in every direction, dividing it into about 90 islands, with nearly 290 bridges. Some of these are of stone, but the majority are of iron and wood, and constructed so as to allow vessels for inland navigation to pass through. The site of Amsterdam was originally a peat bog, and all its buildings rest upon piles that are driven some 40 or 50 feet through a mass of loose sand and mud until they reach a solid stratum of firm clay. This foundation is perfectly secure as long as the piles remain under water. In 1822, however, an overladen corn magazine sank into the mud. The piles are liable to the ravages of wood-worms that are supposed to have been brought by vessels from foreign ports. The streets in the oldest parts of the town are narrow and irregular, but are nowhere without pavements or footways. The houses frequently present a picturesque sky-line, broken by fantastic gables, roofs, chimneys, towers, and turrets of all forms and dimensions. Four of the principal of those towers have exterior galleries very near the top, running round them, from which an alarm used to be blown in case of fire, and a light shown to indicate the locality of the fire to the citizens, who from the age of twenty to fifty are all enrolled in the fire-brigade and civic guard. This mode of signalling is now, however, superseded by a system of telegraphic communication embracing the whole city. Westward of the Amstel, which passes almost through the centre of the city, is the more modern part, where the houses are often exceedingly handsome, and the streets broad, and planted with rows of large trees between the houses and the canals. The chief promenades are the Vondelspark, laid out and maintained by private individuals, with the design of its being ultimately presented to the city; and the Plantaadje or Plantation, part of which is occupied by the botanic and the zoological gardens, and which is also supported by private contributions. Of the public buildings, the principal is the palace, an imposing structure, built in 1648, by the architect Jacob van Kampen, and adorned with stone carvings by the celebrated artist Artus Quellinus of Antwerp. It is supported on 13,659 piles, and is 282 feet long, with a breadth of 235 feet and a height of 116, exclusive of a turreted cupola, which rises 66 feet above the main building. It was originally the Stadhuis, but was appropriated as a palace by King Louis Napoleon in 1808. The most mag-

nificent apartment in it is the great hall, measuring 120 feet by 57, and 90 in height, with walls incrusted with white Italian marble. On the opposite side from the palace of the square called the Dam, stands the Beurs or Exchange, a fine tetraprostyle Ionic building, serving as a front to a large quadrangle with a handsome peristyle of the same order. The Oude Kerk, built about the year 1300, has some beautiful stained windows and a fine organ, as well as monuments to various celebrated Dutchmen, including the naval heroes Van Heemskerk and Sweerts. The Niewe Kerk, a much finer edifice, where the kings of Holland are crowned, dating from 1408, is remarkable for the carving of its pulpit, for the elaborate bronze castings of its choir, and for the monuments to the famous Admiral De Ruyter and Holland's greatest poet, Vondel, whose statue stands in the park which bears his name. There are many other places of worship in Amsterdam, including those belonging to the Dutch Reformed Church, the English Episcopalians, the Scotch Presbyterians, the Lutherans, the Jansenists, the Roman Catholics, the Greeks, &c., and also several Jewish synagogues; but, as a rule, the church architecture of the town is bald and uninteresting. We may except, however, the synagogue of the Shephardim Jews, the equal of which is only to be found at Leghorn; the Moses and Aaron's Church (R.C.); and the new Lutheran place of worship, which has a green copper cupola. The Paleis voor Volksvlijt is a building of iron and glass, 440 feet long by 280 broad, with a dome 200 feet high, erected between 1855 and 1864. It is used for industrial exhibitions, the performance of operas, &c., and possesses a collection of pictures (copies and some originals), as well as a fine garden. The Schreijerstoren, or "crier's tower," at the end of the Geldersche Kade, where vessels left for all parts of the globe, was built about 1482, and got its name from the tears of the sailors who here bid their friends farewell. The chief literary institutions of Amsterdam are the Athenæum, the society called "*Felix Meritis*," from the first words of the inscription on their place of meeting; the society "*Natura Artis Magistra*," to whom the zoological gardens belong; the Royal Academy of the Fine Arts, and the Seaman's Institute. The galleries of pictures in the city are of great value. The museum in the Trippenhuis contains over 400 works, chiefly of the Flemish and Dutch schools, including the "Night Guard" of Rembrandt, whose statue may be seen on the Kaasplein, opposite the house he occupied, and the "Banquet of the Civic Guard," by Van der Helst; besides nearly 4000 engravings, and a magnificent numismatic collection, considered one of the finest in the world. Among the other collections are those in the Museum Van der Hoop and in the Fodor Museum, that belonging to the "*Arti et Amicitiæ*" Society, as well as several private galleries. Amsterdam is also remarkable for the number and high character of its benevolent institutions, which are to a large extent supported by voluntary contributions. Among others may be mentioned hospitals for the sick, the aged, the infirm, the blind, the deaf, the dumb, the insane, widows, orphans, and foundlings. There is a noble institution, the Society for the Public Welfare, whose object is to promote the education and improvement of all classes. It has branches in nearly every town and village in Holland. There is also an admirable sailors' home.



City Arms of Amsterdam.

Amsterdam is now capitally supplied with water for drinking and culinary purposes from the Haarlem dunes. Formerly the inhabitants were dependent on the rain-water collected in cisterns, and the supply brought from Weesp in large flat-bottomed barges. This, added to the general humidity of the atmosphere caused by the canals, made Amsterdam an unpleasant place of residence in summer, but the exertions of the inhabitants have done much of late to counteract these noxious influences. The people usually have a robust appearance, and the death-rate of the city is low.

The population (1874) is estimated at 285,000, of whom about 60,000 are Roman Catholics, and 30,000 Jews, the rest being mostly Protestants of various sects.

The accompanying plan indicates the extent and position of the docks of Amsterdam. The arsenal and the admiralty offices are situated on the island of Kattenburg, between the Dijk Gracht and the Niewe Vaart. The approach to the city from the Zuyder Zee is intricate and dangerous, owing to the numerous shallows; and a bar at the entrance to the Y compels vessels to unload part of their cargo in the roadstead. These delays and dangers were to a large extent provided against in 1825, by the opening of a canal across North Holland from the Niewe Diep, opposite the Texel, to Amsterdam; and a more direct and capacious canal to the North Sea is at present in process of construction. The following table gives the chief shipping statistics for the five years ending December 1870:—

Year.	Arrivals.		Departures.	
	Vessels.	Tonnage.	Vessels.	Tonnage.
1866	1604	420,094	1662	423,623
1867	1466	392,975	1560	404,717
1868	1465	430,799	1508	421,566
1869	1374	425,329	1443	448,891
1870	1297	405,109	1341	402,933

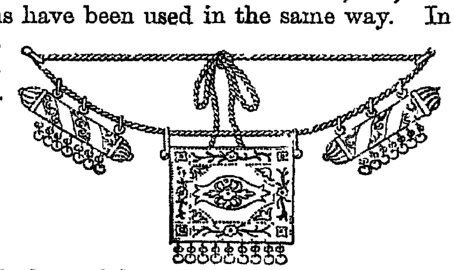
The principal imports of Amsterdam are—coffee, amounting in 1870 to 1,147,240 bags and 1499 casks; tea, in the same year, 79,573 chests; sugar, in the same year, 273,750,000 lb; tobacco, rice, cotton, indigo, timber, tin, hemp, and grain. The exports comprise cheese, butter, madder, clover, rape, linseed oil, gin, and other products of Holland, besides general goods and manufactures from various European countries. There is also a large export trade in the produce of the East and West Indies. There are two lines of railway, the one connecting Amsterdam with Haarlem, Leyden, and Rotterdam; and the other with Utrecht, Arnheim, and Prussia. Amsterdam has sugar refineries; soap, oil, glass, iron, dye, and chemical works; distilleries, breweries, tanneries; tobacco and snuff factories. The cutting of diamonds has long been extensively practised in the city by the Jews. Although no longer the centre of the banking transactions of the world, Amsterdam is still a place of considerable importance in this respect. The celebrated bank of Amsterdam, founded in 1609, was dissolved in 1796; and the present bank of the Netherlands was established on the model of the Bank of England in 1814.

About the year 1200 Amsterdam was a small fishing village, held in fief by the lords of Amstel, together with the surrounding district, called Amstelland. Towards the close of the 13th century it reverted, in consequence of the complicity of Gysbrecht Van Amstel in the murder of Count Floris V., to the counts of Holland, who gave it a charter and other privileges. It was fortified in 1482, and soon rose to be the most important commercial city of the Netherlands. The early voyages to India, and the union of the seven provinces in 1579, added greatly to the

prosperity of Amsterdam—so much so, that it excited the cupidity of the earl of Leicester, who made a futile attempt to surprise it in 1587; and its position was still further improved by the peace of Westphalia in 1648, which closed the navigation of the Scheldt, and consequently ruined the trade of Antwerp. Two years later, the stadtholder William II. intended to surprise it, but the bold attitude of the inhabitants obliged him to give up his project. Amsterdam suffered so severely from the war in the time of Cromwell, that more than 4000 houses stood tenantless; and the French occupation during the First Empire inflicted a more permanent injury upon the city. Since 1813, however, much of its former commercial influence has returned; and the completion of the above-mentioned canal will, no doubt, confirm its position as the chief commercial city of the kingdom, its secondary place as a seaport lately having been due to the difficulty of access to it from the sea. Among the many eminent men who saw the light in Amsterdam may be mentioned the celebrated philosopher Baruch Spinosa (1632), the flower painter Van Huysum (1682), the naturalist Swammerdam (1637), and the poet Bilderdyk (1750). (See Caspar Commelins, *Beschryving van Amsterdam*, and J. Wagenaar's work bearing the same title.)

AMSTERDAM, an uninhabited and almost inaccessible island in the Indian Ocean, in 37° 58′ S. lat., and 70° 34′ E. long., about 60 miles S. of St Paul's Island, and nearly midway between the Cape of Good Hope and Tasmania. It was discovered by Van Diemen in 1633.

AMULET (in late Latin *amuletum*, probably from the Arabic *hamalet*, a pendant), anything worn as a charm, generally, but not invariably, hung from the neck, to protect the wearer against witchcraft, sickness, accidents, and other evils, or to deliver him from ills under which he labours. Amulets have been of many different kinds, and formed of different substances,—stones, metals, and strips of parchment being the most common, with or without characters or legends engraved or written on them. Gems have often been employed and greatly prized, serving for ornaments as well, as for charms. Certain herbs, too, and animal preparations have been used in the same way. In setting them apart to their use as amulets, great precautions have been taken that fitting times be selected, stellar and other magic influences propitious, and everything avoided that might be supposed to destroy or weaken the force of the charm. From the earliest ages the Oriental races have had a firm belief in the prevalence of occult evil influences, and a superstitious trust in amulets and similar preservatives against them. There are references to, and apparently correctives of, these customs in the Mosaic injunctions to bind portions of the law upon the hand and as frontlets between the eyes, as well as write them upon the door-posts and the gates; but, among the later Jews especially, the original design and meaning of these usages were lost sight of; and though it has been said that the phylacteries were not strictly amulets, there is no doubt that they were held in superstitious regard. Amulets were much used by the ancient Egyptians, and also among the Greeks and Romans. We find traces of them too in the early Christian church, in the emphatic protests of Chrysostom, Augustine, and others against them. The fish was a favourite symbol on these charms, from the word ἰχθύς being the initials of Ἰησοῦς Χριστὸς Θεοῦ υἱὸς σωτήρ. A firm faith in amulets still prevails widely among Asiatic nations. The accompanying woodcut represents the boxes employed to hold written charms worn by Arab women at the present day. *Talisman*, also from the Arabic, is a word of similar meaning and use, but some distinguish it as importing a more powerful charm. A talisman, whose "virtues are still applied to for stopping blood and in cases of canine madness," figures prominently in, and gives name to, one of Scott's *Tales of the Crusaders*. A measure of belief in amulets or charms exists, but appears to be diminishing, among the uneducated of our own country and time. (See Arpe, *De Prodigiis Naturæ et Artis Operibus Talismanes et Amuleta dictis*, Hamburg, 1717; Ewele, *Ueber Amulete*, 1827; and Kopp's *Palæographica Critica*, vols. iii. and iv., 1829.)



AMURATH or MURAD I. was born in 1326 A.D. (726 A.H.), succeeded his father Orkhan as sultan of the Ottoman Turks in 1360, and died in 1389. He is entitled to notice as being the first who led the Turkish arms into Europe, which he quickly overran as far as the Balkan. In 1361 he made himself master of Adrianople, where he fixed his residence, built a splendid mosque, and otherwise added to the architectural adornment of the city. The first treaty of peace between a Christian people and this formidable neighbour was struck in 1365, when the little republic of Ragusa put itself under his protection. His power becoming more and more formidable, Urban V. preached a crusade—disastrous, as it proved, for the crusaders—against him; and John Palæologus, the Greek emperor, entered into an alliance with him. He had several rebellions to contend against, but he was invariably successful. One of his sons persuaded a son of Palæologus, who had been sent by his father to learn the art of war under Amurath, to join him in a revolt; but the youthful conspirators were defeated. Immediate revenge was taken by the sultan on his own son, and the young Palæologus was sent back to his father with an imperious demand that he too should be punished. Like all great conquerors, Amurath was active in military reform; he perfected the discipline of the *spahis* (or cavalry) and *woinaks* (or baggage corps), and gave stability to the *janissaries*, a body of troops that had been first incorporated by his father. Of literary culture he was altogether destitute, signing his treaties by dipping his hand in ink, and impressing the mark of three fingers together, with the thumb and fourth finger at a slight distance on each side. He lost his life at the close of a great battle at Kossova, which he had successfully fought against Lazarus, despot of Servia, and was succeeded by his son Bajazet.

AMURATH II., the tenth emperor of the Turks, was born about 1404, and died February 9, 1451. He succeeded Mohammed I. in 1422. At first he had to contend against a pretender, the pseudo-Mustapha, who was supported by the Greek emperor and others; but through the assistance of an astute state prisoner, Mohammed Bey (Michael Ogli), he obtained a bloodless victory over him. He then turned his arms against the Greek emperor himself, but failed in the siege of Constantinople. Against his younger brother Mustapha he was successful by bribes. In April 1429 he besieged and took Saloniki (*Thessalonica*), which was under Venetian rule, thus opening up the way for the final subjugation of Greece. He continued almost without any reverses of fortune till 1442, when Hunniades defeated his forces in the battle of Vasag, and obliged him to make peace with the Christian princes. The treaty was hardly concluded when his son Ala-Eddin died. In his grief he abdicated in favour of his son Mohammed, a boy of fourteen, while he retired to Magnesia in search of repose. But the Christian princes took advantage of his abdication to renew their attacks, and he was called to oppose them, which he did with terrible suc-

cess in the battle of Varna, Nov. 10, 1444, when the king of Hungary, Ladislaus, fell. Having saved his country, he again gave up the reins to his son, and returned to Magnesia. But the janissaries revolted, and his presence was demanded. Again on his throne, he invaded Albania and Peloponnesus, but was repulsed by George Castriot or *Scanderbeg*. He retreated, however, only to gain a great victory over his former adversary Hunniades at Kossova (Oct. 17, 1448), the battle lasting three days. He died at Adrianople, Feb. 11, 1451, from a stroke of apoplexy, according to the most probable account. His Mussulman biographers tell that whenever he took a town he was careful to build in it a *jami* (or cathedral), a *mosque*, an *imaret*, a *medrésseh* (or ecclesiastical school), and a *khan*. The mosque of Adrianople is especially remarkable. He was the first Ottoman emperor who caused bridges of great length to be built; and during his reign, poetry, jurisprudence, and theology began to flourish with promise of the Augustan luxuriance which they attained under his son and successor, Sultan Mohammed-Elfatyh.

AMURATH III., sultan of the Turks, born about 1545, succeeded in 1574 his father Selim II. The first words he addressed to his courtiers were—"I am hungry: give me something to eat;" and the evil omen was fulfilled in the famines and disasters that marked his reign. In 1579 Queen Elizabeth of England managed to gain his friendship, and obtained a favourable commercial treaty for Great Britain. It was under him that the janissaries began to feel their power, and to hasten the ruin of the state by their revolt. He was superstitious, feeble, and irritable, as well as extremely addicted to the pleasures of the harem. He was fond of dancing and music, and has left a few literary trifles. He died Jan. 16, 1595.

AMURATH IV. was born about 1611, and succeeded his uncle Mustapha in 1623. The chief event of his reign was the recovery in 1638, after thirty days of unremitting assault, of the city of Baghdad which had fallen into the hands of the Persians. He disgraced his victory by revolting cruelties, slaughtering 30,000 Persians in cold blood. So numerous and horrible are the atrocities recorded of him, that he stands pre-eminent even among Turkish Neroes. Some historians ascribe this feature of his character to his almost perpetual inebriation. Be this as it may, he soon enfeebled his constitution, and falling at the same time under a superstitious anticipation of death, he died in 1640, at the early age of twenty-nine.

AMWELL, a village of Hertfordshire, in the parish of Great Amwell, on a hill overlooking the Lea, 3 miles from Hertford and 20 from London. Near it are the sources of the New River, formed between 1606 and 1612 in order to supply London with water; and on a small island in the stream there is a monument to Sir Hugh Myddleton, through whose exertions this work was carried out. Haileybury college, formerly the property of the East India Company, is also in this parish, which has a population of 2245.

AMYMONE ('Αμυμώνη), in *Greek Legend*, a daughter of Danaüs, by whom, with her sisters, she had been sent to look for water, the district of Argus being then parched through the anger of Neptune. Amymone having thrown her spear at a stag, missed it, but hit a satyr asleep in the brake. The satyr pursued her, and she called on Neptune for help, who appeared, and for love of her beauty caused a spring to well up, which received her name. By Neptune she became the mother of Nauplius, the wrecker. Amymone at the spring is represented on ancient engraved gems.

AMYOT, Jacques, a famous French writer, was born, of poor parents, at Melun, October 30, 1513; found his way—a pale-faced, bare-footed, ill-clad boy—to the "College de France" in Paris, and there picked up a knowledge of the classical languages, serving some of the richer students as valet and composer of Latin, to enable him to continue his studies. He became M.A. at Paris, and doctor of civil law at Bourges; obtained, through Jacques Colure (or Colin), abbot of St Ambrose in the latter city, a tutorship in the family of a secretary of state; by the secretary was recommended to the duchess of Berry, only sister of Francis I.; and, through her influence, was made professor of Greek and Latin at Bourges. Here he translated the *Theagenes and Chariclea* of Heliodorus (1547, fol.), for which he was rewarded by Francis I. with the abbey of Bellozane, and thereby enabled to go to Italy to study the Vatican text of Plutarch, on whose *Lives* he had been some time engaged. On the way he turned aside on a mission to the council of Trent. Returning home, he was selected as tutor to the sons of Henry II., by one of whom (Charles IX.) he was afterwards made grand almoner, and by the other (Henry III.) was appointed commander of the order of the Holy Ghost. Pius I. promoted him to the bishopric of Auxerre, and here he continued to live in comparative quiet, repairing his cathedral and perfecting his translations, for the rest of his days, though troubled towards the close by the insubordination and revolts of his clergy. He died February 6, 1593, bequeathing, it is said, 1200 crowns to the hospital at Orleans for the twelve "deniers" he received there when "poor and naked" on his way to Paris. His fame rests on his vigorous and idiomatic version of Plutarch's *Lives* (1559, 2 vols.), which was translated into English by North, and supplied Shakespeare with materials for his Roman plays. His style was greatly admired by Racine and Rousseau, and Montaigne said of him, "I give the palm, and rightly, methinks, to Jacques Amyot over all our French writers."

AMYRAUT, Moses, a pre-eminent French Protestant theologian and metaphysician, was born at Bourgueil, in the valley of Anjou, in 1596. His family was an ancient and illustrious one from Hagenau, Alsace. They migrated to Orleans in the 13th or 14th century. His father was a lawyer of local note, and designing Moses for his own profession, on the completion of his studies at Orleans of humanity and philosophy, he sent him to the university of Poictiers. It is recorded that there the youth studied fourteen hours a day, and made such swift progress that he was able to maintain theses and disputations, and to take the degree of licentiate (B.A.) of laws. On his way home from the university he passed through Saumur, and having visited Mons. Bonchereau, pastor of the Protestant church there, he introduced him to the renowned lord of Plessis-Mornay, governor of the city. Both were struck with young Amyraut's ability and culture, and both urged him to change from law to theology. Plessis-Mornay, who was chary of laudations, pronounced that "there was nothing above the grasp of his great parts." Returned home, his father, after considerable hesitation, gave consent to the change from law to divinity, with a proviso that he should revise his philological and philosophical studies, and read over Mons. Calvin's *Institutions*, before finally determining. He did so, and, as might have been anticipated, decided for theology. He thereupon removed to Saumur—destined to be for ever associated with his name—and "sat at the feet of the great Cameron," who ultimately regarded him as his greatest scholar. He had a brilliant course, and was in due time licensed as a minister of the French Protestant Church. The contemporary civil wars and excitements hindered his advancement. His first church was in St Aignau, in the province of Maine. There he remained two years. The celebrated Daille, being then removed to Paris, advised the church at Saumur to secure Amyraut as his successor, praising him "as above himself."

The university of Saumur at the same time had fixed its eyes on him as professor of theology. The great churches of Paris and Rouen also contended for him, and sent their deputies to win him, to the provincial synod of Anjou. Amyraut had left the choice to the synod. He was appointed to Saumur, and to the professor's chair along with the pastorate. On the occasion of his inauguration he maintained for thesis *De Sacerdotio Christi*. His co-professors were Lewis Capell and Josua de la Place, who were also Cameron's pupils. Very beautiful was the life-long friendship of these three remarkable men. They remain associated still as the joint authors of a body of divinity entitled *Theses Salmurienses*. Full of energy in every atom of him, Amyraut devoted himself to his labour of love with a fine enthusiasm of love of labour. He very speedily gave French Protestantism a potentiality it had never possessed before. In 1631 he published his *Traité des Religions*, a book that still lives; and from this year onward he was a foremost man in the church, especially at the national and provincial synods. One incident in his synodical services stands out, as the like do in the story of Luther and of John Knox. Chosen to represent the provincial synod of Anjou, Touraine, and Maine at the national synod held in 1631 at Charenton, that assembly appointed him their orator to address the king, and to present to him "The Copy of their Complaints and Grievances for the Infractions and Violations of the Edict of Nantes." Previous deputies had addressed the king on their bended knees, whereas the representatives of the Roman Catholics had been permitted to stand. Amyraut consented to be orator only if the assembly authorised him to stand. There was intense resistance. Richelieu himself, preceded by lesser dignitaries, condescended to visit Amyraut privately, to draw him over to kneel; but the stout-hearted orator held resolutely to equality with the Roman Catholics, and carried his point. Standing in the presence of king and court, he recounted the complaints and grievances of his church, and charmed even his adversaries with his mingled dignity of manner and suavity of address. Long afterwards Richelieu recalled the memorable incident; and the "Oration," which was immediately published in the French *Mercury*, remains a historic landmark in the history of French Protestantism. During his absence on this matter the assembly debated "Whether the Lutherans who desired it, might be admitted into communion with the Reformed Churches of France at the Lord's Table?" It was decided in the affirmative previous to his return; but he approved with astonishing eloquence, and thereafter was ever in the front rank in maintaining intercommunication between all churches holding the main doctrines of the Reformation. His defence against many adversaries on the question was published in 1647—*De Secessione ab Ecclesiâ Romanâ deque Ratione Pacis inter Evangelicos in Religionis Negotio constituendæ*. Bayle (*s.v.*) recounts the title-pages of no fewer than thirty-two books of which Amyraut was the author. These show that he took part in all the great controversies on Predestination and Arminianism which then so agitated and harassed all Europe. Substantially he held fast the Calvinism of his preceptor Cameron; but, like Richard Baxter in England, by his breadth and charity exposed himself to all manner of misconstruction from Peter du Moulin and others ultra-orthodox. His *La Defense de Calvin* never was answered, although superabundantly replied to. The university of Saumur became the university of French Protestantism. Amyraut had as many as a hundred students in attendance upon his prelections. Another historic part filled by Amyraut was in the negotiations originated with Mons. le Goux, lord of Berchère, first president of the parliament of Burgundy, when exiled to Saumur, for a reconciliation and reunion of the Roman Catholics of France with the French Protestants. Very large were the concessions made by Richelieu in his personal interviews with Amyraut; but, as with the Worcester House negotiations in England between the Church of England and Nonconformists, they inevitably fell through. On all sides the statesmanship and eloquence of Amyraut were conceded. When the king visited Saumur in 1651, Amyraut declined to close his church on the Sunday, but preached a sermon that rang through Europe on the text, "Fear God, honour the king." Amyraut remained to the end one of the most prominent names of French Protestantism; and his *De l'Elévation de la Foy et de l'Abaissement de la Raison en la Créance des Mystères de la Religion* (1641) gave him early a high place as a metaphysician, which was sustained by after works. Exclusive of his controversial writings, he left behind him a very voluminous series of practical evangelical books, which remain the fireside favourites of the peasantry of French Protestantism still. His *Estat des Fidèles après la Mort* has comforted many mourners; his *Sur l'Oraison Dominicale* is striking and rich; his *Du Mérite des Œuvres* and *Traité de la Justification*, weighty and powerful; his Paraphrases on Old Testament and New Testament books of Holy Scripture, judicious and suggestive—sometimes penetrative. His closing years were weakened by a severe fall he met with in 1657. He died on 18th January 1664. His portrait was published by his son, but with no name or inscription underneath. (Bayle, *s.v.*; *Biog. Univ.*, *s.v.*; John Quick's *Synod. in Gall. Reform.*, pp. 352–7; ibid. MS. *Icones Sacræ Gallicanæ*; *Life of Cameron*.) (A. B. G.)

ANA, a Latin plural termination appropriated to various collections of the observations and criticisms of eminent men, delivered in conversation and recorded by their friends, or discovered among their papers after their decease. Though the term Ana is of comparatively modern origin, the introduction of this species of composition is not of recent date. It appears, from D'Herbelot's *Bibliothèque Orientale*, that from the earliest periods the Eastern nations were in the habit of preserving the maxims of their sages. From them the practice passed to the Greeks and Romans. Plato and Xenophon treasured up and recorded the sayings of their master Socrates; and Arrian, in the concluding books of his *Enchiridion*, now lost, collected the casual observations of Epictetus. The numerous apophthegms scattered in Plutarch, Diogenes Laertius, and other writers, show that it was customary in Greece to preserve the colloquially expressed ideas of illustrious men. It appears that Julius Cæsar compiled a book of apophthegms, in which he related the *bon mots* of Cicero; and Quintilian informs us that a freedman of that celebrated wit and orator composed three books of a work entitled *De Jocis Ciceronis*. We are told by Suetonius that Caius Melissus, originally the slave but afterwards the freedman and librarian of Mæcenas, collected the sayings of his master; and Aulus Gellius has filled his *Noctes Atticæ* with anecdotes which he heard from the eminent scholars and critics whose society he frequented in Rome.

But though vestiges of Ana may be traced in the classical ages, it is only in modern times that they have come to be regarded as constituting a distinct species of composition, comprising literary anecdotes, critical reflections, and historical incidents, mingled with the detail of *bon mots* and ludicrous tales. The term Ana seems to have been applied to such collections as far back as the beginning of the 15th century. Francesco Barbaro, in a letter to Poggio, says that the information and anecdotes which Poggio and Barthelemi Montepolitiano had picked up during a literary excursion through Germany will be called *Ana*: "Quemadmodum mala ab Appio e Claudia gente

Appiana, et pira a Mallio *Malliana* cognominata sunt, sic hæc literarum quæ vestra ope et opera Germania in Italiam deferentur, aliquando et *Poggiana* et *Montepolitiana* vocabuntur."

Poggio Bracciolini, to whom this letter is addressed, and to whom the world is indebted for the preservation of so many classical remains, is the first eminent person of modern times whose jests and opinions have been transmitted to posterity. Poggio was secretary to five successive popes. During the pontificate of Martin V., who was chosen in 1417, Poggio and other members of the Roman chancery were in the habit of assembling in a common hall adjoining the Vatican, in order to converse freely on all subjects. Being more studious of wit than of truth, they termed this apartment *Buggiale*, a word which Poggio himself interprets *Mendaciorum Officina*. Here Poggio and his friends discussed the news and scandal of the day; communicated entertaining anecdotes; attacked what they did not approve (and they approved of little); and indulged in the utmost latitude of satiric remark, not sparing even the pope and cardinals. The jests and stories which occurred in these unrestrained conversations were collected by Poggio, and formed the chief materials of his *Facetiæ*, first printed, according to De Bure, in 1470. This collection, which forms a principal part of the *Poggiana*, is chiefly valuable as recording interesting anecdotes of eminent men of the 14th and 15th centuries. It also contains a number of quibbles or *jeux de mots*, and a still greater number of idle and licentious stories. Many of these are not original, some of them being taken from ancient authors, and a still greater number from the *Fabliaux* of the *Trouveurs*. On the other hand, Poggio has suggested much to succeeding writers. Prior's *Hans Carvel* and several of Fontaine's fables are from stories originally related by Poggio. The *Facetiæ* forms, upon the whole, the most amusing and interesting part of the *Poggiana* printed at Amsterdam in 1720; but this collection also comprehends additional anecdotes of Poggio's life, and a few extracts from his graver compositions.

Though Poggio was the first person whose remarks and *bon mots* were collected under the name of Ana, the *Scaligerana*, which contains the opinions of Joseph Scaliger, was the first work *published* under that appellation, and accordingly may be regarded as having led the way to that class of publications. There are two collections of Scaligerana—the *Prima* and *Secunda*. The first was compiled by a physician named Francis Vertunien, Sieur de Lavau, who attended a family with whom Joseph Scaliger resided. He, in consequence, had frequent opportunities of meeting the celebrated critic, and was in the custom of committing to writing the observations which dropped from him in the course of conversation, to which he occasionally added remarks of his own. This collection, which was chiefly Latin, remained in manuscript many years after the death of the compiler. It was at length purchased by M. de Sigogne, who published it in 1669, under the title of *Prima Scaligerana, nusquam antehac edita*, calling it *prima* in order to preserve its claim of priority over another *Scaligerana*, which, though published three years before, had been more recently compiled. This second work, known as *Secunda Scaligerana*, was collected by two brothers of the name of Vassan, students of the university of Leyden, of which Scaliger was one of the professors. Being particularly recommended to Scaliger, they were received in his house, and enjoyed his conversation. Writing down what they had heard, particularly on historical and critical subjects, they soon made up a large manuscript volume, in which, however, there was neither connection nor arrangement of any description. After passing through various hands, this manuscript came into the possession of M. Daillé, who for his own use arranged in alphabetical order the articles which it contained. Isaac Vossius, obtaining the manuscript in loan from M. Daillé, transcribed it, and afterwards published it at the Hague, under the title of *Scaligerana, sive Excerpta ex Ore Josephi Scaligeri*. This edition was full of inaccuracies and blunders, and a more correct impression was afterwards published by M. Daillé, with a preface complaining of the use that Vossius had made of the manuscript, which he declares was never intended for publication, and was not of a nature to be given to the world. Indeed, most literary men in that age conceived that the *Scaligerana*, particularly the *second*, detracted considerably from the reputation of the great scholar. Joseph Scaliger, with more extensive erudition, but, as some think, less genius than his father Julius Cæsar Scaliger, had inherited his vanity and dogmatical spirit. Conversing with two young students, he would probably be but little cautious in the opinions he expressed, as his literary errors could not be detected or exposed. Unfortunately the blind admiration of his pupils led them to regard his opinions as the responses of an oracle, and his most unmerited censures as just condemnations. The *Scaligerana*, accordingly, contains many falsehoods, with much unworthy personal abuse of the most distinguished characters of the age.

In imitation of the *Scaligerana*, a prodigious number of similar works appeared in France towards the end of the 17th and beginning of the 18th century. At first these collections were confined to what had fallen from eminent men in conversation; but they were afterwards made to embrace fragments found among their papers, and even passages extracted from their works and correspondence. Of those which merely record the conversations of eminent men, the best known and most valuable is the *Menagiana*. Gilles Ménage was a person of good sense, of various and extensive information, and of a most communicative disposition. For a long period an assembly of literary men met once a week at his house; and during his later years he daily received critics and scholars as visitors. Much of his time was thus spent in conversation; and his habitual associates were at pains to record his opinions, which were generally founded on a correct taste and judgment, and were always delivered in an interesting and lively manner. A collection of his oral opinions was published in 1693, soon after his death; and this collection, which was entitled *Menagiana*, was afterwards corrected and enlarged by M. la Monnoye, in an edition published by him in 1715.

The *Perroniana*, which exhibits the opinions of Cardinal du Perron, was compiled from his conversation by M. de Puy, and published by Vossius, by the same contrivance which put him in possession of the *Scaligerana*. Some parts of this collection are useful in illustrating the literary and ecclesiastical history of the age in which Du Perron lived; but it contains many puerile, imprudent, and absurd remarks, many of them the interpolations of his friends. The *Thuana*, or observations of the president De Thou, have usually been published along with the *Perroniana*. This collection is not extensive, and by no means of such value as might have been expected from a man so able and distinguished.

The *Valesiana* is a collection of the literary opinions of the historiographer Adrian de Valois, published by his son. M. de Valois was a great student of history, and the *Valesiana* accordingly comprehends many valuable historical observations, particularly on the works of Du Cange.

The *Fureteriana* (1696) contains the *bon mots* of M. Furetière of the French Academy, the stories which he was in the habit of telling, and a number of anecdotes and remarks found in his papers after his decease. This pro-

duction, however, comprehends but few thoughts, opinions, or criticisms on books, consisting chiefly of short stories, and containing numerous allusions to a violent quarrel he had with the French Academy, of which he was a member, concerning his *Dictionnaire Universel de la Langue Française.*

The *Chevrœana* (2 vols. 8vo, 1700), so called from M. Chevreau, exhibits more research than most works of a similar description, and is probably more accurate, as it differs from the Ana proper, of which the works described above are instances, in having been published during the life of the author, and revised by himself. Among other interesting articles, it contains a learned and ingenious commentary on the works of Malherbe, to whom the French language and poetry were greatly indebted for their perfection.

Parrhasiana (Amst., 2 vols. 8vo, 1699–1701) is the work of Jean le Clerc, a professor of Amsterdam, who bestowed this appellation on his miscellaneous productions with the view of discussing various topics of philosophy and politics with more freedom than he could have employed under his own name. This work is not of the light and unconnected description of most of the Ana which have been above enumerated, as it contains much learned philological disquisition, and a long dissertation on poetry and eloquence. In the first volume there is a list of his published works, and a bitter reply to all who had censured them.

The *Huetiana* contains the detached thoughts and criticisms of Huet, bishop of Avranches, which he himself committed to writing when he was far advanced in life. Huet was born in 1630, and in 1712 he was attacked by a malady which impaired his memory, and rendered him incapable of the sustained attention necessary for the completion of a long or laborious work. In this situation he employed himself in putting his detached observations on paper. These were published by the Abbé d'Olivet the year after his death (1722), under the name of *Huetiana,*—a work which is not, like some other Ana, a succession of *bon mots* or anecdotes, but forms a series of thoughts and criticisms on various topics of morals, philosophy, and literature. One of the most instructive discussions to a scholar, in this collection, is that on the Latinisation of names and surnames. His critical judgments on Montaigne, Rochefoucauld, and Tacitus are valuable. But were there no other literary memorials of the bishop of Avranches, he certainly would not derive high reputation from the *Huetiana.* It was not, indeed, to be expected from the circumstances in which the articles were composed, that they should always display that correct judgment which distinguishes many of the other works of this learned writer.

The *Casauboniana* presents us with the miscellaneous observations, chiefly philological, of the celebrated Isaac Casaubon. During the course of a long life that eminent commentator was in the daily practice of committing to paper anything remarkable which he heard in conversation with his friends, especially if it bore on the studies in which he was engaged. He also made annotations from day to day on the works he read, with which he connected his judgments concerning the authors and their writings. This compilation, which was styled *Ephemerides,* together with his *Adversaria,* and materials amassed for a refutation of the *Ecclesiastical Annals of Baronius,* were bequeathed by his son Meric Casaubon to the Bodleian library at Oxford. These were shown to Christopher Wolfius during a visit which he paid to that university; and having been transcribed by him, were published in 1710 under the title of *Casauboniana.* This collection consists of opinions concerning various eminent writers, illustrations of passages of Scripture, and philological observations and animadversions on the first thirty-four years of the *Annals of Baronius.* The materials and information which it contains are probably more accurate than is usually the case in works of the same description, as they were not reported by others, but were committed to writing by Casaubon himself while the works on which he commented remained fresh in his recollection.

Besides the above a great many works, under the title of Ana, appeared in France about the same period. Thus. the opinions and conversation of Charpentier, Colomesius, and St Evremond were recorded in the *Carpenteriana, Colomesiana,* and *St Evremoniana;* and those of Segrais in the *Segraisiana,*—a collection formed by a person stationed behind the tapestry in a house where Segrais was accustomed to visit, of which Voltaire declared, "que de tous les Ana c'est celui qui merite le plus d'être mis au rang des mensonges imprimés, et surtout des mensonges insipides." The Ana, indeed, from the popularity which they now enjoyed, were compiled in such numbers and with so little care that they became almost proverbial for inaccuracy. About the middle of the 18th century, too, they were sometimes made the vehicles of revolutionary and heretical opinions. Thus the evil naturally began to cure itself, and by a reaction the French Ana sunk in public esteem as much below their intrinsic value as they had formerly been exalted above it.

Of the examples England has produced of this species of composition, perhaps the most interesting is the *Walpoliana,* a transcript of the literary conversation of Horace Walpole, Earl of Orford. That multifarious author spent a great portion of his time in conversation, and, possessing opportunities of information enjoyed by few, was distinguished for his resources of anecdote, wit, and judicious remark. It was suggested to him that he ought to form a collection of anecdotes and observations, but this he declined, furnishing, however, the editor of the *Walpoliana* with many anecdotes in his own handwriting. After his death several specimens of this miscellany were published in the *Monthly Magazine;* and being afterwards enlarged by the recollections of the editor and the communications of others, were published in two volumes under the title of *Walpoliana.* Most other works which in this country have been published under the name of *Ana,* as *Baconiana, Atterburyana,* &c., are rather extracts from the writings and correspondence of eminent men than memorials of their conversation.

There are some works which, though they do not bear the title, belong more strictly to the class of Ana than many of the collections which are known under that appellation. Such are the *Mélanges d'Histoire et de Littérature,* published under the name of *Vigneul Marville,* though the work of a Benedictine, D'Argonne; and the *Locorum Communium Collectanea, ex Lectionibus Philippi Melanchthonis,*—a work of considerable reputation on account of its theological learning, and the information it communicates concerning the early state of the Reformed Church. But of those productions which belong to the class, though they do not bear the name, of Ana, the most celebrated are the *Colloquia Mensalia* of Luther and Selden's *Table-Talk.* The former, which comprehends the conversation of Luther with his friends and coadjutors in the great work of the Reformation, was first published in 1566. Captain Bell, who translated it into English in the time of the Commonwealth, informs us that, an edict having been promulgated commanding the works of Luther to be destroyed, it was for some time supposed that all the copies of the *Colloquia Mensalia* had been burned; but in 1626, on the foundation of a house being removed, a printed copy was found lying in a deep hole, and wrapped up in a linen

cloth. The book translated by Bell, and again by the younger Hazlitt in 1847, is said to have been originally collected by Dr Anthony Lauterbach, "out of the holy mouth of Luther." It consists chiefly of observations and discussions on idolatry, auricular confession, the mass, excommunication, clerical jurisdiction, general councils, and all the points agitated by the Reformed Church in those early periods. The *Table-Talk* of Selden contains a more genuine and undisguised expression of the sentiments of that eminent man than we find in his more studied productions. It was published after his death by Richard Milward, his amanuensis, who affirms that for twenty years he enjoyed the opportunity of daily hearing his discourse, and made it his practice faithfully to commit to writing "the excellent things that usually fell from him." The work contains, along with much of a lighter kind, many curious facts and opinions concerning the political and ecclesiastical history of the interesting period during which Selden lived, and in the important events of which he bore a considerable share. The style of Selden, in most of the works published under his own care, is harsh and obscure; but Clarendon describes him as "a clear discourser, possessed of the faculty of making difficult things easy, and presenting them clearly to the understanding." This talent for elucidation shines chiefly in his *Table-Talk*, which is filled with the stores of his extensive reading, delivered without any pretensions to that order and method the want of which has been attributed to his other productions. Many more recent works, under such titles as *Literary Remains*, *Table-Talk*, &c., partake more or less of the nature of Ana, but do not call for separate notice.

The most remarkable collection of Ana in the English language—and, indeed, in any language—is to be found in a work which does not correspond to the normal type either in name or in form. In his *Life of Samuel Johnson, LL.D.*, Boswell relates that to his remark, *à propos* of French literature, "Their Ana are good," Johnson replied, "A few of them are good; but we have one book of that kind better than any of them—Selden's *Table-Talk*." Boswell's own work is incomparably superior to all. In worth as a book this has been rated, on the high authority of Carlyle, beyond any other product of the 18th century, and the value it has depends mainly on its Ana. Its interest arises, not from the details it furnishes of the events of Dr Johnson's career, still less from any attempt at a discriminating estimate of his work and character, but from the graphic representation it gives of his habitual manner of life and speech. The innate greatness of Johnson appears, more than in all his writings, in his portrait, delineated with the exactness of a sharply-defined photograph, as he appeared to the eyes of his admiring biographer in his daily *dishabille*.

Wolfius has given a history of the Ana in a preliminary discourse to his edition of the *Casauboniana*, published in 1710. In the *Répertoire de Bibliographies Spéciales, Curieuses, et Instructives*, by Peignot, there is a *Notice Bibliographique* of these collections; but many of the books there enumerated consist of mere extracts from the writings of popular authors.

ANABAPTISTS (*re-baptisers*, from ἀνά and βαπτίζω), a name sometimes applied indiscriminately to all denominations of Christians that deny the validity of infant baptism, but restricted in general usage to certain sects which became prominent in Germany and elsewhere at the period of the Reformation. In both cases the designation originates with opponents, and is repudiated by the great majority of those to whom it is applied. Believing, as they do, that the baptism of infants is no baptism, they naturally object to a name which implies that their baptism of such persons as may have been baptised in infancy is a second administration of the rite. It is therefore desirable to avoid the use of the term as descriptive of those who hold what are otherwise known as antipædobaptist views. In its more limited sense the word has been too long in use, and is too well known to be now discarded, though it is open to the further objection, in addition to that already stated, that it describes a sect by one of the least important of its distinctive doctrines and practices. The Anabaptists of Germany are historically noteworthy, not because they insisted on re-baptism as the condition of admission to their communion, but because the enthusiasm of the Reformation manifested itself in them in a form and manner altogether peculiar. Their views as to the true constitution of the church and its relation to the state, and the efforts they made to realise these views, furnish a problem, partly theological, partly historical, of which a satisfactory solution is not easy. To one who looks merely at the extravagance and lawlessness which appear on the surface, fanaticism and madness may furnish a sufficient explanation of the whole Anabaptist movement, but a deeper insight will find many elements in it that are quite inconsistent with the supposition of nothing more than barefaced imposture in the leaders, and blind delusion in the followers. There is an obvious genetic, though not historical connection between the Anabaptists and those earlier sects (Novatians, Donatists, Albigenses, Waldenses) which did not practise infant baptism. It is more important, however, to trace the relation between the Anabaptists and the great body of the Reformers. Anabaptism, as a system, may be defined as the Reformation doctrine carried to its utmost limit; the Anabaptists were the extreme left in the army of the Reformers. It is true that they regarded each other as in different camps; but their mutual denunciations cannot conceal the fact that even the most peculiar doctrines of the Anabaptists were to them only corollaries, illegitimately drawn, as the more orthodox Reformers thought, from the fundamental principle, common to both, of the independence of the individual judgment, and the supreme importance of the subjective element, personal faith, in religion. The connection of this principle with their theory of the church and its relation to the state, their doctrine of the sacraments, and even their political rising, is so obvious that it need not be dwelt upon. The history of the Anabaptist movement in its outward development is brief but eventful. In 1521 their first rising took place at Zwickau, under the leadership of Thomas Münzer, the Lutheran pastor of that place. (See MÜNZER.) Compelled to leave Zwickau, Münzer visited Bohemia, resided two years at Altstadt and Thuringia, and in 1524 spent some time in Switzerland. During this period he proclaimed his revolutionary doctrines in religion and politics with growing vehemence, and, so far as the lower orders were concerned, with growing success. The crisis came in the so-called Peasants' War in South Germany, in 1525. In its origin a revolt against feudal oppression, it became, under the leadership of Münzer, a war against all constituted authorities, and an attempt to establish by force his ideal Christian commonwealth, with absolute equality and the community of goods. The total defeat of the insurgents at Frankenhausen (May 15, 1525), followed as it was by the execution of Münzer and several other leaders, proved only a temporary check to the Anabaptist movement. Here and there throughout Germany, Switzerland, and the Netherlands there were zealous propagandists, through whose teaching many were prepared to follow as soon as another leader should arise. A second and more determined attempt to establish a theocracy was made at Münster, in Westphalia (1532–5). Here the sect had gained considerable influence, through the adhesion of Rothmann, the Lutheran pastor, and several prominent citizens; and the leaders, Johann Matthyszoon or Matthiesen, a baker of

Haarlem, and Johann Bockhold, a tailor of Leyden, had little difficulty in obtaining possession of the town and deposing the magistrates. Vigorous preparations were at once made, not only to hold what had been gained, but to proceed from Münster as a centre to the conquest of the world. The town being besieged by Count Waldeck, its expelled bishop (April 1534), Matthiesen, who was first in command, made a sally with only thirty followers, under the fanatical idea that he was a second Gideon, and was cut off with his entire band. Bockhold, better known in history as John of Leyden, was now supreme. Giving himself out as the successor of David, he claimed royal honours and absolute power in the new "Zion." He justified the most arbitrary and extravagant measures by the authority of visions from heaven, as others have done in similar circumstances. With this pretended sanction he legalised polygamy, and himself took four wives, one of whom he beheaded with his own hand in the market-place in a fit of frenzy. As a natural consequence of such licence, Münster was for twelve months a scene of unbridled profligacy. After an obstinate resistance the town was taken by the besiegers on the 24th June 1535, and in January of the following year Bockhold and some of his more prominent followers, after being cruelly tortured, were executed in the market-place. The outbreak at Münster was the crisis of the Anabaptist movement. It never again had the opportunity of assuming political importance, the civil powers naturally adopting the most stringent measures to suppress an agitation whose avowed object was to suppress them. It is difficult to trace the subsequent history of the sect as a religious body. The fact that, after the Münster insurrection, the very name Anabaptist was proscribed in Europe, is a source of twofold confusion. The enforced adoption of new names makes it easy to lose the historical identity of many who really belonged to the Münster Anabaptists, and, on the other hand, has led to the classification of many with the Münster sect who had no real connection with it. The latter mistake, it is to be noted, has been much more common than the former. The Mennonites, for example, have been identified with the earlier Anabaptists, on the ground that they included among their number many of the fanatics of Münster. But the continuity of a sect is to be traced in its principles and not in its adherents, and it must be remembered that Menno and his followers expressly repudiated the distinctive doctrines of the Münster Anabaptists. They have never aimed at any social or political revolution, and have been as remarkable for sobriety of conduct as the Münster sect was for its fanaticism. (See MENNONITES.) In English history frequent reference is made to the Anabaptists during the 16th and 17th centuries, but there is no evidence that any considerable number of native Englishmen ever adopted the principles of the Münster sect. Many of the followers of Münzer and Bockhold seem to have fled from persecution in Germany and the Netherlands to be subjected to a persecution scarcely less severe in England. The mildest measure adopted towards these refugees was banishment from the kingdom, and a large number suffered at the stake. It has already been explained that the application of the term Anabaptist to those English sects that had nothing in common with the German Anabaptists except the practice of adult baptism, is unjustifiable. (See BAPTISTS.)

ANABASIS (ἀνάβασις, a march into the interior; from ἀναβαίνω, to ascend), the title given by Xenophon to his narrative of the expedition of Cyrus the younger against his brother, Artaxerxes of Persia, 401 B.C., and adopted by Arrian for his history of the expedition of Alexander the Great. (See Ainsworth's *Trav. in Track of Ten Thousand Greeks: Journal of Roy. Geog. Soc.* 1870, p. 463.)

ANACHARSIS, a Scythian philosopher, who lived about 600 B.C. His father was one of the chiefs of his nation, and married a woman of Greece. Instructed in the Greek language by his mother, he prevailed upon the king to intrust him with an embassy to Athens. On his arrival in that renowned city he became acquainted with Solon, from whom he rapidly acquired a knowledge of the wisdom and learning of Greece. By the influence of Solon he was introduced to the principal persons in Athens, and was the first stranger who received the privileges of citizenship. After he had resided several years at Athens, he travelled through different countries in quest of knowledge, and then returned home filled with the desire of instructing his countrymen in the laws and the religion of the Greeks. According to Herodotus, he was killed by his brother Saulius while he was performing sacrifice to the goddess Cybele. His simple and forcible mode of expressing himself gave birth to the proverbial expression, "Scythian eloquence." (Herodot. iv. 76; Lucian, *Scytha.*)

ANACHRONISM, a neglect or falsification, whether wilful or undesigned, of chronological relation. Its commonest use restricts it (agreeably to its etymology, ἀνά, back, and χρόνος, time) to the ante-dating of events, circumstances, or customs; in other words, to the introduction, especially in works of imagination that rest on a historical basis, of details borrowed from a later age. Anachronisms may be committed in many ways, originating, for instance, in disregard of the different modes of life and thought that characterise different periods, or in ignorance of the progress of the arts and sciences and the other ascertained facts of history, and may vary from glaring inconsistency to scarcely perceptible misrepresentation. Much of the thought entertained about the past is so deficient in historical perspective as to be little better than a continuous anachronism. It is only since the close of the 18th century that this kind of untruthfulness has jarred on the general intelligence. Anachronisms abound in the works of Raphael and Shakespeare, as well as in those of the meanest daubers and playwrights of earlier times. In particular, the artists, on the stage and on the canvas, in story and in song, assimilated their *dramatis personæ* to their own nationality and their own time. The Virgin was represented here as an Italian contadina, and there as a Flemish frow; Alexander the Great appeared on the French stage in the full costume of Louis Quatorze down to the time of Voltaire; and in our own country the contemporaries of Addison could behold, without any suspicion of burlesque,

> "Cato's long wig, flower'd gown, and lacquer'd chair."

Considerable difference of opinion has been expressed regarding the legitimacy of anachronism, especially when it is introduced designedly into historical novels. The safe and the just course here appears to be to "regard the writer's end," and not to hold an author responsible for historical accuracy or verisimilitude who does not profess to write history.

ANACOLUTHON is the lack of grammatical symmetry in a sentence, either through the consequent taking an unexpected form or being altogether suppressed, the writer or speaker desiring to present his thought in another aspect, or feeling that he has already made his meaning sufficiently plain. In the case of a man who is full of his subject, or who is carried along by the passion of the moment, such inconsequents are very apt to occur. Of Niebuhr it is told that his oral lectures consisted almost entirely of anacoluthic constructions. To this kind of licence some languages, as Greek and English, readily lend themselves; while the grammatical rigidity of others, as Latin and French admits of it but sparingly. In Hero-

dotus, Thucydides, Æschylus, Pindar, and Plato, abundant specimens are to be found; and the same is true of the writers of the Elizabethan age in our own language. The following is an example:—"And he charged him to tell no man; *but go show thyself*," &c. (Luke v. 14).

ANACONDA, a gigantic snake of South America, sometimes over 30 feet in length, called the *water-serpent*, from frequenting swamps and rivers, and preying on water animals. Its colour is a rich brown, with bright golden rings on each side, and two rows of large black spots along the back. The natives kill it for an oil they obtain from its carcase. It is not venomous, and is said to be harmless.

ANACREON, an Ionian Greek, born at Teos, on the coast of Asia Minor, probably about 562 B.C. His reputation as a lyric poet stood very high both in his own age and in those that followed. "The charming"—"the honey-tongued"—"the swan of Teos"—"the glory of Ionia," are some of the epithets constantly given him by ancient writers. "Sing us one of the songs of Alcæus or Anacreon," cries one of the guests in a comedy of Aristophanes. "When I hear the verses of Sappho or Anacreon," says the poet to his friends, in the *Symposium* of Plato, "I set down my cup for very shame of my own performances." But though he has given his name to that class of light and free lyric effusions which celebrate the joys of love and wine, he is to us moderns little more than a name. We can no longer say of him, as Horace could, that "time has not drowned his sportive lays;" and we have to judge of his merits as a poet chiefly from the warm praises of those who had his poems in their hands. Of the five books of lyrical pieces by Anacreon which Suidas and Athenæus mention as extant in their time, we have now but the merest fragments, collected from the citations of later writers. Those graceful little poems (most of them first printed from the MSS. by Henry Stephens in 1554), which long passed among the learned for the songs of Anacreon, and which are well known to many English readers in the translations of Cowley and Moore, are really of much later date, though possibly here and there genuine fragments of the poet have been woven up in them. They will always retain a certain popularity from their lightness and elegance, and some of them are fair copies of Anacreon's style, which would lend itself readily enough to a clever imitator. But an almost conclusive argument against their genuineness lies in the fact that the peculiar forms of the Ionic Greek, in which Anacreon wrote, are not to be found in these reputed odes, while the fragments of his poems quoted by ancient writers are full of Ionicisms. Of the poet's life little is known beyond a few scattered notices, not in all cases certainly authentic. He probably shared the voluntary exile of the mass of his fellow-townsmen, who, when Cyrus the Great was laying siege to the Greek cities of Asia, took ship, and founded a colony at Abdera in Thrace, rather than surrender their city to his general Harpagus. From Thrace he soon removed to the island of Samos, ruled at that time by Polycrates, one of the grandest of those old "tyrants" who by no means deserved the name in its worst sense. It is said that he acted as Polycrates's tutor; that he stood very high in his confidence we learn from so good an authority as Herodotus, who represents the poet as sitting in the royal chamber when audience was given to the Persian herald. In return for such favour and protection, he wrote many complimentary odes upon Polycrates and his favourites. But if an anecdote found in Stobæus is true, he was no mercenary flatterer. On one occasion the "tyrant" presented him with the sum of five talents. He spent two wakeful nights in thinking of his money, and then returned it to the giver, saying that it "was not worth the care it cost him." A cursory remark in the writings of Maximus of Tyre shows at least the high estimation in which the poet was supposed to have been held by his royal patron. That writer says that not even the warning given to Polycrates by Amasis, king of Egypt, that his too great prosperity would surely arouse the jealousy of the gods, could make a man doubt the stability of his happiness, who had, like Polycrates, the command of the Ionian sea, a navy so powerful, and such a friend as Anacreon. The same authority tells us that this companionship exercised a beneficial influence over the stern temper of the tyrant. Like his fellow-lyrist, Horace, who was one of his great admirers, and in many respect of a kindred spirit, Anacreon seems to have been made for the society of courts. On the death of Polycrates, Hipparchus, who was then in power at Athens, and who inherited the literary tastes of his father Pisistratus, sent a special embassy to fetch the popular poet to Athens in a galley of fifty oars. He must have fully enjoyed and contributed much to the enjoyment of the brilliant circle with which Hipparchus had surrounded himself, and there he made acquaintance, amongst others, with the poet Simonides. When this circle was broken up by the assassination of Hipparchus, Anacreon seems to have returned to his native town of Teos. There, according to a metrical epitaph ascribed to his friend Simonides, he died and was buried. Lucian mentions him amongst his instances of the longevity of eminent men, as having completed eighty-five years. If an anecdote given by Pliny (*Nat. Hist.* vii. 7) is to be trusted, he was choked at last by a grape-stone; but the story has an air of mythical adaptation to the poet's habits, which makes it somewhat apocryphal. Anacreon had a reputation as a composer of hymns, as well as of those bacchanalian and amatory lyrics which are commonly associated with his name. Two short hymns to Diana and Bacchus, consisting of eight and eleven lines respectively, stand first amongst his few undisputed remains, as printed by recent editors. But pagan hymns, especially when addressed to such deities as Venus, Eros, and Bacchus, are not so very unlike what we call "Anacreontic" poetry as to make the contrast of style so great as the word might seem to imply. The tone of Anacreon's lyric effusions has probably led to an unjust estimate, both by ancients and moderns, of the poet's personal character. As Homer was accused of bibulous propensities by some because he makes frequent and kindly mention of "the purple wine," so Anacreon was held to have been a thorough sensualist because he sang so persistently of wine and love. But a poet must not always be judged by the flights of his fancy. The "triple worship" of the Muses, Wine, and Love, ascribed to him as his religion in an old Greek epigram (*Anthol.* iii. 25, 51), may have been as purely professional in the two last cases as in the first, and his private character on such points was probably neither much better nor worse than that of his contemporaries. Athenæus remarks acutely that he seems at least to have been sober when he wrote; and he himself strongly repudiates, as Horace does, the brutal characteristics of intoxication as fit only for "barbarians" and "Scythians" (*Fragm.* 64, Bergk). His own excuse, when charged with hymning the reigning beauties of the day rather than the orthodox gods and goddesses, is said to have been made in these words—

"But are not these also lesser divinities?"

The best editions of Anacreon are those of J. F. Fischer, Leipsic, 1703, and I. Bergk, Leipsic, 1854. (W. L. C.)

ANADYOMENE (Ἀναδυομένη), an epithet of Aphrodite (Venus), expressive of her having risen (*i.e.*, been born) from the foam of the sea. In works of ancient art—*e.g.*, in many existing bronze statuettes—Venus was represented

under this title as if just emerged from the sea, and in the act of wringing her tresses. This was the subject of a painting by Apelles, one of the most celebrated pictures of antiquity, the conception having been, it was said, suggested to him by seeing Phryne bathing. This painting belonged first to the people of Cos, from whom it was taken to Rome by Augustus in part payment of tribute levied by him. By the time of Nero it had become almost entirely ruined by decay.

ANADYR, the name of a gulf and of a river in the north-east of Siberia. The gulf extends from Cape Tchutotskoi, on the north, to Cape St Thadeus, on the south, forming part of the Behring Sea; while the river, taking its rise from a lake in the Stanovoi mountains, called Ivashki or Ivachno, about 67° N. lat., and 173° E. long., flows through the Tchutchee country, at first to the west and then to the east, entering the gulf of Anadyrskaia, a branch of the gulf of Anadyr, after a course of about 600 miles. Anadyrsk is the only town on its banks, and the country through which it passes is thinly populated, barren, and desolate. For nine months of the year the ground is covered with snow, and there is not sufficient pasturage for cattle. Reindeer, upon which the inhabitants feed, are found in considerable numbers.

ANÆSTHESIA (α privative, αἴσθησις, sensation), a term in medicine used to describe a state of insensibility to external impressions, either as the result of disease or as induced artificially by the employment of certain substances known as anæsthetics.

In diseases of the brain or spinal cord anæsthesia is an occasional symptom, but in such cases it is usually limited in extent, involving a limb or a definite area of the surface of the body. Complete anæsthesia has been observed in persons who were in a state of catalepsy or trance.

The artificial induction of anæsthesia by the use of drugs or the inhalation of vapours is a subject of great interest, both historically and from its practical application to the relief of suffering and the treatment of disease. Although it is mainly owing to the researches of distinguished chemists and physicians of the present century that the employment of anæsthesia has come to occupy a foremost place among remedies, there is abundant evidence to show that it is a practice of great antiquity. Besides the mention by Homer of the anæsthetic effects of nepenthe, and the reference by Herodotus to the practice of the Scythians of inhaling the vapours of a certain kind of hemp to produce intoxication, the employment of anæsthetics in surgery by the use of mandragora is particularly alluded to by Dioscorides and Pliny. It also appears, from an old Chinese manuscript laid before the French Academy by M. Julien, that a physician named Hoa-tho, who lived in the 3d century, gave his patients a preparation of hemp, whereby they were rendered insensible during the performance of surgical operations. Mandragora was extensively used as an anæsthetic by Hugo de Lucca, who practised in the 13th century. The soporific effects of mandrake are alluded to by Shakespeare, who also makes frequent mention of anæsthetising draughts, the composition of which is not specified.

In the *Medical Gazette*, vol. xii. p. 515, Dr Sylvester, quoting from a German work by Meissner, published in 1782, mentions the case of Augustus, king of Poland, who underwent amputation while rendered insensible by a narcotic. But the practice of anæsthesia had never become general, and surgeons appear to have usually regarded it with disfavour. When, towards the close of last century, the brilliant discoveries of Priestley gave an impetus to chemical research, the properties of gases and vapours began to be more closely investigated, and the belief was then entertained that many of them would become of great medicinal value. In 1800, Sir Humphrey Davy, experimenting on nitrous oxide gas, discovered its anæsthetic properties, and described the effects it had on himself when inhaled, with the view of relieving local pain. He suggested its employment in surgery in the following words:—"As nitrous oxide, in its extensive operation, seems capable of destroying physical pain, it may probably be used with advantage in surgical operations in which no great effusion of blood takes place." His suggestion, however, remained unheeded for nearly half a century. The inhalation of sulphuric ether for the relief of asthma and other lung affections had been employed by Dr Pearson, of Birmingham, as early as 1785; and in 1805 Dr Warren, of Boston, U.S., used this treatment in the later stages of pulmonary consumption.

In 1818 Faraday showed that the inhalation of the vapour of sulphuric ether produced anæsthetic effects similar to those of nitrous oxide gas; and this property of ether was also shown by the American physicians, Godman (1822), Jackson (1833), Wood and Bache (1834).

These observations, however, appear to have been regarded in the light of mere scientific curiosities and subjects for lecture-room experiment, rather than as facts capable of being applied practically in the treatment of disease, till December 1844, when Dr Horace Wells, a dentist of Hartford, Connecticut, underwent in his own person the operation of tooth extraction while rendered insensible by nitrous oxide gas. Satisfied, from further experience, that teeth could be extracted in this way without pain, Dr Wells proposed to establish the practice of painless dentistry under the influence of the gas; but in consequence of an unfortunate failure in an experiment at Boston, he abandoned the project. On 30th September 1846, Dr Morton, a dentist of Boston, employed the vapour of sulphuric ether to procure general anæsthesia in a case of tooth extraction, and thereafter administered it in cases requiring surgical operation with complete success. This great achievement marked a new era in surgery. Operations were performed in America in numerous instances under ether inhalation, the result being only to establish more firmly its value as a successful anæsthetic. The news of the discovery reached England on 17th December 1846. On 19th December, Mr Robinson, a dentist in London, and on the 21st, Mr Liston, the eminent surgeon, operated on patients anæsthetised by ether; and the practice soon became general both in Great Britain and on the Continent.

The late Sir James Y. Simpson, of Edinburgh, was the first to apply anæsthesia by ether in midwifery practice. This he did on 19th January 1847, and he subsequently employed ether inhalation in numerous cases of both easy and difficult parturition, an account of which he published, containing much important information. The results of his trials showed that while the anæsthesia annulled the conscious sufferings of the patient, it in no way interfered with the muscular contractions of the uterus and the progress of the labour, and that it did not injuriously affect the child.

These observations excited great interest in the medical world, and led to the extensive employment of ether inhalation till November 1847, when Simpson announced his discovery of the anæsthetic properties of chloroform (the trial of which had been suggested to him by Mr Waldie, a chemist of Liverpool), and proposed it as a substitute for sulphuric ether. So convincingly did he demonstrate the great advantages of chloroform, that this substance speedily superseded the use of ether as an anæsthetic, and continues to the present time probably the most widely-used of all the agents employed in medicine for the relief of human suffering.

As the result of further investigations in this department of scientific research, in which the labours of Dr Snow, Mr Nunneley, and Dr Richardson have been conspicuous, numerous other volatile organic fluids have been found to possess anæsthetic properties. Several of these have been used in surgical practice, but as yet none of them have been found to possess such superiority as would entitle them to supersede chloroform.[1]

There are many who prefer ether as being a safer anæsthetic than chloroform, less apt to depress the circulation, and less apt to excite vomiting; but any advantage it has in these respects appears, in the estimation of surgeons, to be practically counterbalanced by the greater efficiency and facility of application of the latter substance. Ether, however, continues to be largely used in America.

When introduced by inhalation into the system, anæsthetic vapours act upon the brain and sensory nerves in such a manner as more or less completely to abolish their natural sensibility. The degree in which they do this can be in large measure regulated by the quantity administered. Thus, taking the familiar instance of chloroform, the effect of the inhalation of a small quantity (say less than half a drachm) is a feeling of exhilaration or semi-intoxication, accompanied with diminished sensibility to pain, but without entire loss of consciousness. By continuing the inhalation and increasing the quantity, profound stupor, stertorous breathing, fixing of the eyes, and muscular relaxation mark the occurrence of complete anæsthesia. In many cases it is desirable to produce merely the former of these conditions, viz., that of imperfect anæsthesia; and this is the extent to which chloroform is usually applied in uncomplicated labour. On the other hand, in surgical operations requiring absolute stillness on the part of the patient the inhalation must be carried to the extent of producing total unconsciousness. The state of anæsthesia can be safely kept up for long periods by continuing to apply, with due caution, the anæsthetic vapour. Whenever the inhalation is stopped, consciousness begins to return, and, in most cases, is soon completely restored.

The importance to the science of medicine of the introduction of anæsthesia can scarcely be over-estimated. By the employment of anæsthetics in surgery, not only is the work of the surgeon relieved of a source of embarrassment, and operations the most difficult and delicate undertaken which otherwise would have been impossible, but the death-rate in the worst cases has by universal testimony been greatly diminished. In no department of medicine has the use of anæsthetics been so extensive, or their value so manifest, as in midwifery. The power of chloroform in mitigating the pain attendant on ordinary labour, and in facilitating operative interference in cases of difficulty, is a matter of every-day experience in the practice of the accoucheur. In short, there is almost no condition of great physical suffering which may not be alleviated by the employment, under proper precautions, of anæsthetics. But if the boon has been great to medical science, it has been greater still to mankind; for not merely is an incalculable amount of actual pain prevented, but the dread of submitting to surgical operations is beyond measure lessened by the thought that they can be performed while the sufferer is kept in a state of tranquil sleep.

Unfortunately, there is no known method of artificially producing insensibility which is entirely free from risk, and deaths have occasionally occurred under the administration of anæsthetic vapours. Like all medicinal substances of a poisonous nature, the utmost care and watchfulness are requisite in their administration. The danger, *cæteris paribus*, is in proportion to the dose. It is more than probable that many of the fatal instances of anæsthetic inhalation have been the result of carelessness; and it is certain that by a better acquaintance with the physiological action of the agents employed, and a closer observation of the indications of danger in their use, the deaths may be greatly diminished. The importance of this has been recognised in many large hospitals, where the administration of anæsthetics is entrusted to one individual skilled in their properties and uses.

But it is doubtful whether many of the deaths occurring under anæsthesia can justly be ascribed to that cause. Sudden deaths occurring in the course of operations were by no means unheard of before anæsthetics came to be employed in surgery at all. Even, however, admitting that all the reported cases of death from anæsthesia are correct, it must be acknowledged that they are insignificant in amount, considering the enormous extent to which the use of chloroform and other anæsthetic agents prevails in all departments of medical practice.

The employment of local anæsthesia in surgery has the obvious advantage of being free from risk to life. Many means of accomplishing this have been suggested, the best known of which is the method of Dr Richardson, of the application of ether spray to the part of the body which it is desired to render insensible. By the rapid evaporation of the ether the tissues become frozen, and insensibility of the part is produced. Since, however, the anæsthesia merely affects the superficial textures, this plan is only available in the minor operations of surgery. (J. O. A.)

ANAGNI, a town of Italy, in the province of Roma, situated on a hill 37 miles E.S.E. of Rome. It is ill-built, but contains a cathedral, of the 11th century, and several ruins. Anagni is the ancient *Anagnia*, at one time the capital of the Hernici, and a place of considerable importance both under the Empire and under the popes. It is still the seat of a bishop. Population, 8220.

ANAGRAM, the transposition of the letters of a word or words, is derived from the Greek ἀνάγραμμα, which was used in precisely the same sense. But the number of different ways in which even a few letters can be arranged being very great (with eight different letters, for instance, it is $1 \times 2 \times 3 \times 4 \times 5 \times 6 \times 7 \times 8 = 40{,}320$), the term anagram is generally restricted to such rearrangements of the letters as form other words, and these usually words which express a meaning. Camden (*Remains*, 7th ed., 1674) defines "Anagrammatisme" as "a dissolution of a name truly written into his letters, as his elements, and a new connection of it by artificial transposition, without addition, substraction, or change of any letter, into different words, making some perfect sence applyable to the person named." Considering the amount of labour that has been spent (or misspent) in transpositions of this kind,—in "torturing one poor word ten thousand ways,"—the anagrams that display a felicitous perfection of "applyable sence" are remarkably few. Among the best are the anagrammatic answer to Pilate's question, "*Quid est veritas?*"—namely, "*Est vir qui adest;*" and the transposition of "Horatio Nelson" into "*Honor est a Nilo;*" and of "Florence Nightingale" into "Flit on, cheering angel." James I.'s courtiers discovered in "James Stuart" "A just master," and converted "Charles James Stuart" into "Claimes Arthur's seat." "Eleanor Audeley," wife of Sir John Davies, is said to have been brought before the High Commission in 1634 for extravagances, stimulated by the discovery that her name could be transposed to "Reveale, O Daniel," and to have been laughed out of court by another anagram submitted by the Dean of the Arches, "Dame Eleanor Davies," "Never soe mad a ladie." There must be few names that could furnish so many anagrams as that of "Augustus de

[1] Nitrous oxide gas has been reintroduced, and is now extensively employed in dentistry.

Morgan," who tells that a friend had constructed about 800 on his name, specimens of which are given in his *Budget of Paradoxes*, p. 82. The pseudonyms adopted by authors are often transposed forms, more or less exact, of their names; thus "Calvinus" becomes "Alcuinus;" "François Rabelais," "Alcofribas Nasier;" "Bryan Waller Proctor," "Barry Cornwall, poet;" "Henry Rogers," "R. E. H. Greyson," &c. It is to be noted that the last two are impure anagrams, an "r" being left out in both cases. "Telliamed," a simple reversal, is the *title* of a well-known work by "De Maillet." The most remarkable pseudonym of this class is the name "Voltaire," which the celebrated philosopher assumed instead of his family name, "François Marie Arouet," and which is now generally allowed to be an anagram of "Arouet, l.j.," that is, Arouet the younger. Perhaps the only practical use to which anagrams have been turned is to be found in the transpositions in which some of the astronomers of the 17th century embodied their discoveries, with the design apparently of avoiding the risk that, while they were engaged in further verification, the credit of what they had found out might be claimed by others. Thus Galileo announced his discovery that Venus had phases like the moon in the form, "*Hæc immatura a me jam frustra leguntur — oy*," that is, "*Cynthiæ figuras æmulatur Mater Amorum.*"

ANAHUAC, the name of the great central plateau of Mexico, lying between 15° and 30° N. lat., and 95° and 110° W. long., at an elevation of from 6000 to 9000 feet above the sea. Anahuac comprises three-fourths of the territory of Mexico, including the capital; and although much of its surface is level, many lofty mountains rise out of the table-land, the highest of which is Popocatepetl (17,720 feet), an active volcano. The name Anahuac is also used to designate a much less extensive part of the table-land, as well as that portion of the Rocky Mountains which lies to the south of 40° N. lat. The word itself is said to signify "near the water" in the old Mexican language, and seems to have been at one time the name of several other places in the ancient empire of Mexico.

ANALOGY is the name in logic for a mode of real or material inference, proceeding upon the resemblance between particulars: speaking generally, it is that process whereby, from the known agreement of two or more things in certain respects, we infer agreement in some other point known to be present in one or more, but not known to be present in the other or others. It was signalised already by Aristotle under the different name of Example (παράδειγμα), the word Analogy (ἀναλογία) having with him the special sense of mathematical proportion or resemblance (equality) of ratios. The earliest use of the name in its current logical sense is to be found apparently in Galen. While, in popular language, the word has come to be vaguely used as a synonym for resemblance, the logical authorities, though having generally the same kind of inference in view, are by no means agreed as to its exact nature and ground. It has chiefly to be distinguished from the related process of Induction, in their conception of which logicians are notoriously at variance. (See INDUCTION.)

Aristotle, distinguishing Syllogism and Induction as passing the one from whole to part (any part), and the other from part (all the parts) to whole, notes under each a loose or rhetorical form—Enthymeme under Syllogism, and Paradigm, or Example, under Induction. Thus, to give his own instance, it is an inference by way of example—if a war to come of Athens against Thebes is condemned because a past war of Thebes against Phocis is known to have been disastrous. Here the reasoning, which may be said to pass from part to part, is resolved by Aristotle as compounded of an imperfect induction and a syllogism; the particular case of Thebes against Phocis started from being first inductively widened into war between neighbours generally, and the particular case of Athens against Thebes arrived at being then drawn out by regular syllogism from that major. Example, or, to speak of it by its later name, the inference from analogy, is thus presented by Aristotle as directly related to induction: it differs from an imperfect induction—what is now often called real or material induction from particulars incompletely enumerated—only in having its conclusion particular instead of general, and its datum singular instead of plural.

Kant and his followers, while maintaining a relation between induction and analogy, mark the difference otherwise than Aristotle. By induction, it is said, we seek to prove that some attribute belongs (or not) to all the members of a class, because it belongs (or not) to many of that class; by analogy, that all the attributes of a thing belong (or not) to another thing, because many of the attributes belong (or not) to this other. In this country Sir William Hamilton has adopted this view (*Lectures on Logic*, vol. ii. pp. 165–174), though he differs from Kant in understanding it only of the process called applied or modified induction,—not of the pure form of reasoning from all the parts to the whole, which, in the manner of Aristotle, he puts on a level with pure syllogistic deduction. The relation and difference of the two processes may be formulated in the short expressions: One in many, therefore one in all (Induction); Many in one, therefore all in one (Analogy). For instance, it would be an analogical inference—to conclude that a disease corresponding in many symptoms with those observed in typhus corresponds in all, or, in other words, is typhus; whereas it would be an induction—to infer that a particular symptom appearing in a number of typhus patients will appear in all.

The view of Kant and Hamilton does not reach below the surface of the matter, if it can be maintained at all. In the first of the examples just given the inference might well be a good induction, all depending upon the kind of symptoms that are made the ground of the conclusion; on the other hand, the second might be a case of mere analogy, not to be called induction. Neither, again, is Aristotle's view satisfactory, which practically makes the difference to depend upon the mere quantity of the conclusion, worked out as particular for analogy by appending to the induction involved a syllogism of application. Since the universal always carries with it the particular, and cannot be affirmed unless the particular can, the two processes become to all intents and purposes one and the same. If the particular or analogical conclusion is justifiable, it is because there was ground for a good induction (only not of the pure sort); if there was no ground for a good induction, then, upon Aristotle's resolution, there can be no ground for the particular inference either. Should it be said, indeed, that the peculiarity of the case lies not so much in the conclusion, as in the start being made from one particular instance, whence the process gets its name Example, that undoubtedly will distinguish it from anything that can seriously be called induction; but then what becomes of the resolution that Aristotle makes of it? That resolution can be upheld only at the cost of the character of the inductive process.

The logician who has done most to elaborate the theory of real or material induction, John Stuart Mill, has also been able to give an interpretation of analogy, which, without in the least severing its connection with induction, leaves it as a process for which a distinct name is necessary. According to him, the two kinds of argument, while homogeneous in the type of their inference, which holds for all reasoning from experience,—namely, that things

agreeing with one another in certain respects agree also in certain other respects,—yet differ in respect of their degree of evidence. In both the argument is from known points of agreement to unknown; but, whereas in induction the known points of agreement are supposed by due comparison of instances to have been ascertained as the material ones for the case in hand or conclusion in view,—in other words, to be invariably connected by way of causation with the inferred properties,—it is otherwise in analogy, where it is only supposed that there is no incompatibility between the inferred properties and the common properties, or known points of resemblance, that are taken as the ground of inference. Thus, if by comparison of instances it had been ascertained, or otherwise it were known, that organic life is dependent on the bare possession of an atmosphere in planetary bodies rotating upon an axis, then it would be an induction to infer the presence of life upon any heavenly body, known or as yet undiscovered, in which these conditions should be detected. With our actual knowledge, confined to the case of the Earth, and only enabling us to say that the absence of an atmosphere must destroy life, the inference to such a planet as Mars, where the conditions stated seem to be present, is but analogical; while to the Moon, which seems to have no atmosphere, the inference has not even this amount of force, but there is rather ground for inductively concluding *against* the possibility of organic life. Upon this view it ceases to be characteristic of analogy that the inference should be to a particular case only; for the inductive conclusion, when the evidence is of a kind to admit of such being drawn, may as well be particular; and, again, it may equally well happen that the analogical inference, where nothing stronger can be drawn, should have universal application. Notwithstanding, it will be found in general that, where the evidence, consisting of bare similarity of attributes in two or more particular instances, permits only of an analogical inference being made, the extension in thought takes place to particular cases only which have a special interest, and the mind hesitates to commit itself to a general law or rule. Mill, therefore, though he does not raise the point, is practically at one with Aristotle and all others who make example or analogy to consist in the passage from one or more particular cases to a particular new case bearing resemblance to the former. It is his peculiar merit to have determined the specific conditions under which the passage in thought, whether to a particular or a general, acquires the authority of an effective induction.

Analogy is so much resorted to in science in default of induction, either provisionally till induction can be made, or as its substitute where the appropriate evidence cannot be obtained,—it is also much relied upon in practical life for the guidance of conduct,—that it becomes a matter of great importance to determine its conditions. Whether in science or in the affairs of life, the abuse of the process, or what is technically called False Analogy, is one of the most besetting snares set for the human mind. It is obvious that, as the argument from analogy proceeds upon bare resemblance, its strength increases with the amount of similarity; so that, though no connection is, or can be, inductively made out between any of the agreeing properties and the additional property which is the subject of inference, yet (in Mill's words), "where the resemblance is very great, the ascertained difference very small, and our knowledge of the subject-matter very extensive, the argument from analogy may approach in strength very near to a valid induction. If (he continues), after much observation of B, we find that it agrees with A in nine out of ten of its known properties, we may conclude, with a probability of nine to one, that it will possess any given derivative property of A" (*Logic*, b. iii., c. xx., § 3). But it is equally obvious that against the resemblances the ascertainable differences should be told off. For bare analogy, the differences in the two (or more) cases must as little as the resemblances be known to have any connection, one way or the other, with the point in question; both alike must only not be known to be immaterial, else they should fall quite out of the reckoning. As regards the differences, however, this is what can least easily be discovered, or is, by the mind in its eagerness to bring things together, most easily overlooked; and, accordingly, the error of false analogy arises chiefly from neglecting so to consider them. Thus, if the inference is to the presence of organic life of the terrestrial type on other planetary bodies, any agreements, even when extending to the details of chemical constitution, are of small account in the positive sense, compared with the negative import of such facts as absence of atmosphere in the Moon, and excess of heat or cold in the inmost or outermost planets. To neglect such points will not simply make the analogy loose; but, as the very point in question is concerned in them, the analogy becomes false and positively misleading. Still greater is the danger when the things analogically brought together belong not at all to the same natural classes, but the resemblance is only in some internal relation of each to another thing of its own kind; as when, for example, under the name of motives, particular states of mind (feelings, &c.) are supposed to determine the action of a man, as the motion of a body may be determined by a composition of forces. In such cases there may be nothing to prevent the drawing of a good analogy upon a strictly limited issue; nay, there may even sometimes, in special circumstances, be ground for drawing an inductive conclusion; but generally the elements of difference are so numerous, and their import either so hard to appreciate, or, when appreciable, so decisive in a sense opposite to the conclusion aimed at, that to leave them out of sight and argue without reference to them, as the mind is tempted to do, vitiates the whole proceeding. What is not sufficient for analogy may, however, be good as metaphor, and metaphor is of no small use for expository purposes; while (as Mill says), though it is not an argument, it may imply that an argument exists.

The sense just mentioned of a resemblance of relations suggests the question how far the common argument from analogy and mathematically determinate proportion, which was originally called by the name, are cognate processes. Undoubtedly the common argument, proceeding upon resemblance in the properties of things, can be made to assume roughly the guise of a proportion,—*e.g.*, Earth : Mars : : Men : Mars-dwellers, or Earth : Men = Mars : Mars-dwellers, the fact of planetary nature, or other resembling attributes gone upon, being regarded as common exponent. Less easy is it to interpret a determinate proportion, with numerical equality of ratios, as analogy in the common sense; for here the very determinateness makes all the difference.

The name analogy is so suggestive to English readers of Bishop Butler's famous treatise, that a word, in conclusion, seems called for on the nature and scope of the particular application of the process made by him. His work is entitled *The Analogy of Religion, Natural and Revealed, to the Constitution and Course of Nature*, and consists in an attempt to convince deists that there are no difficulties urged against revelation, or the system of natural religion, which do not bear with equal force against the order of nature as determined by Providence. The argument is a perfectly fair one within the limits assigned, and Butler must be allowed the credit of very well apprehending the logical conditions involved in it. In his introduction he understates rather than overstates the strength of his posi-

tion; for, on the assumption that the system of nature and the system of religion must both spring from one causal source, his argument acquires rather an inductive character. Accordingly, it is interesting to see how, in connection with his sense of analogy, he practically raises, in his Introduction, the question which the general theory of inductive logic, as now understood, has first to consider,—the question, namely, "whence it proceeds that *likeness* should beget that presumptive opinion and full conviction which the human mind is formed to receive from it;" though he would not take it upon him to say "how far the extent, compass, and force of analogical reasoning can be reduced to general heads and rules, and the whole be formed into a system." (G. C. R.)

ANALOGY, in *Comparative Anatomy*, is equivalent to "similarity of function." See ANATOMY.

ANALYSIS means literally, in the Greek, an unloosening or breaking-up, understood of anything complex in which simpler constituents or elements may thus be brought to view. It is this general sense that must be supposed to have been present to the mind of Aristotle when he gave the name of *Analytica* to the great logical work in which he sought to break up into its elements the complex process of reasoning; as, accordingly, in the body of the work (*Anal. Prior.* i. 32), we find him once using the verb "analyse" of arguments, when they are to be presented in "figure," or brought to the ultimate formal expression in which they can best be tested or understood. Obviously any more special sense that may be ascribed to the process of analysis must vary with the kind of complex to be resolved. Mental states, material substances, motions of bodies, relations of figures, are but a few examples of the complex things or subjects that fall to be analysed, if there is to be any scientific comprehension of them. Nor is it only that the analysis will be into constituents differing from each other as much as the complex subjects differ; for the same subject may be analysed in different ways, and with very different results, according to the particular aspect in which it is considered. Hence it becomes impossible, or at least very difficult, to describe the process in any terms fitting equally all the variety of its applications. It is from taking stand by some particular application, and either overlooking all others, or trying to force them within the frame of the one, that different writers have given such discrepant accounts of the process—discrepant often to the extent of being mutually exclusive. The express object of the present article will, on the contrary, be to give an unprejudiced view of the different applications of analysis in science, that one being first and most prominently put forward which was earliest recognised and practised, namely, mathematical analysis. The other applications, selected for their representative character, will, as they follow, naturally suggest the consideration how far the difference of matter in the various sciences tends to modify the nature of the process which is called analysis in all.

By the side of Analysis, at the different stages, we shall at the same time treat of the related process called, after the Greek, Synthesis, which means a putting together or compounding. If analysis and synthesis were merely related to each other as mutually inverse processes, expository convenience alone might be pleaded in favour of the parallel treatment; but the two are in practice often employed as strictly complementary processes, in support of each other on the same occasion; or, in other words, the composition in synthesis may be a direct re-composition of the principles or elements then and there got out by analysis. As a matter of course, therefore, the foregoing general remarks apply also to synthesis, especially the remark as to the modifying effect of difference in the subject-matter worked with.

I. *Mathematical Analysis and Synthesis.*—In the *Elements* of Euclid, containing so many examples of geometrical propositions variously established, there is a scholion near the beginning of Book XIII. which distinguishes two general methods for the treatment of particular questions, under the names of Analysis and Synthesis. In analysis, it is said, the thing sought is taken for granted, and consequences are deduced from it which lead to some truth recognised; synthesis, on the other hand, starts from that which is recognised, and deduces consequences therefrom, till the thing sought is arrived at. With more detail, but some wavering in his use of terms, Pappus of Alexandria (about 380 A.D.) describes the two processes at the beginning of Book VII. of his *Mathematical Collections.* He appears, however, to regard synthesis not at all as an independent process to be applied alternatively with analysis for the solution of particular questions (which is the view suggested by Euclid), but rather as a complementary process bound up with the use of analysis. These are his words: "In synthesis, putting forward as done the thing arrived at as ultimate result in the way of analysis, and disposing now in a natural order as antecedents what were consequents in the analysis, we put them together, and finally come at the construction of the thing sought." The two processes are involved together in what he calls the τόπος ἀναλυόμενος, or, as we may call it, one general Method of Analysis, the use of which for the solution of problems, he says, has to be learned after the *Elements,* having been developed by Euclid himself, Apollonius of Perga, and Aristæus the elder. In a similar sense, Robert Simson, its modern editor, speaking of the Euclidean book of *Data,* calls it "the first in order of the books written by the ancient geometers to facilitate and promote the method of resolution or analysis." Beyond Euclid, however, the invention of the method was carried back by the tradition of antiquity to Plato. The philosopher, whom we know to have been an ardent student of geometry, and otherwise a discoverer in the science, is said by Diogenes Laertius (III. i. 19), to have devised the method for one Leodamas, and is further said by Proclus (*Comm. in Eucl.*, ed. Basil, p. 58) to have made much use of it himself. Though the report is a loose one, it may well be that this method of analysis was first expressly formulated by the theoretic genius of Plato, especially in view of a passage (*Eth. Nicom.* iii. 5) in Aristotle, which has not been sufficiently noticed, showing that in his time, before Euclid was born, it was currently employed by geometricians. Aristotle there compares the gradually regressive process of thought, whereby the means of effecting a practical end is discovered, to the mathematical way of inquiry upon a diagram, remarking of both that the last stage in the analysis (ἀναλύσει) is the first in the production or construction (γενέσει). However surprising it may be thought that Aristotle in his logical works makes so little of a process which thus must have been familiar to him, the fact that it was familiar carries it back at least to the time of Plato. In truth it must have been practised earlier still, from the very beginnings of scientific geometry, though it may have had to wait some time to be formulated.

Taking analysis and synthesis, thus defined, either as distinct processes or as conjoined in one method, called analytical, we have next to see how they were brought to bear by the ancients in treating geometrical questions. Propositions such as those contained in the *Elements* fall into two classes with respect to the form of their enunciation, namely, theorems and problems. The distinction was not marked by Euclid himself, nor is it in any sense radical, for either kind of proposition may easily be transformed into the expression of the other; but, as commonly accepted, it amounts to this—that a theorem is given out

as an assertion to be accepted, and has to be shown true; a problem is given out as an act to be done, and has to be shown possible. In the case of a theorem, Euclid accordingly, after enunciating the proposition, proceeds generally to show, with more or less of construction on a particular diagram, and working always with fixed definitions, that the assertion follows deductively from certain truths, either assumed as evident (axioms), or formerly proved therefrom, and seen to be applicable to the present case by inspection of the figure as constructed. The grounding propositions are allowed by the reader as they are brought forward, though he may for the moment have not the least idea whither the author is tending, and at the end the conclusion is accepted, because the successive premises, being allowed, have been combined logically. In the case of a problem, after an express construction for which no reason is given, the object is to show that what has been brought to pass really supplies what was sought; but the procedure is not different from what it was in the case of a theorem, because the object is attained by showing again that certain truths allowed, in their particular application to the figure constructed, involve as a conclusion some relation which the figure is seen to exhibit. Now if this is Euclid's procedure in general—there is an exception, afterwards to be noted, where he proves his point indirectly—it is undeniably synthetic, in any meaning that can be ascribed to that term, the result being obtained by a massing or combining of elements or conditions. But on Euclid's part the process is one of demonstration, not of discovery. Still less is the reader's mind in the attitude of discovery: he is led on to a result which is indeed indicated, but by a way which he does not know, and, as it were, blindfold. There must, however, have been discovery before there could be such demonstration; or how should the proposition admit of definite enunciation at the beginning? Thus there is, in the background, an earlier question of procedure or method, and it is this that the ancient geometricians had chiefly in view when speaking of analysis and synthesis.

Now, some propositions are so simple that they must have been seen into almost as soon as conceived, and conceived as soon as the human mind began to be directed to the consideration of forms or figures; in which case no method of discovery, to speak of, can have been necessary. There is, again, another class of propositions, more complex though still simple, which probably were established by a process of straightforward synthesis. An inquirer must have in his head some knowledge in the shape of principles more or less fixed, or he would not be an inquirer; and either the accidental combination of such principles may lead in his mind to particular results, or the first time a particular question suggests itself to him, it may be seen at once to involve, or to follow from, certain of the principles. Many propositions in the *Elements*, giving the most apparent properties of triangles, circles, &c., it can hardly be doubted, were arrived at by this way of discovery, even when a more elaborate process of synthesis was employed for their formal demonstration; as, for example, in the case of the famous fifth proposition of Book I. But the same process of direct composition (understood always as joined with inspection) is no longer applicable, or is not effective, when the question is of less obvious properties, or of construction to be made under special conditions. To discover the fact or the feasibility in such cases is so much the real difficulty, that the question of demonstration becomes of merely secondary importance. And there is even a still prior question of discovery; for it has to be determined that some points rather than others should be made the subject of express inquiry. This, however, may be left aside. To any one engaged in geometrical inquiry, in the constant inspection of figures for the understanding of their properties and mutual relations, questions must incessantly be occurring—so incessantly and inevitably that it is needless, if it were not vain, to seek out a reason for the particular suggestions. As in all discovery to the last, so more especially at the first stages, there is an element of instinctive tact in the mind's action which eludes expression; and there is also an element of what might be called chance, were it not that those only get the benefit of it who are consciously on the look-out, either generally or in some special direction. A particular question being started by whatsoever suggestion, how shall the mind arrive at certain knowledge regarding it? Such, practically, is the form which is assumed by geometrical inquiry.

Besides the thing sought there is nothing else given, or at least there is nothing else immediately given or suggested. But the mind is supposed to have some knowledge pertaining to the matter—though not extending to the particular aspect of it—in question, also some knowledge of such matters generally. In such circumstances the aim of the inquirer must be to bring what is sought into some definite relation with what is known. Direct composition or synthesis of the known, with more or less of construction, if it led to that which is sought as a result, would determine the relation for the inquirer, and determine it in like manner for all who allow the principles whence the conclusion is logically deduced, being thus at one stroke both discovery and demonstration. But synthesis, arbitrarily made, as it must be where the question is at all difficult, may fail, however often it is attempted. Without a proper start it avails nothing; and what is to determine the start? There is always one course open. Let the objective itself be made the starting-point, and let it be seen whether thence it may not be possible by some continuous route to get upon known ground. In other words, a thing sought, when itself assumed, may admit of being brought into relation, upon some side or other, with the body of ascertained knowledge. If it can be so brought, through whatever number of steps, there is then attained as a result what before it was impossible to light upon as a beginning; and now nothing hinders from making the start originally desired, and from reaching as a proper conclusion the assumed beginning, if the path struck out before is measured over again in the opposite direction. The course thus becomes once more synthetic, but only because of what was first accomplished. Till the point in question was made to yield up its own secret by a process fitly called analysis or resolution, nothing certain could be determined. At the analytic stage, however, the line taken may be twofold. The proposition, assumed at starting as something definite to work from, either may be held as following deductively from some other, which again is dependent on still another or others, till one is worked up to that is known to be true; or it may be taken as itself a premiss leading deductively to some other proposition, which in turn, by one or more steps, leads to a true proposition as conclusion. In either case the implication is that a proposition must itself be true, if by any line of formally correct logic it leads to a proposition known to be true. And though the expression must be modified for questions in the form of problems, requiring something to be done—to which form of question, indeed, the analytic process is peculiarly applicable—the point of logical principle remains there exactly the same.

But is the process, thus stated as it was understood by the ancient geometricians, logically valid? In the first of the two alternative forms, it is valid: the proposition assumed at starting will undoubtedly be true, if a proposition on which it is shown to be ultimately dependent is true. At the same time, there is in this case no guarantee

that the most effective line for establishing it has been taken, in view of the well-known logical principle that the same conclusion may follow from different premisses. In the other form of the process, where the proposition assumed is itself used as a premiss, the case as to validity is otherwise. As Aristotle first clearly apprehended and showed, it is quite possible to reach a (materially) true conclusion by strict logical deduction from premisses either one or both false; and thus the mere fact that the proposition assumed is found, in combination with others, to lead to a conclusion known to be true, does nothing to establish its own character. Yet although the process of analysis thus carried out by way of deduction, as formulated by Euclid and (in one of his expressions) by Pappus, is theoretically faulty, through neglect or ignorance of Aristotle's observation, the practice of Euclid is not therefore invalidated. It was his habit, as Pappus also enjoins, to follow up the analysis by a synthesis consisting in a reversal of it, and this would effectively get rid of error; since the result of the analysis, if it did not follow from the assumed premiss by true implication, but only accidentally, could not itself, when in turn used as a premiss for the synthesis, be made to yield the original proposition as a legitimate conclusion. In order, however, to validate this form of analysis it is not necessary to resort to the laborious expedient of retracing the whole path synthetically. As Duhamel, in his treatise *Des Méthodes dans les Sciences de Raisonnement* (pt. i. c. 5), has pointed out, it is enough if, at the different stages of the deduction, the inquirer assures himself, as he easily may do where it is the fact, that there is perfect "reciprocity" among the propositions successively obtained from the one first assumed; meaning that, in the circumstances of the deduction, each may as well follow from the one coming after as it is fitted to yield that. And the same simple expedient suffices equally to obviate the less grave defect above noted in analysis carried out by regression from consequents to conditions, or conclusions to premises; reciprocity, if it can be made out here at the different stages, will guarantee the exclusive validity of the line of reasoning taken. So may analysis become perfectly independent as a method of discovery, and give as much insight as synthesis, where this is directly applicable, does; while it is—what synthesis is not directly—applicable to every kind of question, however complex.

It is unnecessary, for the purposes of the present article, to enter further into details respecting the methods anciently practised in geometry. Let it suffice to mention only the method of indirect proof known as *reductio ad absurdum*, employed sometimes by Euclid in the *Elements*. This conforms to the type of analysis in that it starts from the question to be determined, though it is peculiar in following out, not the assumption itself, but what is thereby suggested as excluded, with the final result that the point in question is established upon the ruin of every other supposition. It is a method of discovery as well as a method of demonstration; while the previous argument has shown that analysis, directly practised, may be made a method of demonstration by itself, besides being the most potent and unfailing instrument of discovery. Also it was seen before that synthesis may be a method of discovery, though it is more frequently employed as a method of demonstration in sequence upon discovery by analysis. To insist thus upon the double character alike of analysis and synthesis, as practised in geometry, is of vital importance, because of the change in application which the terms have undergone among mathematicians. In modern times analysis has come to mean the employment of the algebraical and higher calculus, and synthesis any direct treatment of the properties of geometrical figures, in the manner of the ancients, without the use of algebraical notation and transformations. The excuse for the change lies in the fact that, while the Greeks had only extremely undeveloped means of analysis, they gave the highest possible finish and exactness to their synthetic demonstrations of geometrical propositions, seldom being content to let their discoveries rest upon the ground of that analysis by which they were made. But though it has this excuse or motive, the change involves a misunderstanding, as all mathematicians allow who have turned their minds seriously to consider the *rationale* of their practice. It is, in the first place, clear that only by the process described above, rightly called analysis, can anything be determined about the more complex properties and relations of geometrical figures; haphazard synthesis is of no avail. The ancients therefore, in their geometry, had an analysis. It is next to be remarked that the algebraical solution of problems is not so exclusively analytic in character that it may not in simple cases assume the form of direct (algebraical) synthesis; and in all cases, for verification, it admits of being followed up by an exposition that is truly synthetic. The moderns, therefore, in their calculus, are not without their synthesis. Furthermore, the ancients, however little progress they made, comparatively speaking, in the general science of calculation, and however their special methods for the resolution of geometrical questions, even as involving direct figured construction, still more as applying calculation, fell short of the variety and pliability of modern devices, yet had their own analytical weapons, though they cannot be specified here. For our present purpose it is equally unnecessary to enter into details as regards the modern devices, whether belonging to the lower or higher analysis, or as regards the principle for applying them developed by Descartes and his successors; but to arrogate for these exclusively the name of analysis, it cannot be too pointedly declared, is to lose sight of the end in the means.

II. *Chemical Analysis and Synthesis.*—After mathematics, chemistry is the science in which application has most expressly been made of processes termed analysis and synthesis. In physics, regarded as the science of motion, whether abstractly taken or as manifested actually in natural bodies, the application is universal; the resolution and composition of velocities, motions, and forces being fundamental processes pervading the whole science under all variety of circumstances. There is nothing, however, in such an employment of analysis and synthesis that is not easily intelligible in the light of the processes as practised either in the more general science of mathematics, dealing with relations of quantity in number and form, or in the more special science of chemistry, which deals with those characteristic qualities of actual bodies for which no definite expression in terms of motion can be found.

The concrete substances in nature are found to be such that some by no means in our power can be brought to anything simpler, while others can be broken up into constituents differing in character from the original substances and also among themselves. Hence a division is made of bodies into elements and compounds; elements being all such bodies, not farther reducible, as are either actually found in nature, or, though not so found, have emerged in the manipulation of actual bodies; compounds, all such as, being actually found, are reducible to two or more different elements, or have by artificial combination been constituted. The process of reduction to elements is called analysis; the process of re-combination or free combination is called synthesis. When the analysis is carried out simply with the view of detecting what elements are present in a substance, it is called qualitative; and quantitative, if with the further view of determining the definite proportions

(by weight) in which the constituents are present in a definite quantity of the substance. There are corresponding varieties of synthesis.

Now here the subject-matter is so manifestly different from what it is in mathematics, that it is idle to look for exact correspondence in the processes practised under the same names within the two sciences. In fact, however, the correspondence is greater than may at first sight appear. Chemical analysis of a given substance is a process of discovery real and actual, like the analysis of a mathematical problem, and proceeds similarly by taking what is given, and working with it in relation to other substances, to see whether it can be made to yield up aught that is already known, or may be regarded as fixed and certain. Again, just as mathematical synthesis may be a process of invention, either generally, by way of combination of principles, or sometimes specially, in reference to particular questions, so does chemical synthesis give a knowledge of new forms of matter, or haply solve the question as to the constitution of particular substances in hand. Once more, the relation of analysis and synthesis as two complementary phases of one process (instead of their being regarded as two processes) is exhibited as plainly in chemistry as in mathematics. It may seem to be exhibited even more impressively, when the very constituents got out by analysis of a substance are used in the synthesis to give it being again. This circumstance, however, is far from giving to the science of chemistry a character of evidence superior to that of mathematics: its inferiority in this respect is but too well marked, and has a reason that at the same time explains what else is peculiar in its application of analysis and synthesis. The chemist deals with things known only by experience, and connected by way of physical causation: true, they are things with which he can freely experiment—and this gives to chemistry a prerogative character among the natural sciences—but the things are taken as they are found, and experience is constantly disclosing in each new attributes which have simply to be accepted, at least in the present state of our knowledge, by the side of the others. On the contrary, the mathematician deals with things over which he has full power of construction, and whose relations in the fact of constructing he constitutes, whether they are internal or external relations. But positive construction carries with it an insight which is wanting in experiment, be the physical conditions ever so favourable; and thus analysis and synthesis have in mathematics, along with perfect freedom of scope, a determinateness far surpassing anything that is attainable in chemistry.

III. *Psychological Analysis and Synthesis.*—Passing for the next signal application of analysis from the world of matter to mind, we have here a subject which more perhaps than any other calls for an exercise of the process in order to be scientifically understood. Physical things in their superficial relations lie to a great extent open to direct apprehension, and, whatever deeper connections there may be to be traced out among things the most remote in their nature as apprehended, yet the fact of their separation in space involved in our perception of them is already something done, leaving the scientific function (analytic and synthetic) to be exercised chiefly in the attempt to comprehend them. Very different is the state of affairs in mind, where everything, as it were, runs or melts into everything else. Even to lay hold of particular mental phenomena, with a view to the explanation of them, implies already an express scientific attitude, which must be called analytic.

Particular mental states being supposed to be got, with such definiteness of apprehension (always more or less imperfect) as the subject-matter admits of, the business of the psychologist becomes substantially one with that of the physical inquirer. Accordingly, it is often urged that complex mental states conform to the two types of mechanical and chemical composition, in the sense that some are to be resolved after the manner of complex phenomena of motion, and others by a process analogous to that employed in chemistry for the qualities of concrete substances. The analogy, however, especially in the second class of states, is decidedly loose. Psychological phenomena of cognition or emotion, held to be developed, under general mental laws, out of simpler states of sense, resemble chemical compounds only in having a character unlike that of any of the elements that go to make them; in particular, they do not admit of that actual resolution into their elements which lends so much evidence to the processes of chemistry. The realm of nature supplies a far apter analogy in the phenomena of organic growth, more especially as mental states do, in fact, stand in direct relation with states of the bodily organism. It is as impossible to make an actual analysis or synthesis of the physiological complex of life as of the psychological complex of mind; and it is only more difficult (the phenomena being undoubtedly more recondite and fluctuating) to practise experiments in psychology than in physiology. But, at all events, there is no new principle involved in the scientific treatment of mind; nor again in the treatment of moral and social questions, for an insight into which psychological knowledge is indispensable.

IV. *Logical Analysis and Synthesis.*—To logic, taken in its widest sense as the methodology of all science, it belongs to appreciate the general import of all such applications of analysis and synthesis as have now been considered. There remains, however, a special variety which is itself entitled logical analysis and synthesis, and which has the more carefully to be distinguished from the other heads, because it stands in an opposition to them all.

Logical analysis is the same process as that which is otherwise called metaphysical division. (The process called logical division is different. See LOGIC and DIVISION.) Given, say, a concrete subject like man, this may be divided physically into a number of parts in space, or, as a concept, metaphysically into a number of qualities or attributes,—metaphysically, because none of these has an independent subsistence or physical existence apart. They are distinguished in the way of mental consideration, or, as it is technically called, abstraction; and, this being a thought-process or logical act, the resolution of the given complex into such conceptual elements gets the name also of logical analysis. The corresponding act of synthesis proceeds by the way that is technically called determination; thus the general concept man, to take the traditional example, has the attribute of rational joined to the attributes of animal, or is determined by that addition, and much else has to be added in a similar way before the particular concrete can be determined.

Now it is evident that such analysis and synthesis have an application to any kind of thought that the mind can conceive; and thus logicians, in meaning, as they have commonly done, nothing more by the names, have signalised processes that are in truth of no small account for knowledge in general. There is no kind of scientific inquiry, strictly so called, and whatever be its scope and method, that does not involve at all stages from the first such analysis or abstract mental consideration. Nay, it may be said that science, as opposed to the natural experience of things, or to the artistic interest which centres upon fully bodied-out concretes, is analysis in this present sense, everywhere breaking up to find community of character under the mask of superficial difference, and sifting out the one from the many. But when logicians, not

disregarding the various applied methods of the real sciences, or consciously excluding them as lying beyond the province of pure logic, would seek to reduce all scientific procedure to this kind of mental action, the attempt implies a deep misapprehension. It is one thing for the mind to have its subject of inquiry clearly and sharply defined apart from what else is given therewith, or again to have its existing knowledge always well in hand and sifted out to the uttermost; it is another thing for the mind to be making advances, to be passing out from the known to the unknown, or labouring to bring the unknown into relation with that which is known already. Condillac is the thinker who has most expressly made the attempt to bring all scientific method back to the conception of mere logical analysis, repeating it everywhere throughout his works. The sixteenth chapter of his unfinished treatise, the *Langue des Calculs*, may especially be noted in this respect; the more because he there endeavours to justify his developed expression for the procedure of all science—that it consists in a continued substitution of identical propositions—by the actual solution of an algebraical problem. Simple, however, though the instance chosen is, he fails to make good his view, appearing to prove it only by leaving out the step of critical moment.

To analysis and synthesis in the specially logical sense is undoubtedly related the distinction that logicians have made of analytic and synthetic method. Without stepping beyond the bounds of logic conceived as a formal doctrine, a fourth department, under the name of Method or Disposing, may be added to the three departments regularly assigned — Conceiving (Simple Apprehension), Judging, Reasoning; and this would consider how reasonings, when employed continuously upon any matter whatever, should be set forth to produce their combined effect upon the mind. The question is formal, being one of mere exposition, and concerns the teacher in relation to the learner. How should results, attained by continuous reasoning, be set before the mind of a learner? Upon a line representing the course by which they were actually wrought out? Or always in the fixed order of following from express principles to which preliminary assent is required? If the latter, all teaching becomes synthetic, and follows a progressive route from principles to conclusions, even when discovery (supposing discovery foregone) was made by analysis or regression to principles; of which expository method no better illustration could be given than the practice of Euclid in the demonstrations of his *Elements*. On the other hand, it may be said that the line of discovery is itself the line upon which the truth about any question can best be expounded or understood, for the same reason that was found successful in discovery, namely, that the mind (now of the learner) has before it something quite definite and specific to start from; upon which view, the method of exposition should be analytic or regressive to principles, at least wherever the discovery took that route. The blending of both methods, where possible, is doubtless most effective; otherwise it depends upon circumstances—chiefly the character of the learner, but also the nature of the subject in respect of complexity—which should be preferred, when one alone is followed.

The question of prime logical, or general, importance remaining is to determine the relation of Analysis and Synthesis as methods of real science, to the ground-processes of all reasoning, known since the days of Aristotle under the names of Induction and Deduction. Much difference of opinion has been expressed on this subject, not only because of the want of agreement as to what should be called analysis and synthesis, but also because of more fundamental disagreement regarding the nature of the inductive and deductive processes.

It was remarked before as somewhat surprising, that Aristotle himself did not more expressly consider the relation, when we have seen that he was familiar with the process of geometrical analysis, under the very name. The distinction, however, upon which he lays so much stress throughout his works, between knowledge from principles, prior or better known by nature, and knowledge of or from facts, prior in experience or relatively to us, has generally been understood to imply a connection of synthesis with deduction, of analysis with induction; so much so indeed, that synthetic and deductive method, analytic and inductive method, have come to be used respectively almost as interchangeable terms. Nor, although Sir William Hamilton seems to wish to reverse the usual association of the terms, when he calls induction a purely synthetic process, and declares it to be erroneously viewed as analytic (*Metaphysics*, i. p. 102), is he really at variance with the other authorities; his observation having a special reference which the others also might allow. But any such association seems to rest upon a misconception, not to be laid to the charge of Aristotle himself. In the sense of analysis and synthesis for which it is important to determine the relation, namely, when they are taken as the means of real discovery in science, the true view rather is that they are the different methods in which reasoning, whether inductive or deductive, must be applied for discovering truth in the form of special or particular questions. Analysis, as well as synthesis, may proceed by way of deduction, as we have seen in the process of mathematics; on the other hand, synthesis as applied in chemistry is as much an inductive act, being strictly experimental, as anything could well be. Induction and deduction are concerned about the relation of the particular and general in thought; analysis and synthesis about the relation of the known and the unknown. The two points of view are of course related to each other: analysis and synthesis, as practised by the human mind, either for purposes of science or in the affairs of life, cannot be worked except under those highest laws of the relation between the particular and general in thought which Aristotle's genius first was able to extract from the instinctive practice of human reason. But whether the processes are applied singly, or, for greater assurance, conjointly, it depends upon the matter of the inquiry under which laws—those of induction or those of deduction—they shall be worked; and in any case there is implied a peculiar intellectual attitude different from that of mere formal reasoning. It is the difference between the act of finding out and proving. If it should ever become possible to develop a logic of Discovery, it must consist in the formulation of the processes of Analysis and Synthesis, conceived in the general sense attributed to them in the foregoing article. (G. C. R.)

ANALYTIC JUDGMENTS have been distinguished under that name, in opposition to Synthetic, since the time of Kant. It was necessary, for the purposes of his critical inquiry into the principles of human knowledge, that he should carefully determine the character of those assertions which metaphysicians had so freely made respecting the supernatural, and he found them to be such that, while the predicate was added on to the subject, not involved in it, the connection was affirmed as necessary and universal. He therefore called them, as well as other assertions of like character in mathematics and pure physics, synthetic judgments *à priori*, and the aim of his critical inquiry came to be the determining of the conditions under which such judgments were possible. Now, as differing from these, he noted two classes of judgments: (1), such as in the predicate added indeed to the content of the subject, but only

empirically, as, for example, Bodies have weight, and these he called synthetic *à posteriori;* (2), such as were indeed necessary and universal, but added nothing to the content of the subject, as, for example, Bodies are extended, and these he called analytic.

The general distinction of analytic and synthetic judgments has a value apart from the specific character of those (synthetic) judgments in which Kant was most interested, and for the sake of which mainly it was fixed by him. Trained in the metaphysics of the Leibnitzo-Wolffian school, which marked off necessary judgments from those of simple fact without considering the kinds of necessity, Kant, when he came, by the route that can be traced in his earlier works, to apprehend the difference between merely logical analysis and real synthesis in thought, applied it almost exclusively to those judgments for which a character of necessity was claimed. He therefore noticed traces of the distinction in other thinkers, as Locke, only in so far as there was a suggestion also of this special reference. In truth, the general distinction, under a variety of expressions, was familiar to both Hume and Locke, and it had already been drawn by the ancients. The old doctrine of the Predicables, in distinguishing the essential predication of genus, species, and difference from the non-essential predication of property and accident, plainly involves it; making besides, as between the last two predicables, a distinction which is very closely related to that drawn by Kant between the *a priori* and *a posteriori* synthetic. From the nominalistic point of view it is expressed by the difference of Verbal and Real propositions, as in Mill's *Logic*, and also often in Locke.

While the synthetic judgment, as the name implies, brings together in thought two distinct concepts, each of which may be thought apart, the analytic judgment is merely the explication of a single concept in the form of a proposition. It is disputed what may be the ground of synthesis in different cases, but on all hands it is agreed that the logical Law of Contradiction is the controlling principle for the explication of concepts already in the mind, however they may have come there. Now the explication may be made either completely or partially, according as the whole or part only of the intension of the concept is set forth: in other words, the aim may be to give the definition (where, in the full sense, that is possible), or simply to express any one or more of the contained attributes. Propositions giving such partial explication are spoken of by Locke as "trifling;" and it is true that, if the concept is supposed already in the mind, no increase of knowledge is thereby obtained. This word, however, is unfortunate. Not to say that it is equally applicable to definitions, where the explication is only more complete, it tends to keep out of view the fact that analytic judgments, when not arbitrarily formed, are themselves—or rather the concepts, of which they are the explications, are—the permanent result or deposit of foregone real synthesis. So much, indeed, is this the case with concepts of things in nature—what Mill calls natural kinds—that in them a constant process of accretion is going on; new attributes, as they are discovered, being taken up into the essence, if they are at the same time characteristic and underived. Much also that is mere explication to one mind is real information to another.

The terms Analytic and Synthetic, thus applied to judgments, are so expressive in themselves that they have now come into general use. It is, however, a serious drawback to such an association of the terms, that it traverses what is otherwise the consistent use of the words analysis and synthesis in relation to each other. As the article ANALYSIS has shown, there is a synthesis which, as much as any analysis, is purely logical, and there is an analysis which, as much as any synthesis, is a means of real advance in knowledge. The terms Explicative (*Erläuterungsurtheile*) and Ampliative (*Erweiterungsurtheile*), also employed by Kant, while not less expressive, are open to no such objection. (G. C. R.)

ANAM, or ANNAM, also called COCHIN CHINA, a large empire of Asia, forming the eastern portion of the Indo-Chinese peninsula. See COCHIN CHINA.

ANASTASIUS I., Emperor of Constantinople, was born at Dyrrhachium not later than 430 A.D. At the time of the death of Zeno (491), Anastasius, though only one of the guards (*silentiarii*) in the palace, held a very high character, and was raised to the throne of the Roman empire of the East, mainly through the influence of Ariadne, Zeno's widow, whom he married shortly after his accession. His reign, though afterwards disturbed by foreign and intestine wars and religious distractions, commenced auspiciously. He gained the popular favour by a judicious remission of taxation, and displayed great vigour and energy in administering the affairs of the empire. The principal wars in which Anastasius was engaged were those known as the Isaurian and the Persian. The former (492–8) was stirred up by the supporters of Longinus, the brother of Zeno, and resulted in Anastasius's favour; in the latter (502–5) he was signally defeated, but the provinces the Persians had won from him were restored on payment of a ransom. He also suffered defeat at the hands of the Goths of Italy, to check whose incursions he built the "Anastasian wall," extending from the Propontis to the Euxine. For the support he gave to the Eutychians, Anastasius was anathematised by Pope Symmachus. The latter years of his reign were troubled by revolts in Constantinople, excited by his avarice and by his reputed heretical tendencies. He died in 518.

ANASTASIUS II., Emperor, whose original name was Artemius, was raised to the throne of Constantinople by the voice of the senate and people in 713 A.D., on the deposition of Philippicus, whom he had served in the capacity of secretary. His territories being threatened both by sea and land, he sent an army under Leo the Isaurian, afterwards emperor, to defend Syria; adopted wise and resolute measures for the defence of his capital; and equipped and despatched a formidable naval force, with orders not only to resist the approach of the enemy, but to destroy their naval stores. The fleet mutinied at Rhodes, and proclaimed Theodosius, a person of low extraction, emperor. After a six months' reign, Constantinople was taken by Theodosius; and Anastasius, who had fled to Nicæa, was compelled to submit to the new emperor, and, retiring to Thessalonica, became a monk (716). In 721 he headed a revolt against Leo, who had succeeded Theodosius, and receiving a considerable amount of support, laid siege to Constantinople; but the enterprise failed, and Anastasius falling into Leo's hands, was put to death by his orders.

ANATHEMA (ἀνάθεμα, from ἀνατίθημι, lit. anything offered up) is frequently used in classic Greek (in the form ἀνάθημα) to denote things consecrated to the gods, and deposited in a temple. In the LXX. it is the equivalent of the Hebrew חֵרֶם, which denotes an offering devoted to God absolutely, and therefore, in the case of a living creature, put to death. The idea of destruction or perdition thus became associated with the word, which gradually lost its primary sense of consecration. In the New Testament it signifies separated from the church and accursed, and it became the technical term for a form of excommunication at an early date.

ANATOLIA (from ἀνατολή, the east), a name first used under the Byzantine empire for the country east of the Bosphorus. In the form *Anadoli*, it denotes a modern Turkish division almost coincident with ASIA MINOR, *q.v.*

ANATOMY

ANATOMY ('Ανατομή) means in its literal sense the dissection or separation of parts by cutting, but in its usual acceptation it is employed to denote the science the province of which is to determine the construction, the form, and the structure of organised bodies, *i.e.*, of bodies which either are or have been living. It is therefore a department of the science of BIOLOGY. It resolves itself into two great divisions—ANIMAL ANATOMY or ZOOTOMY, the object of which is to investigate the structure of animals; and VEGETABLE ANATOMY or PHYTOTOMY, the object of which is to elucidate the structure of plants. As Vegetable Anatomy will be treated of in the article BOTANY, it does not require to be considered here. ANIMAL ANATOMY, again, naturally resolves itself into two divisions: one in which the construction, form, and structure of two or more animals are compared with each other, so as to bring out their features of resemblance or dissimilarity,—this is called COMPARATIVE ANATOMY; the other, in which the construction, form, and structure of parts in a single animal are considered, which is termed SPECIAL ANATOMY. The special anatomy of an animal may be studied from various points of view: (*a*) with reference to the succession of forms which it exhibits at various periods from its first appearance as an embryo to the assumption of its adult characters; this is termed DEVELOPMENTAL or EMBRYOLOGICAL ANATOMY; (*b*) with reference either to its form and structure, or to the investigation of the laws by which these are determined, termed MORPHOLOGICAL ANATOMY; (*c*) with reference to the function, use, or purpose performed by a part or structure in an animal, termed TELEOLOGICAL or PHYSIOLOGICAL ANATOMY; (*d*) with reference merely to the relative position of different parts or structures, termed TOPOGRAPHICAL ANATOMY; (*e*) with reference to the structure and general properties of the tissues or textures which enter into the construction of the parts or organs of animals; to this branch of study have been applied the terms GENERAL ANATOMY, ANATOMY OF TEXTURES, HISTOLOGY, and, from the microscope being so largely employed in the examination of the textures, MICROSCOPIC or MINUTE ANATOMY; (*f*) with reference to the changes induced by disease in the organs or tissues, termed MORBID or PATHOLOGICAL ANATOMY. From its manifold aspects anatomy forms the basis of the Biological Sciences. As a knowledge of the laws of motion is essential, and must be constantly recurred to at every step before any true progress can be made in the investigation of the physical sciences, so must the structure of animal bodies be constantly appealed to by the zoologist in all attempts at classification; by the physiologist in all inquiries into the functions performed by the organs and textures in a state of health, and into the special adaptation of parts to particular uses; and by the physician in considering the alterations or disturbance of the functions of parts in the course of disease. To describe the anatomy of the multitudinous forms of animal life from these different points of view would require, not one, but several voluminous treatises, and would much exceed the compass of a single article. Moreover, it is advisable that the anatomy of the different classes of the animal kingdom should be considered under their respective heads,—*e.g.*, that of the Crabs under CRUSTACEA, that of Reptiles under REPTILIA, &c. It is intended to devote this article more particularly to the description of the Special Anatomy of the Human Body in a state of health; in other words, to make it a short treatise on HUMAN ANATOMY or ANTHROPOTOMY, which, as forming a department of the general science of Comparative Anatomy, is interesting not only to men of science generally, but, from its intimate connection with the several divisions of the art of healing, and with the study of the functions of the human body, possesses the highest importance to the physician, surgeon, and physiologist.

Previous to entering on the consideration of the Anatomy of the Human Body, it may be well to take a historical view of the progress of the science from its origin to the present time.

HISTORY OF ANATOMY.

In tracing the history of the origin of anatomy, it may be justly said that more learning than judgment has been displayed. Some writers claim for it the highest antiquity, and pretend to find its first rudiments alternately in the animal sacrifices of the shepherd kings, the Jews, and other ancient nations, and in the art of embalming as practised by the Egyptian priests. Even the descriptions of wounds in the Iliad have been supposed adequate to prove that in the time of Homer mankind had distinct notions of the structure of the human body. Of the first it may be said that the rude information obtained by the slaughter of animals for sacrifice does not imply profound anatomical knowledge; and those who adduce the second as evidence are deceived by the language of the poet of the Trojan war, which, distinguishing certain parts by their ordinary Greek epithets, as afterwards used by Hippocrates, Galen, and all anatomists, has been rather too easily supposed to prove that the poet had studied systematically the structure of the human frame.

Hippocrates. 460–37? B.C.

With not much greater justice has the cultivation of anatomical knowledge been ascribed to Hippocrates, who, because he is universally allowed to be the father of medicine, has also been thought to be the creator of the science of anatomy. Of the seven individuals of the family of the Heracleidæ who bore this celebrated name, the second, who was son of Heraclides and Phenarita, and grandson of the first Hippocrates, was indeed distinguished as a physician of great observation and experience, and the first who appreciated the value of studying accurately the phenomena, effects, and terminations of disease. It does not appear, however, notwithstanding the vague and general panegyrics of Riolan, Bartholin, Le Clerc, and Portal, that the anatomical knowledge of this illustrious person was either accurate or profound. Of the works ascribed to Hippocrates, five only are genuine.[1] Most of them were written either by subsequent authors of the same name, or by one or other of the numerous impostors who took advantage of the zealous munificence of the Ptolemies, by fabricating works under that illustrious name. Of the few which are genuine, there is none expressly devoted to anatomy; and of his knowledge on this subject the only proofs are to be found in the exposition of his physiological opinions, and his medical or surgical instructions. From these it appears that Hippocrates had some accurate notions on osteology, but that of the structure of the human body in general his ideas were at once superficial and erroneous. In his book on injuries of the head, and in that on fractures, he shows that he knew the sutures of the cranium and the relative situation of the bones, and that he had some notion of the shape of the bones in general, and of their mutual connections. Of the muscles, of the soft parts in general, and of the internal organs, his ideas are confused, indistinct, and erroneous. The term φλέβς he seems, in imitation of the colloquial Greek, to have used generally

to signify a blood-vessel, without being aware of the distinction of vein and artery; and the term ἀρτηρία, or air-holder, is restricted to the windpipe. He appears to have been unaware of the existence of the nervous chords; and the term *nerve* is used by him, as by Grecian authors in general, to signify a *sinew* or *tendon*. On other points his views are so much combined with peculiar physiological doctrines, that it is impossible to assign them the character of anatomical facts; and even the works in which these doctrines are contained are with little probability to be ascribed to the second Hippocrates. If, however, we overlook this difficulty, and admit what is contained in the genuine Hippocratic writings to represent at least the sum of knowledge possessed by Hippocrates and his immediate descendants, we find that he represents the brain as a gland, from which exudes a viscid fluid; that the heart is muscular and of pyramidal shape, and has two ventricles separated by a partition, the fountains of life—and two auricles, receptacles of air; that the lungs consist of five ash-coloured lobes, the substance of which is cellular and spongy, naturally dry, but refreshed by the air; and that the kidneys are glands, but possess an attractive faculty, by virtue of which the moisture of the drink is separated, and descends into the bladder. He distinguishes the bowels into colon and rectum (ὁ ἀρχός).

The knowledge possessed by the second Hippocrates was transmitted in various degrees of purity to the descendants and pupils, chiefly of the family of the Heracleidæ, who succeeded him. Several of these, with feelings of grateful affection, appear to have studied to preserve the written memory of his instructions, and in this manner to have contributed to form part of that collection of treatises which have long been known to the learned world under the general name of the *Hippocratic writings*. Though composed, like the genuine remains of the physician of Cos, in the Ionian dialect, all of them differ from these in being more diffuse in style, more elaborate in form, and in studying to invest their anatomical and medical matter with the fanciful ornaments of the Platonic philosophy. Hippocrates had the merit of early recognising the value of facts apart from opinions, and of those facts especially which lead to general results; and in the few genuine writings which are now extant it is easy to perceive that he has recourse to the simplest language, expresses himself in terms which, though short and pithy, are always precise and perspicuous, and is averse to the introduction of philosophical dogmas. Of the greater part of the writings collected under his name, on the contrary, the general character is verboseness, prolixity, and a great tendency to speculative opinions. For these reasons, as well as for others derived from internal evidence, while the Aphorisms, the Epidemics, and the works above mentioned, bear distinct marks of being the genuine remains of Hippocrates, it is impossible to regard the book περὶ Φύσιος Ανθρώπου as entirely the composition of that physician; and it appears more reasonable to view it as the work of some one of the numerous disciples to whom the author had communicated the results of his observation, which they unwisely attempted to combine with the philosophy of the Platonic school and their own mysterious opinions.

Polybus. 374. Among those who aimed at this distinction, the most fortunate in the preservation of his name is Polybus, the son-in-law of the physician of Cos. This person, who must not be confounded with the monarch of Corinth immortalised by Sophocles in the tragic story of Œdipus, is represented as a recluse, severed from the world and its enjoyments, and devoting himself to the study of anatomy and physiology, and to the composition of works on these subjects. To him has been ascribed the whole of the book on the *Nature of the Child* and most of that *On Man*; both physiological treatises interspersed with anatomical sketches. His anatomical information, with which we are specially concerned, appears to have been rude and inaccurate, like that of his preceptor. He represents the large vessels of the body as consisting of four pairs; the first proceeding from the head by the back of the neck and spinal chord to the hips, lower extremities, and outer ankle; the second, consisting of the jugular vessels (αἱ σφαγίτιδες), proceeding to the loins, thighs, hams, and inner ankle; the third proceeding from the temples by the neck to the *scapula* and lungs, and thence by mutual intercrossings to the spleen and left kidney, and the liver and right kidney, and finally to the rectum; and the fourth from the forepart of the neck to the upper extremities, the fore-part of the trunk, and the organs of generation.

This specimen of the anatomical knowledge of one of 363.
the most illustrious of the Hippocratic disciples differs not essentially from that of Syennesis, the physician of Cyprus, and Diogenes, the philosopher of Apollonia, two authors for the preservation of whose opinions we are indebted to Aristotle. They may be admitted as representing the state of anatomical knowledge among the most enlightened men at that time, and they only show how rude and erroneous were their ideas on the structure of the animal body. It may indeed, without injustice, be said that the anatomy of the Hippocratic school is not only erroneous, but fanciful and imaginary, in often substituting mere supposition and assertion for what ought to be matter of fact. From this censure it is impossible to exempt even the name of Plato himself, for whom some notices in the *Timæus* on the structure of the animal body, as taught by Hippocrates and Polybus, have procured a place in the history of the science.

Amidst the general obscurity in which the early history Aristotle.
of anatomy is involved, only two leading facts may be admitted with certainty. The first is, that previous to the time of Aristotle there was no accurate knowledge of anatomy; and the second, that all that was known was derived from the dissection of the lower animals only. By the appearance of Aristotle this species of knowledge, which was hitherto acquired in a desultory and irregular manner, began to be cultivated systematically and with a definite object; and among the services which the philosopher of Stagira rendered to mankind, one of the greatest and most substantial is, that he was the founder of Comparative Anatomy, and was the first to apply its facts to the elucidation of zoology. The works of this ardent and original naturalist show that his zootomical knowledge was extensive and often accurate; and from several of his descriptions it is impossible to doubt that they were derived from frequent personal dissection. Aristotle, who was born 384 years before the Christian era, or in the first 384.
year of the 99th Olympiad, was, at the age of 39, requested by Philip to undertake the education of his son Alexander. During this period it is said he composed several works on anatomy, which, however, are now lost. The military expedition of his royal pupil into Asia, by laying open the animal stores of that vast and little known continent, furnished Aristotle with the means of extending his knowledge, not only of the animal tribes, but of their structure, and of communicating more accurate and distinct notions than were yet accessible to the world. A sum of 800 talents, and the concurrent aid of numerous intelligent 334-327.
assistants in Greece and Asia, were intended to facilitate his researches in composing a system of zoological knowledge; but it has been observed that the number of instances in which he was thus compelled to trust to the testimony of other observers led him to commit errors in description which personal observation might have enabled him to avoid.

The first three books of the *History of Animals*, a treatise consisting of ten books, and the four books on the *Parts of Animals*, constitute the great monument of the *Aristotelian Anatomy*. From these we find that Aristotle was the first who corrected the erroneous statements of Polybus, Syennesis, and Diogenes regarding the blood-vessels, which they made, as we have seen, to arise from the head and brain. These he represents to be two in number, placed before the spinal column, the larger on the right, the smaller on the left, which, he also remarks, is by some called *aorta* (ἀορτή), the first time we observe that this epithet occurs in the history. Both he represents to arise from the heart, the larger from the largest upper cavity, the smaller or aorta from the middle cavity, but in a different manner and forming a narrower canal. He also distinguishes the thick, firm, and more tendinous structure of the aorta from the thin and membranous structure of vein. In describing the distribution of the latter, however, he confounds the *vena cava* and pulmonary artery, and, as might be expected, he confounds the ramifications of the former with those of the arterial tubes in general. While he represents the lung to be liberally supplied with blood, he describes the brain as an organ almost destitute of this fluid. His account of the distribution of the aorta is wonderfully correct. Though he does not notice the cœliac, and remarks that the aorta sends no direct branches to the liver and spleen, he had observed the mesenteric, the renal, and the common iliac arteries. It is nevertheless singular that though he remarks particularly that the renal branches of the aorta go to the substance and not the *pelvis* (κοιλία) of the kidney, he appears to mistake the ureters for branches of the aorta. Of the nerves (νευρά) he appears to have the most confused notions. Making them arise from the heart, which he says has nerves (tendons) in its largest cavity, he represents the aorta to be a nervous or tendinous vein (νευρώδης φλέβς). By and by, afterwards saying that all the articulated bones are connected by *nerves*, he makes them the same as ligaments.

He distinguishes the windpipe or air-holder (ἀρτηρία) from the œsophagus, because it is placed before the latter, because food or drink passing into it causes distressing cough and suffocation, and because there is no passage from the lung to the stomach. He knew the situation and use of the epiglottis, seems to have had some indistinct notions of the larynx, represents the windpipe to be necessary to convey air to and from the lungs, and appears to have a tolerable understanding of the structure of the lungs. He repeatedly represents the heart, the shape and site of which he describes accurately, to be the origin of the blood-vessels, in opposition to those who made them descend from the head; yet, though he represents it as full of blood and the source and fountain of that fluid, and even speaks of the blood flowing from the heart to the veins, and thence to every part of the body, he says nothing of the circular motion of the blood. The diaphragm he distinguishes by the name διάζωμα, and ὑπόζωμα. With the liver and spleen, and the whole alimentary canal, he seems well acquainted. The several parts of the quadruple stomach of the ruminating animals are distinguished and named; and he even traces the relations between the teeth and the several forms of stomach, and the length or brevity, the simplicity or complication, of the intestinal tube. Upon the same principle he distinguishes the *jejunum* (ἡ νῆστις), or the empty portion of the small intestines in animals (τὸ ἔντερον λεπτόν), the *cæcum* (τυφλον τι καὶ ὄγκωδες), the colon (τὸ κῶλον), and the sigmoid flexure (στενώτερον καὶ εἱλιγμένον). The modern epithet of *rectum* is the literal translation of his description of the straight progress (εὐθύ) of the bowel to the anus (πρωκτός). He knew the nasal cavities and the passage from the tympanal cavity of the ear to the palate, afterwards described by Eustachius. He distinguishes as "partes similares" those structures, such as bone, cartilage, vessels, sinews, blood, lymph, fat, flesh, which, not confined to one locality, but distributed throughout the body generally, we now term the tissues or textures, whilst he applies the term "partes dissimilares" to the regions of the head, neck, trunk, and extremities.

Next to Aristotle occur the names of Diocles of Carystus, 354.
and Praxagoras of Cos, the last of the family of the Asclepiadæ. The latter is remarkable for being the first 341.
who distinguished the arteries from the veins, and the author of the opinion that the former were air-vessels.

Alexandrian school.

Hitherto anatomical inquiry was confined to the examination of the bodies of brute animals. We have, indeed, no testimony of the human body being submitted to examination previous to the time of Erasistratus and Herophilus; and it is vain to look for authentic facts on this point before the foundation of the Ptolemaic dynasty of sovereigns in Egypt. This event, which, as is generally known, succeeded the death of Alexander, 320 years before the Christian era, collected into one spot the scattered embers of literature and science, which were beginning to languish in Greece under a weak and distracted government and an unsettled state of society. The children of her divided states, whom domestic discord and the uncertainties of war rendered unhappy at home, wandered into Egypt, and found, under the fostering hand of the Alexandrian monarchs, the means of cultivating the sciences, and repaying with interest to the country of Thoth and Osiris the benefits which had been conferred on the infancy of Greece by Thales and Pythagoras. Alexandria became in this manner the repository of all the learning and knowledge of the civilised world; and while other nations were sinking under the effects of internal animosities and mutual dissensions, or ravaging the earth with the evils of war, the Egyptian Greeks kept alive the sacred flame of science, and preserved mankind from relapsing into their original barbarism. These happy effects are to be ascribed in an eminent degree to the enlightened government and liberal opinions of Ptolemy Soter, and his immediate 285.
successors Philadelphus and Euergetes. The two latter princes, whose authority was equalled only by the zeal with which they patronised science and its professors, were the first who enabled physicians to dissect the human body, and prevented the prejudices of ignorance and superstition from compromising the welfare of the human race. To this happy circumstance Herophilus and Erasistratus are indebted for the distinction of being known to posterity as the first anatomists who dissected and described the parts of the human body. Both these physicians flourished under Ptolemy Soter, and probably Ptolemy Philadelphus, and were indeed the principal supports of what has been named in medical history the Alexandrian School, to which their reputation seems to have attracted numerous pupils. But though the concurrent testimony of antiquity assigns to these physicians the merit of dissecting the human body, time, which wages endless war with the vanity and ambition of man, has dealt hardly with the monuments of their labours. As the works of neither have been preserved, great uncertainty prevails as to the respective merits of these ancient anatomists; and all that is now known of their anatomical researches is obtained from the occasional notices of Galen, Oribasius, and some other writers. From

Erasistratus. 304.

these it appears that Erasistratus recognised the valves of the heart, and distinguished them by the names of *tricuspid* and *sigmoid*; that he studied particularly the shape and structure of the brain, and its divisions, and cavities, and membranes, and likened the convolutions to the folds of the jejunum; that he first formed a distinct idea of the

nature of the nerves, which he made issue from the brain; and that he discovered lymphatic vessels in the mesentery, first in brute animals, and afterwards, it is said, in man. He appears also to have distinguished the nerves into those of sensation and those of motion.

Of Herophilus it is said that he had extensive anatomical knowledge, acquired by dissecting not only brutes but human bodies. Of these he probably dissected more than any of his predecessors or contemporaries. Devoted to the assiduous cultivation of anatomy, he appears to have studied with particular attention those parts which were least understood. He recognised the nature of the pulmonary artery, which he denominates *arterious vein;* he knew the vessels of the mesentery, and showed that they did not go to the *vena portæ*, but to certain glandular bodies; and he first applied the name of *twelve-inch* or *duodenum* (δωδεκαδάκτυλος) to that part of the alimentary canal which is next to the stomach. Like Erasistratus, he appears to have studied carefully the configuration of the brain; and though, like him, he distinguishes the nerves into those of sensation and those of voluntary motion, he adds to them the ligaments and tendons. A tolerable description of the liver by this anatomist is preserved in the writings of Galen. He first applied the name of choroid or vascular membrane to that which is found in the cerebral ventricles; he knew the straight venous sinus which still bears his name; and to him the linear furrow at the bottom of the fourth ventricle is indebted for its name of *calamus scriptorius*.

The celebrity of these two great anatomists appears to have thrown into the shade for a long period the names of all other inquirers; for, among their numerous and rather celebrated successors in the Alexandrian school, it is impossible to recognise a name which is entitled to distinction in the history of anatomy. In a chasm so wide it is not uninteresting to find, in one who combined the characters of the greatest orator and philosopher of Rome, the most distinct traces of attention to anatomical knowledge. Cicero, in his treatise *De Natura Deorum*, in a
44. short sketch of physiology, such as it was taught by Aristotle and his disciples, introduces various anatomical notices, from which the classical reader may form some idea of the state of anatomy at that time. The Roman orator appears to have formed a pretty distinct idea of the shape and connections of the windpipe and lungs; and though he informs his readers that he knows the alimentary canal, he omits the details through motives of delicacy. In imitation of Aristotle, he talks of the blood being conveyed by the veins (*venæ*), that is, blood-vessels, through the body at large; and, like Praxagoras, of the air inhaled by the lungs being conveyed through the arteries.

Aretæus, though chiefly known as a medical author, makes some observations on the lung and the pleura, maintains the glandular structure of the kidney, and describes the anastomosis or communications of the capillary extremities of the *vena cava* with those of the portal vein.

Celsus. 53 B.C.—7 A.D.

The most valuable depository of the anatomical knowledge of these times is the work of Celsus, one of the most judicious medical authors of antiquity. He left, indeed, no express anatomical treatise; but from the introductions to the 4th and 8th books of his work, *De Medicina*, with incidental remarks in the 7th, the modern reader may form very just ideas of his anatomical attainments. From these it appears that Celsus was well acquainted with the windpipe and lungs and the heart; with the difference between the windpipe and oesophagus (*stomachus*), which leads to the stomach (*ventriculus*); and with the shape, situation, and relations of the diaphragm. He enumerates also the principal facts relating to the situation of the liver, the spleen, the kidneys, and the stomach. He appears, however, to have been unaware of the distinction of *duodenum* or twelve-inch bowel, already admitted by Herophilus, and represents the stomach as directly connected by means of the *pylorus* with the *jejunum* or upper part of the small intestine.

The 7th and 8th books, which are devoted to the consideration of those diseases which are treated by manual operation, contain sundry anatomical notices necessary to explain the nature of the diseases or mode of treatment. Of these, indeed, the merit is unequal; and it is not wonderful that the ignorance of the day prevented Celsus from understanding rightly the mechanism of the pathology of hernia. He appears, however, to have formed a tolerably just idea of the mode of cutting into the urinary bladder; and even his obstetrical instructions show that his knowledge of the uterus, vagina, and appendages was not contemptible. It is in osteology, however, that the information of Celsus is chiefly conspicuous. He enumerates the sutures and several of the holes of the cranium, and describes at great length the superior and inferior maxillary bones and the teeth. With a good deal of care he describes the vertebræ and the ribs, and gives very briefly the situation and shape of the *scapula*, *humerus*, *radius*, and *ulna*, and even of the carpal and metacarpal bones, and then of the different bones of the pelvis and lower extremities. He had formed a just idea of the articular connections, and is desirous to impress the fact that none is formed without cartilage. From his mention of many minute holes (*multa et tenuia foramina*), in the recess of the nasal cavities, it is evident that he was acquainted with the perforated plate of the ethmoid bone; and from saying that the straight part of the auditory canal becomes flexuous, and terminates in numerous minute cavities (*multa et tenuia foramina diducitur*), it is inferred by Portal that he knew the semicircular canals.

Though the writings of Celsus show that he cultivated anatomical knowledge, it does not appear that the science was much studied by the Romans; and there is reason to believe that, after the decay of the school of Alexandria, it languished in neglect and obscurity. It is at least certain that the appearance of Marinus during the reign of Nero is mentioned by authors as an era remarkable for anatomical inquiry, and that this person is distinguished by Galen as the restorer of a branch of knowledge which had been before him suffered to fall into undeserved neglect. From Galen also we learn that Marinus gave an accurate account of the muscles, that he studied particularly the glands, and that he discovered those of the mesentery. He fixed the number of nerves at seven; he observed the palatine nerves, which he rated as the fourth pair; and described as the fifth the auditory and facial, which he regards as one pair, and the hypoglossal as the sixth.

Rufus.

Not long after Marinus appeared Rufus of Ephesus, a Greek physician, who in the reign of Trajan was much attached to physiology, and as a means of cultivating this science studied Comparative Anatomy, and made sundry experiments on living animals. Of the anatomical writings of this author there remains only a list or catalogue of names of different regions and parts of the animal body. He appears, however, to have directed attention particularly to the tortuous course of the uterine vessels, and to have recognised even at this early period the Fallopian tube. He distinguishes the nerves into those of sensation and those of motion. He knew the recurrent nerve. His name is further associated with the ancient experiment of compressing in the situation of the carotid arteries the pneumogastric nerve, and thereby inducing insensibility and loss of voice.

Of all the authors of antiquity, however, none possesses

Galen.

so just a claim to the title of anatomist as Claudius Galenus, the celebrated physician of Pergamus, who was born about the 130th year of the Christian era, and lived under the reigns of Hadrian, the Antonines, Commodus, and Severus. He was trained by his father Nicon (whose memory he embalms as an eminent mathematician, architect, and astronomer) in all the learning of the day, and initiated particularly into the mysteries of the Aristotelian philosophy. In an order somewhat whimsical he afterwards studied philosophy successively in the schools of the Stoics, the Academics, the Peripatetics, and the Epicureans. When he was seventeen years of age, his father, he informs us, was admonished by a dream to devote his son to the study of medicine; but it was fully two years after that Galen entered on this pursuit, under the auspices of an instructor whose name he has thought proper to conceal. Shortly after he betook himself to the study of anatomy under Satyrus, a pupil of Quintus, and of medicine under Stratonicus, a Hippocratic physician, and Æschrion, an empiric. He had scarcely attained the age of twenty when he had occasion to deplore the loss of the first and most affectionate guide of his studies; and soon after he proceeded to Smyrna to obtain the anatomical instructions of Pelops, who, though mystified by some of the errors of Hippocrates, is commemorated by his pupil as a skilful anatomist. After this he appears to have visited various cities distinguished for philosophical or medical teachers; and, finally, to have gone to Alexandria with the view of cultivating more accurately and intimately the study of anatomy under Heraclianus. Here he remained till his twenty-eighth year, when he regarded himself as possessed of all the knowledge then attainable through the medium of teachers. He now returned to Pergamus to exercise the art which he had so anxiously studied, and received, in his twenty-ninth year, an unequivocal testimony of the confidence which his fellow-citizens reposed in his skill, by being intrusted with the treatment of the wounded gladiators; and in this capacity he is said to have treated wounds with success which were fatal under former treatment. A seditious tumult appears to have caused him to form the resolution of quitting Pergamus and proceeding to Rome, at the age of thirty-two. Here, however, he remained only five years; and returning once more to Pergamus, after travelling for some time, finally settled in Rome as physician to the Emperor Commodus. The anatomical writings ascribed to Galen, which are numerous, are to be viewed not merely as the result of personal research and information, but as the common depository of the anatomical knowledge of the day, and as combining all that he had learnt from the several teachers under whom he successively studied with whatever personal investigation enabled him to acquire. It is on this account not always easy to distinguish what Galen had himself ascertained by personal research from that which was known by other anatomists. This, however, though of moment to the history of Galen as an anatomist, is of little consequence to the science itself; and from the anatomical remains of this author a pretty just idea may be formed both of the progress and of the actual state of the science at that time.

The osteology of Galen is undoubtedly the most perfect of the departments of the anatomy of the ancients. He names and distinguishes the bones and sutures of the cranium nearly in the same manner as at present. Thus, he notices the quadrilateral shape of the parietal bones; he distinguishes the squamous, the styloid, the mastoid, and the petrous portions of the temporal bones; and he remarks the peculiar situation and shape of the sphenoid bone. Of the ethmoid, which he omits at first, he afterwards speaks more at large in another treatise. The malar he notices under the name of zygomatic bone; and he describes at length the upper maxillary and nasal bones, and the connection of the former with the sphenoid. He gives the first clear account of the number and situation of the vertebræ, which he divides into *cervical*, *dorsal*, and *lumbar*, and distinguishes from the sacrum and coccyx. Under the head *Bones of the Thorax*, he enumerates the sternum, the ribs (αἱ πλευραί), and the dorsal vertebræ, the connection of which with the former he designates as a variety of *diarthrosis*. The description of the bones of the extremities and their articulations concludes the treatise.

Though in myology Galen appears to less advantage than in osteology, he nevertheless had carried this part of anatomical knowledge to greater perfection than any of his predecessors. He describes a frontal muscle, the six muscles of the eye, and a seventh proper to animals; a muscle to each *ala nasi*, four muscles of the lips, the thin cutaneous muscle of the neck, which he first termed *platysma myoides*, or muscular expansion, two muscles of the eyelids, and four pairs of muscles of the lower jaw—the temporal to raise, the masseter to draw to one side, and two depressors, corresponding to the digastric and internal pterygoid muscles. After speaking of the muscles which move the head and the scapula, he adverts to those by which the windpipe is opened and shut, and the intrinsic or proper muscles of the larynx and hyoid bone. Then follow those of the tongue, pharynx, and neck, those of the upper extremities, the trunk, and the lower extremities successively; and in the course of this description he swerves so little from the actual facts that most of the names by which he distinguishes the principal muscles have been retained by the best modern anatomists. It is chiefly in the minute account of these organs, and especially in reference to the minuter muscles, that he appears inferior to the moderns.

The angiological knowledge of Galen, though vitiated by the erroneous physiology of the times and ignorance of the separate uses of the arteries and veins, exhibits, nevertheless, some accurate facts which show the diligence of the author in dissection. Though, in opposition to the opinions of Praxagoras and Erasistratus, he proved that the arteries in the living animal contain not air but blood, it does not appear to have occurred to him to determine in what direction the blood flows, or whether it was movable or stationary. Representing the left ventricle of the heart as the common origin of all the arteries, though he is misled by the pulmonary artery, he nevertheless traces the distribution of the branches of the aorta with some accuracy. The *vena azygos* also, and the jugular veins, have contributed to add to the confusion of his description, and to render his angiology the most imperfect of his works.

In neurology we find him to be the author of the dogma that the brain is the origin of the nerves of sensation, and the spinal chord of those of motion; and he distinguishes the former from the latter by their greater softness or less consistence. Though he admits only seven cerebral pairs, he has the merit of distinguishing and tracing the distribution of the greater part of both classes of nerves with great accuracy. His description of the brain is derived from dissection of the lower animals, and his distinctions of the several parts of the organ have been retained by modern anatomists. His mode of demonstrating this organ, which indeed is clearly described, consists of five different steps. In the first the bisecting membrane—*i.e.* the falx (μῆνιγξ διχοτομοῦσα)—and the connecting blood-vessels are removed; and the dissector, commencing at the anterior extremity of the great fissure, separates the hemispheres gently as far as the *torcular*, and exposes a smooth surface (τὴν χώραν τυλώδη πως οὖσαν), the mesolobe of the moderns, or the middle band. In the second he exposes by successive sections the ventricles, the choroid plexus, and the middle partition.

The third exhibits the pineal body (σῶμα κωνοειδές) or conarium, concealed by a membrane with numerous veins, meaning that part of the plexus which is now known by the name of *velum interpositum*, and a complete view of the ventricles. The fourth unfolds the third ventricle (τὶς ἄλλη τρίτη κοιλία), the communication between the two lateral ones, the arch-like body (σῶμα ψαλιδοειδές) *fornix*, and the passage from the third to the fourth ventricle. In the fifth he gives an accurate description of the relations of the third and fourth ventricle, of the situation of the two pairs of eminences, *nates* (γλουτά) and *testes* (διδυμία or ὄρχεις), the scolecoid or worm-like process, anterior and posterior, and lastly the linear furrow, called by Herophilus *calamus scriptorius*.

In the account of the thoracic organs equal accuracy may be recognised. He distinguishes the *pleura* by the name of inclosing membrane (ὑμὴν ὑπεζωκώς, *membrana succingens*), and remarks its similitude in structure to that of the peritoneum, and the covering which it affords to all the organs. The pericardium also he describes as a membranous sac with a circular basis corresponding to the base of the heart, and a conical apex; and after an account of the tunics of the arteries and veins, he speaks shortly of the lung, and more at length of the heart, which, however, he takes some pains to prove not to be muscular, because it is harder, its fibres are differently arranged, and its action is incessant, whereas that of muscle alternates with the state of rest; he gives a good account of the valves and of the vessels; and notices especially the bony ring formed in the heart of the horse, elephant, and other large animals.

The description of the abdominal organs, and of the kidneys and urinary apparatus, is still more minute, and in general accurate. Our limits, however, do not permit us to give any abstract of them; and it is sufficient in general to say that Galen gives correct views of the arrangement of the peritoneum and omentum, and distinguishes accurately the several divisions of the alimentary canal and its component tissues. In the liver, which he allows to receive an envelope from the peritoneum, he admits, in imitation of Erasistratus, a proper substance or *parenchyma*, interposed between the vessels, and capable of removal by suitable dissection. His description of the organs of generation is rather brief, and is, like most of his anatomical sketches, too much blended with physiological dogmas.

This short sketch may communicate some idea of the condition of anatomical knowledge in the days of Galen, who indeed is justly entitled to the character of rectifying and digesting, if not of creating, the science of anatomy among the ancients. Though evidently confined, perhaps entirely by the circumstances of the times, to the dissection of brute animals, so indefatigable and judicious was he in the mode of acquiring knowledge, that many of his names and distinctions are still retained with advantage in the writings of the moderns. Galen was a practical anatomist, and not only describes the organs of the animal body from actual dissection, but gives ample instructions for the proper mode of exposition. His language is in general clear, his style as correct as in most of the authors of the same period, and his manner is animated. Few passages in early science are indeed so interesting as the description of the process for demonstrating the brain and other internal organs which is given by this patient and enthusiastic observer of nature. To some it may appear absurd to speak of anything like good anatomical description in an author who writes in the Greek language, or anything like an interesting and correct manner in a writer who flourished at a period when taste was depraved or extinct and literature corrupted,—when the philosophy of Antoninus and the mild virtues of Aurelius could do little to soften the iron sway of Lucius Verus and Commodus; but the habit of faithful observation in Galen seems to have been so powerful that, in the description of material objects, his genius invariably rises above the circumstances of his age. Though not so directly connected with this subject, it is nevertheless proper to mention that he appears to have been the first anatomist who can be said, on authentic grounds, to have attempted to discover the uses of organs by vivisection and experiments on living animals. In this manner he ascertained the position and demonstrated the action of the heart; and he mentions two instances in which, in consequence of disease or injury, he had an opportunity of observing the motions of this organ in the human body. In short, without eulogising an ancient author at the expense of critical justice, or commending his anatomical descriptions as superior to those of the moderns, it must be admitted that the anatomical writings of the physician of Pergamus form a remarkable era in the history of the science; and that by diligence in dissection and accuracy in description he gave the science a degree of importance and stability which it has retained through the lapse of many centuries.

The death of Galen, which took place at Pergamus in the seventieth year of his age and the 200th of the Christian era, may be regarded as the downfall of anatomy in ancient times. After this period we recognise only two names of any celebrity in the history of the science—those of Soranus and Oribasius, with the more obscure ones of Meletius and Theophilus, the latter the chief of the imperial guard of Heraclius.

Soranus, who was an Ephesian, and flourished under the emperors Trajan and Hadrian, distinguished himself by his researches on the female organs of generation. He appears to have dissected the human subject; and this perhaps is one reason why his descriptions of these parts are more copious and more accurate than those of Galen, who derived his knowledge from the bodies of the lower animals. He denies the existence of the hymen, but describes accurately the clitoris. Soranus the anatomist must be distinguished from the physician of that name, who was also a native of Ephesus.

Oribasius, who was born at Pergamus, is said to have Oribasius.
been at once the friend and physician of the Emperor
Julian, and to have contributed to the elevation of 361–363.
that apostate to the imperial throne. For this he appears
to have suffered the punishment of a temporary exile
under Valens and Valentinian; but was soon recalled, and
lived in great honour till the period of his death. By
Le Clerc, Oribasius is regarded as a compiler; and indeed 387.
his anatomical writings bear so close a correspondence with those of Galen that the character is not altogether groundless. In various points, nevertheless, he has rendered the Galenian anatomy more accurate; and he has distinguished himself by a good account of the salivary glands, which were overlooked by Galen.

To the same period generally is referred the Anatomical Introduction of an anonymous author, first published in 1618 by Lauremberg, and more recently by Bernard. It is to be regarded as a compilation formed on the model of Galen and Oribasius. The same character is applicable to the treatises of Meletius and Theophilus.

The decline indicated by these languid efforts soon sunk into a state of total inactivity; and the unsettled state of society during the latter ages of the Roman empire was extremely unfavourable to the successful cultivation of science. The sanguinary conflicts in which the southern countries of Europe were repeatedly engaged with their northern neighbours, between the second and eighth centuries, tended gradually to estrange their minds from scientific pursuits; and the hordes of barbarians by which

the Roman empire was latterly overrun, while they urged them to the necessity of making hostile resistance, and adopting means of self-defence, introduced such habits of ignorance and barbarism, that science was almost universally forgotten. While the art of healing was professed only by some few ecclesiastics or by itinerant practitioners, anatomy was utterly neglected; and no name of anatomical celebrity occurs to diversify the long and uninteresting period commonly distinguished as the Dark Ages.

Arabian Physicians. Anatomical learning, thus neglected by European nations, is believed to have received a temporary cultivation from the Asiatics. Of these, several nomadic tribes, known to Europeans under the general denomination of Arabs and Saracens, had gradually coalesced under various leaders; and by their habits of endurance, as well as of enthusiastic valour in successive expeditions against the eastern division of the Roman empire, had acquired such military reputation as to render them formidable wherever they appeared. After a century and a half of foreign warfare or internal animosity, under the successive dynasties of the Ommiads and Abbassides, in which the propagation of Islamism was the pretext for the extinction of learning and civilisation, and the most remorseless system of rapine and destruction, the Saracens began, under the latter dynasty of princes, to recognise the value of science, and especially of that which prolongs life, heals disease, and alleviates the pain of wounds and injuries. The caliph Almansor combined with his official knowledge of Moslem law the successful cultivation of astronomy; but to his grandson Almamun, the seventh prince of the line of the Abbassides, belongs the merit of undertaking to render his subjects philosophers and physicians. By the directions of this prince the works of the Greek and Roman authors were translated into Arabic; and the favour and munificence with which literature and its professors were patronised speedily raised a succession of learned Arabians. The residue of the rival family of the Ommiads, already settled in Spain, was prompted by motives of rivalry or honourable ambition to adopt the same course; and while the academy, hospitals, and library of Baghdad bore testimony to the zeal and liberality of the Abbassides, the munificence of the Ommiades was not less conspicuous in the literary institutions of Cordova, Seville, and Toledo.

Notwithstanding the efforts of the Arabian princes, however, and the diligence of the Arabian physicians, little was done for anatomy, and the science made no substantial acquisition. The Koran denounces as unclean the person who touches a corpse; the rules of Islamism forbid dissection; and whatever their instructors taught was borrowed from the Greeks. Abu-Bekr Al-Rasi, Abu-Ali Ibn-Sina, Abul-Cassem, and Abu-Walid Ibn-Roshd, the Rhazes, Avicenna, Abulcasis, and Averrhoes of European authors, are their most celebrated names in medicine; yet to none of these can the historian with justice ascribe any anatomical merit. Al-Rasi has indeed left descriptions of the eye, of the ear and its *meatus*, and of the heart; and Ibn-Sina, Abul-Cassem, and Ibn-Roshd give anatomical descriptions of the parts of the human body. But of these the general character is, that they are copies from Galen, sometimes not very just, and in all instances mystified with a large proportion of the fanciful and absurd imagery and inflated style of the Arabian writers. The chief reason of their obtaining a place in anatomical history is, that by the influence which their medical authority enabled them to exercise in the European schools, the nomenclature which they employed was adopted by European anatomists, and continued till the revival of ancient learning restored the original nomenclature of the Greek physicians. Thus, the *cervix*, or nape of the neck, is *nucha;* the œsophagus is *meri;* the umbilical region is *sumen* or *sumac;* the abdomen is *myrach;* the peritoneum is *siphac;* and the omentum, *zirbus.*

From the general character now given justice requires that we except Abdallatif, the annalist of Egyptian affairs. This author, who maintains that it is impossible to learn anatomy from books, and that the authority of Galen must yield to personal inspection, informs us that the Moslem doctors did not neglect opportunities of studying the bones of the human body in cemeteries; and that he himself, by once examining a collection of bones in this manner, ascertained that the lower jaw is formed of one piece; that the sacrum, though sometimes composed of several, is most generally of one; and that Galen is mistaken when he asserts that these bones are not single.

School of Bologna. The era of Saracen learning extends to the 13th century; and after this we begin to approach happier times. The university of Bologna, which, as a school of literature and law, was already celebrated in the twelfth century, became, in the course of the following one, not less distinguished for its medical teachers. Though the misgovernment of the municipal rulers of Bologna had disgusted both teachers and students, and given rise to the foundation of similar institutions in Padua and Naples,—and though the school of Salerno, in the territory of the latter, was still in high repute,—it appears, from the testimony of Sarti, that medicine was in the highest esteem in Bologna, and that it was in such perfection as to require a division of its professors into physicians, surgeons, physicians for wounds, barber-surgeons, oculists, and even some others. Notwithstanding these indications of refinement, however, anatomy was manifestly cultivated rather as an appendage of surgery than a branch of medical science; and, according to the testimony of Guy de Chauliac, the cultivation of anatomical knowledge was confined to Roger, Roland, Jamerio, Bruno, and Lanfranc; and this they borrowed chiefly from Galen. 1222-24. 1241-71.

Mondino. In this state matters appear to have proceeded with the medical school of Bologna till the commencement of the fourteenth century, when the circumstance of possessing a teacher of originality enabled this university to be the agent of as great an improvement in medical science as she had already effected in jurisprudence. This era, indeed, is distinguished for the appearance of Mondino, under whose zealous cultivation the science first began to rise from the ashes in which it had been buried. This father of modern anatomy, who taught in Bologna about the year 1315, quickly drew the curiosity of the medical profession by well-ordered demonstrations of the different parts of the human body. In 1315 he dissected and demonstrated the parts of the human body in two female subjects; and in the course of the following year he accomplished the same task on the person of a single female. But while he seems to have had sufficient original force of intellect to direct his own route, Riolan accuses him of copying Galen; and it is certain that his descriptions are corrupted by the barbarous leaven of the Arabian schools, and his Latin defaced by the exotic nomenclature of Ibn-Sina and Al-Rasi. He died, according to Tiraboschi, in 1325.

Mondino divides the body into three cavities (*ventres*), the upper containing the animal members, as the head, the lower containing the natural members, and the middle containing the spiritual members. He first describes the anatomy of the lower cavity or the abdomen, then proceeds to the middle or thoracic organs, and concludes with the upper, comprising the head and its contents and appendages. His general manner is to notice shortly the situation and shape or distribution of textures or membranes, and then to mention the disorders to which they are subject. The peritoneum he describes under the name of *siphac*, in imitation of the Arabians, the omentum under that of *zirbus*, and the mesentery or *eucharus* as distinct from

both. In speaking of the intestines he treats first of the rectum, then the colon, the left or sigmoid flexure of which, as well as the transverse arch and its connection with the stomach, he particularly remarks; then the cæcum or *monoculus*, after this the small intestines in general under the heads of ileum and jejunum, and latterly the duodenum, making in all six bowels. The liver and its vessels are minutely, if not accurately, examined; and the *cava*, under the name *chilis*, a corruption from the Greek κοίλη, is treated at length, with the emulgents and kidneys. His anatomy of the heart is wonderfully accurate; and it is a remarkable fact, which seems to be omitted by all subsequent authors, that his description contains the rudiments of the circulation of the blood. "Postea vero versus pulmonem est aliud orificium venæ arterialis, quæ *portat* sanguinem ad pulmonem a corde; quia cum pulmo deserviat cordi secundum modum dictum, ut ei recompenset, cor ei *transmittit* sanguinem per hanc venam, quæ vocatur vena arterialis; est vena, quia portat sanguinem, et arterialis, quia habet duas tunicas; et habet duas tunicas, primo quia vadit ad membrum quod existit in continuo motu, et secundo quia portat sanguinem valde subtilem et cholericum." The merit of these distinctions, however, he afterwards destroys by repeating the old assertion that the left ventricle ought to contain spirit or air, which it generates from the blood. His osteology of the skull is erroneous. In his account of the cerebral membranes, though short, he notices the principal characters of the *dura mater*. He describes shortly the lateral ventricles, with their anterior and posterior *cornua*, and the choroid plexus as a blood-red substance like a long worm. He then speaks of the third or middle ventricle, and one posterior, which seems to correspond with the fourth; and describes the infundibulum under the names of *lacuna* and *emboton*. In the base of the organ he remarks, first, two mammillary caruncles, the optic nerves, which he reckons the first pair; the oculo-muscular, which he accounts the second; the third, which appears to be the sixth of the moderns; the fourth; the fifth, evidently the seventh; a sixth, the *nervus vagus*, and a seventh, which is the ninth of the moderns. Notwithstanding the misrepresentations into which this early anatomist was betrayed, his book is valuable, and has been illustrated by the successive commentaries of Achillini, Berenger, and Dryander.

1480. Matthew de Gradibus, a native of Gradi, a town in Friuli, near Milan, distinguished himself by composing a series of treatises on the anatomy of various parts of the human body. He is the first who represents the ovaries of the female in the correct light in which they were subsequently regarded by Steno.

Objections similar to those already urged in speaking of Mondino apply to another eminent anatomist of those
1495. times. Gabriel de Zerbis, who flourished at Verona towards the conclusion of the 15th century, is celebrated as the author of a system in which he is obviously more anxious to astonish his readers by the wonders of a verbose and complicated style than to instruct by precise and faithful description. In the vanity of his heart he assumed the title of *Medicus Theoricus*; but though, like Mondino, he derived his information from the dissection of the human subject, he is not entitled to the merit either of describing truly or of adding to the knowledge previously acquired. He is superior to Mondino, however, in knowing the olfactory nerves.

Achillini. 1463-1512. Eminent in the history of the science, and more distinguished than any of this age in the history of cerebral anatomy, Alexander Achillini of Bologna, the pupil and commentator of Mondino, appeared at the close of the 15th century. Though a follower of the Arabian school, the assiduity with which he cultivated anatomy has rescued his name from the inglorious obscurity in which the Arabian doctors have in general slumbered. He is known in the history of anatomical discovery as the first who described the two tympanal bones, termed *malleus* and *incus*. In 1503 he showed that the tarsus consists of seven bones; he rediscovered the fornix and the infundibulum; and he was fortunate enough to observe the course of the cerebral cavities into the inferior *cornua*, and to remark peculiarities to which the anatomists of a future age did not advert. He mentions the orifices of the ducts, afterwards described by Wharton. He knew the ileo-cæcal valve; and his description of the duodenum, ileum, and colon shows that he was better acquainted with the site and disposition of these bowels than any of his predecessors or contemporaries.

Not long after, the science boasts of one of its most Berenger.
distinguished founders. James Berenger of Carpi, in the 1518.
Modenese territory, flourished at Bologna at the beginning of the 16th century. In the annals of medicine his name will be remembered not only as the most zealous and eminent in cultivating the anatomy of the human body, but as the first physician who was fortunate enough to calm the alarms of Europe, suffering under the ravages of syphilis, then raging with uncontrollable virulence. In the former character he surpassed both predecessors and contemporaries; and it was long before the anatomists of the following age could boast of equalling him. His assiduity was indefatigable; and he declares that he dissected above one hundred human bodies. He is the author of a compendium, of several treatises which he names Introductions (*Isagogæ*), and of commentaries on the treatise of Mondino, in which he not only rectifies the mistakes of that anatomist, but gives minute and in general accurate anatomical descriptions.

He is the first who undertakes a systematic view of the several textures of which the human body is composed; and in a preliminary commentary he treats successively of the anatomical characters and properties of fat, of membrane in general (*panniculus*), of flesh, of nerve, of *villus* or fibre (*filum*), of ligament, of sinew or tendon, and of muscle in general. He then proceeds to describe with considerable precision the muscles of the abdomen, and illustrates their site and connections by woodcuts, which, though rude, are spirited, and show that anatomical drawing was in that early age beginning to be understood. In his account of the peritoneum he admits only the intestinal division of that membrane, and is at some pains to prove that Gentilis, who justly admits the muscular division also, is in error. In his account of the intestines he is the first who mentions the vermiform process of the cæcum; he remarks the yellow tint communicated to the duodenum by the gall-bladder; and he recognises the opening of the common biliary duct into the duodenum (*quidam porus portans choleram*). In the account of the stomach he describes the several tissues of which that organ is composed, and which, after Almansor, he represents to be three, and a fourth from the peritoneum; and afterwards notices the *rugæ* of its villous surface. He is at considerable pains to explain the organs of generation in both sexes, and gives a long account of the anatomy of the fœtus. He was the first who recognised the larger proportional size of the chest in the male than in the female, and conversely the greater capacity of the female than of the male pelvis. In the larynx he discovered the two arytenoid cartilages. He gives the first good description of the thymus; distinguishes the oblique situation of the heart; describes the pericardium, and maintains the uniform presence of pericardial liquor. He then describes the cavities of the heart; but perplexes himself, as did all the anatomists of that age, about the spirit supposed to be contained. The aorta he properly makes

to arise from the left ventricle; but confuses himself with the *arteria venalis*, the pulmonary vein, and the *vena arterialis*, the pulmonary artery. His account of the brain is better. He gives a minute and clear account of the ventricles, remarks the *corpus striatum*, and has the sagacity to perceive that the choroid plexus consists of veins and arteries; he then describes the middle or third ventricle, the infundibulum or *lacuna* of Mondino, and the pituitary gland; and lastly, the passage to the fourth ventricle, the *conarium* or pineal gland, and the fourth or posterior ventricle itself, the relations of which he had studied accurately. He rectifies the mistake of Mondino as to the olfactory or first pair of nerves, gives a good account of the optic and others, and is entitled to the praise of originality in being the first observer who contradicts the fiction of the wonderful net, and indicates the principal divisions of the carotid arteries. He enumerates the tunics and humours of the eye, and gives an account of the internal ear, in which he notices the *malleus* and *incus*.

Italy long retained the distinction of giving birth to the first eminent anatomists in Europe, and the glory she acquired in the names of Mondino, Achillini, Carpi, and Massa, was destined to become more conspicuous in the labours of Columbus, Fallopius, and Eustachius. While Italy, however, was thus advancing the progress of science, the other nations of Europe were either in profound ignorance or in the most supine indifference to the brilliant career of their zealous neighbours. The sixteenth century had commenced before France began to acquire anatomical distinction in the names of Dubois, Fernel, and Etienne; and even these celebrated teachers were less solicitous in the personal study of the animal body than in the faithful explanation of the anatomical writings of Galen. The infancy of the French school had to contend with other difficulties. The small portion of knowledge which had been hitherto diffused in the country was so inadequate to eradicate the prejudices of ignorance, that it was either difficult or absolutely impossible to procure human bodies for the purposes of science; and we are assured, on the testimony of Vesalius and other competent authorities, that the practical part of anatomical instruction was obtained entirely from the bodies of the lower animals. The works of the Italian anatomists were unknown; and it is a proof of the tardy communication of knowledge that, while the structure of the human body had been taught in Italy for more than a century by Mondino and his followers, these anatomists are never mentioned by Etienne, who flourished long after.

French school.

Dubois. 1478–1555.

Such was the aspect of the times at the appearance of Jacques Dubois, who, under the Romanised name of Jacobus Sylvius, according to the fashion of the day, has been fortunate in acquiring a reputation to which his researches do not entitle him. For the name of Jacques Dubois the history of anatomy, it is said, is indebted to his inordinate love of money. At the instance of his brother Francis, who was professor of eloquence in the college of Tournay at Paris, he devoted himself to the study of the learned languages and mathematics; but discovering that these elegant accomplishments do not invariably reward their cultivators with the goods of fortune, Dubois betook himself to medicine. After the acquisition of a medical degree in the university of Montpellier, at the ripe age of fifty-one Dubois returned to Paris to resume a course of anatomical instruction. Here he taught anatomy to a numerous audience in the college of Trinquet; and on the departure of Vidus Vidius for Italy was appointed to succeed that physician as professor of surgery to the Royal College. His character is easily estimated. With greater coarseness in his manners and language than even the rude state of society in his times can palliate, with much varied learning and considerable eloquence, he was a blind, indiscriminate, and irrational admirer of Galen, and interpreted the anatomical and physiological writings of that author in preference to giving demonstrations from the subject. Without talent for original research or discovery himself, his envy and jealousy made him detest every one who gave proofs of either. We are assured by Vesalius, who was some time his pupil, that his manner of teaching was calculated neither to advance the science nor to rectify the mistakes of his predecessors. A human body was never seen in the theatre of Dubois; the carcases of dogs and other animals were the materials from which he taught; and so difficult even was it to obtain human bones, that unless Vesalius and his fellow-students had collected assiduously from the Innocents and other cemeteries, they must have committed numerous errors in acquiring the first principles. This assertion, however, is contradicted by Riolan, and afterwards by Sprengel and Lauth, the last of whom decidedly censures Vesalius for this ungrateful treatment of his instructor. It is certain that opportunities of inspecting the human body were by no means so frequent as to facilitate the study of the science. Though his mention of injections has led some to suppose him the discoverer of that art, he appears to have made no substantial addition to the information already acquired; and the first acknowledged professor of anatomy to the university of Paris appears in history as one who lived without true honour and died without just celebrity. He must not be confounded with Franciscus Sylvius (De le Boe), who is mentioned by Ruysch and Malacarne as the author of a particular method of demonstrating the brain.

Almost coeval may be placed Charles Etienne, a younger brother of the celebrated printers, and son to Henry, who Hellenised the family name by the classical appellation of Stephen (Στέφανος). It is uncertain whether he taught publicly. But his tranquillity was disturbed, and his pursuits interrupted, by the oppressive persecutions in which their religious opinions involved the family; and Charles Etienne drew the last breath of a miserable life in a dungeon in 1564. Etienne, though sprung of a family whose classical taste has been their principal glory, does not betray the same servile imitation of the Galenian anatomy with which Dubois is charged. He appears to have been the first to detect valves in the orifice of the hepatic veins. He was ignorant, however, of the researches of the Italian anatomists; and his description of the brain is inferior to that given sixty years before by Achillini. His comparison of the cerebral cavities to the human ear has persuaded Portal that he knew the inferior *cornua*, the *hippocampus*, and its prolongations; but this is no reason for giving him that honour to the detriment of the reputation of Achillini, to whom, so far as historical testimony goes, the first knowledge of this fact is due. The researches of Etienne into the structure of the nervous system are, however, neither useless nor inglorious; and the circumstance of demonstrating a canal through the entire length of the spinal chord, which had neither been suspected by contemporaries nor noticed by successors till Senac made it known, is sufficient to place him high in the rank of anatomical discoverers.

Etienne 1503–64

The French anatomy of the sixteenth century was distinguished by two circumstances unfavourable to the advancement of the science,—extravagant admiration of antiquity, with excessive confidence in the writings of Galen, and the general practice of dissecting principally the bodies of the lower animals. Both these errors were much amended, if not entirely removed, by the exertions of a young Fleming, whose appearance forms a conspicuous era in the history of anatomy. Andrew Vesalius,

a native of Brussels, after acquiring at Louvain the ordinary classical attainments of the day, began at the age of fourteen to study anatomy under the auspices of Dubois. Though the originality of his mind soon led him to abandon the prejudices by which he was environed, and take the most direct course for attaining a knowledge of the structure of the human frame, he neither underrated the Galenian anatomy nor was indolent in the dissection of brute animals. The difficulties, however, with which the practical pursuit of human anatomy was beset in France, and the dangers with which he had to contend, made him look to Italy as a suitable field for the cultivation of the science; and in 1536 we find him at Venice, at once pursuing the study of human anatomy with the utmost zeal, and requested, ere he had attained his twenty-second year, to demonstrate publicly in the university of Padua. After remaining here about seven years, Vesalius went by express invitation to Bologna, and shortly afterwards to Pisa; and thus professor in three universities, he appears to have carried on his anatomical investigations and instructions alternately at Padua, Bologna, and Pisa, in the course of the same winter. It is on this account that Vesalius, though a Fleming by birth and trained originally in the French school, belongs, as an anatomist, to the Italian, and may be viewed as the first of an illustrious line of teachers by whom the anatomical reputation of that country was in the course of the sixteenth century raised to the greatest eminence.

Vesalius is known as the first author of a comprehensive and systematic view of human anatomy. The knowledge with which his dissections had furnished him proved how many errors were daily taught and learned under the broad mantle of Galenian authority; and he perceived the necessity of a new system of anatomical instruction, divested of the omissions of ignorance and the misrepresentations of prejudice and fancy. The early age at which he effected this object has been to his biographers the theme of boundless commendation; and we are told that he began at the age of twenty-five to arrange the materials he had collected, and accomplished his task ere he had completed his 28th year.

Soon after this period we find him invited as imperial physician to the court of Charles V., where he was occupied in the duties of practice, and answering the various charges which were unceasingly brought against him by the disciples of Galen. After the abdication of Charles he continued at court in great favour with his son Philip II. To this he seems to have been led principally by the troublesome controversies in which his anatomical writings had involved him. It is painful to think, however, that even imperial patronage bestowed on eminent talents does not insure immunity from popular prejudice; and the fate of Vesalius will be a lasting example of the barbarism of the times, and of the precarious tenure of the safety even of a great physician. On the preliminary circumstances authors are not agreed; but the most general account states that when Vesalius was inspecting, with the consent of his kinsmen, the body of a Spanish grandee, it was observed that the heart still gave some feeble palpitations when divided by the knife. The immediate effects of this outrage to human feelings were the denunciation of the anatomist to the Inquisition; and Vesalius escaped the severe treatment of that tribunal only by the influence of the king, and by promising to perform a pilgrimage to the Holy Land. He forthwith proceeded to Venice, from which he sailed with the Venetian fleet, under James Malatesta, for Cyprus. When he reached Jerusalem, he received from the Venetian senate a message requesting him again to accept the Paduan professorship, which had become vacant by the death of his friend and pupil Fallopius. His destiny, however, which pursued him fast, suffered him not again to breathe the Italian air. After struggling for many days with adverse winds in the Ionian Sea, he was wrecked on the island of Zante, where he quickly breathed 1564
his last in such penury that unless a liberal goldsmith had defrayed the funeral charges, his remains must have been devoured by beasts of prey. At the time of his death he was scarcely fifty years of age.

To form a correct estimate of the character and merits of Vesalius, we must not compare him, in the spirit of modern perfection, with the anatomical authors either of later times or of the present day. Whoever would frame a just idea of this anatomist must imagine, not a bold innovator without academical learning,—not a genius coming from a foreign country, unused to the forms and habits of Catholic Europe,—nor a wild reformer, blaming indiscriminately everything which accorded not with his opinion; but a young student scarcely emancipated from the authority of instructors, and whose intellect was still influenced by the doctrines with which it had been originally imbued,—a scholar strictly trained in the opinions of the time, living amidst men who venerated Galen as the oracle of anatomy and the divinity of medicine,—exercising his reason to estimate the soundness of the instructions then in use, and proceeding, in the way least likely to offend authority and wound prejudice, to rectify errors, and to establish on the solid basis of observation the true elements of anatomical science. Vesalius has been denominated the founder of human anatomy; and though we have seen that in this career he was preceded with honour by Mondino and Berenger, still the small proportion of correct observation which their reverence for Galen and Arabian doctrines allowed them to communicate, will not in a material degree impair the original merits of Vesalius. The errors which he rectified and the additions which he made are so numerous, that it is impossible, in such a sketch as the present, to communicate a just idea of them.

Besides the first good description of the sphenoid bone, he showed that the sternum consists of three portions and the sacrum of five or six; and described accurately the vestibule in the interior of the temporal bone. He not only verified the observation of Etienne on the valves of the hepatic veins, but he described well the *vena azygos*, and discovered the canal which passes in the fœtus between the umbilical vein and the *vena cava*, since named *ductus venosus*. He described the omentum, and its connections with the stomach, the spleen, and the colon; gave the first correct views of the structure of the pylorus; remarked the small size of the cæcal appendix in man; gave the first good account of the mediastinum and pleura, and the fullest description of the anatomy of the brain yet advanced. He appears, however, not to have understood well the inferior recesses; and his account of the nerves is confused by regarding the optic as the first pair, the third as the fifth, and the fifth as the seventh.

The labours of Vesalius were not limited to the immediate effect produced by his own writings. His instructions and example produced a multitude of anatomical inquirers of different characters and varied celebrity, by whom the science was extended and rectified. Of these we cannot speak in detail; but historical justice requires us to notice shortly those to whose exertions the science of anatomy has been most indebted.

The first that claims attention on this account is Bartholomeo Eustachi of San Severino, near Salerno, who though greatly less fortunate in reputation than Vesalius, divides with him the merit of creating the science of human anatomy. He extended the knowledge of the internal ear by rediscovering and describing correctly the

Eustachius 1495 or 1500.

tube which bears his name; and if we admit that Ingrassias anticipated him in the knowledge of the third bone of the tympanal cavity, the *stapes*, he is still the first who described the internal and anterior muscles of the *malleus*, as also the *stapedius*, and the complicated figure of the *cochlea*. He is the first who studied accurately the anatomy of the teeth, and the phenomena of the first and second dentition. The work, however, which demonstrates at once the great merit and the unhappy fate of Eustachius is his *Anatomical Engravings*, which, though completed in 1552, nine years after the impression of the work of Vesalius, the author was unable to publish. First communicated to the world in 1714 by Lancisi, afterwards in 1744 by Cajetan Petrioli, again in 1744 by Albinus, and more recently at Bonn in 1790, the engravings show that Eustachius had dissected with the greatest care and diligence, and taken the utmost pains to give just views of the shape, size, and relative position of the organs of the human body.

The first seven plates illustrate the history of the kidneys, and some of the facts relating to the structure of the ear. The eighth represents the heart, the ramifications of the *vena azygos*, and the valve of the *vena cava*, named from the author. In the seven subsequent plates is given a succession of different views of the viscera of the chest and abdomen. The seventeenth contains the brain and spinal chord; and the eighteenth more accurate views of the origin, course, and distribution of the nerves than had been given before. Fourteen plates are devoted to the muscles.

Eustachius did not confine his researches to the study of relative anatomy. He investigated the intimate structure of organs with assiduity and success. What was too minute for unassisted vision he inspected by means of glasses. Structure which could not be understood in the recent state, he unfolded by maceration in different fluids, or rendered more distinct by injection and exsiccation. The facts unfolded in these figures are so important that it is justly remarked by Lauth, that if the author himself had been fortunate enough to publish them, anatomy would have attained the perfection of the 18th century two centuries earlier at least. Their seclusion for that period in the papal library has given celebrity to many names which would have been known only in the verification of the discoveries of Eustachius.

Columbus. 1523. Eustachius was the contemporary of Vesalius. Columbus and Fallopius were his pupils. Columbus, as his immediate successor in Padua, and afterwards as professor at Rome, distinguished himself by rectifying and improving the anatomy of the bones; by giving correct accounts of the shape and cavities of the heart, of the pulmonary artery and aorta and their valves, and tracing the course of the blood from the right to the left side of the heart; by a good description of the brain and its vessels, and by correct understanding of the internal ear, and the first good account of the ventricles of the larynx.

Fallopius. Fallopius, who, after being professor at Pisa in 1548, and at Padua in 1551, died at the age of forty, studied the general anatomy of the bones; described better than heretofore the internal ear, especially the tympanum and its osseous ring, the two *fenestræ* and their communication with the vestibule and cochlea; and gave the first good account of the stylo-mastoid hole and canal, of the ethmoid bone and cells, and of the lacrymal passages. In myology he rectified several mistakes of Vesalius. He also devoted attention to the organs of generation in both sexes, and discovered the utero-peritoneal canal which still bears his name.

1545–80. Osteology nearly at the same time found an assiduous cultivator in John Philip Ingrassias, a learned Sicilian physician, who, in a skilful commentary on the osteology of Galen, corrected numerous mistakes. He gave the first distinct account of the true configuration of the sphenoid and ethmoid bones, and has the merit of first describing 1546. the third bone of the tympanum, called *stapes*, though this is also claimed by Eustachius and Fallopius.

The anatomical descriptions of Vesalius underwent the Aranzi. scrutiny of various inquirers. Those most distinguished 1530–89. by the importance and accuracy of their researches, as well as the temperate tone of their observations, were Julius Cæsar Aranzi, anatomical professor for thirty-two years in the university of Bologna, and Constantio Varoli, physician to Pope Gregory XIII. To the former we are indebted for the first correct account of the anatomical peculiarities of the fœtus, and he was the first to show that the muscles of the eye do not, as was falsely imagined, arise from the *dura mater*, but from the margin of the optic hole. He also, after considering the anatomical relations of the cavities of the heart, the valves, and the great vessels, corroborates the views of Columbus regarding the course which the blood follows in passing from the right to the left side of the heart. Aranzi is the first anatomist who describes distinctly the inferior cornua of the ventricles of the cerebrum, who recognises the objects by which they are distinguished, and who gives them the name by which they are still known (*hippocampus*); and his account is more minute and perspicuous than that of the authors of the subsequent century. He speaks at large of the choroid plexus, and gives a particular description of the fourth ventricle, under the name of *cistern of the cerebellum*, as a discovery of his own.

Italy, though rich in anatomical talent, has probably few Varolius greater names than that of Constantio Varoli of Bologna. 1545. Though he died at the early age of thirty-two, he acquired a reputation not inferior to that of the most eminent of his contemporaries. He is now known chiefly as the author of an epistle, inscribed to Hieronymo Mercuriali, on the optic nerves, in which he describes a new method of dissecting the brain, and communicates many interesting particulars relating to the anatomy of the organ. He observes the threefold division of the inferior surface or base, defines the limits of the anterior, middle, and posterior eminences, as marked by the compartments of the skull, and justly remarks that the cerebral cavities are capacious, communicate with each other, extending first backward and then forward, near the angle of the pyramidal portion of the temporal bone, and that they are folded on themselves, and finally lost above the middle and inferior eminence of the brain. He appears to have been aware that at this point they communicate with the exterior or convoluted surface. He recognised the impropriety of the term *corpus callosum*, seems to have known the communication called afterwards *foramen Monroianum*, and describes the *hippocampus* more minutely than had been previously done.

Among the anatomists of the Italian school, as a pupil 1534. of Fallopius, Eustachius, and Aldrovandus, is generally enumerated Volcher Coiter of Groningen. He distinguished himself by accurate researches on the cartilages, the bones, and the nerves, recognised the value of morbid anatomy, and made experiments on living animals to ascertain the action of the heart and the influence of the brain.

The *Frutefull and Necessary Briefe Worke* of John Halle (1565), and *The Englisheman's Treasure*, by Master Thomas Vicary (1586), English works published at this time, are tolerable compilations from former authors, much tinged by Galenian and Arabian distinctions. A more valuable compendium than either is, however, that of John Banister (1578), entitled *The Historie of Man, from the most approved Anathomistes in this Present Age.*

The celebrity of the anatomical school of Italy was Fabricius. worthily maintained by Hieronymo Fabricio of Acquapendente, who, in imitation of his master Fallopius, laboured

to render anatomical knowledge more precise by repeated dissections, and to illustrate the obscure by researches on the structure of animals in general. In this manner he investigated the formation of the fœtus, the structure of the œsophagus, stomach, and bowels, and the peculiarities of the eye, the ear, and the larynx. The discovery, however, on which his surest claims to eminence rest is that of the membranous folds, which he names *valves*, in the interior of veins. Several of these folds had been observed by Fernel, Sylvius, and Vesalius; and in 1547 Cannani observed those of the *vena azygos;* but no one appears to have offered any rational conjecture on their use, or to have traced them through the venous system at large, until Fabricius in 1574, upon this hypothesis, demonstrated the presence of these valvular folds in all the veins of the extremities.

Fabricius, though succeeded by his pupil Julius Casserius of Placenza, may be regarded as the last of that illustrious line of anatomical teachers by whom the science was so successfully studied and taught in the universities of Italy. The discoveries which each made, and the errors which their successive labours rectified, tended gradually to give anatomy the character of a useful as well as an accurate science, and to pave the way for a discovery which, though not anatomical but physiological, is so intimately connected with correct knowledge of the shape and situation of parts, that it exercised the most powerful influence on the future progress of anatomical inquiry. This was the knowledge of the circular motion of the blood,—a fact which, though obscurely conjectured by Aristotle, Nemesius, Mondino, and Berenger, and partially taught by Servetus, Columbus, Cæsalpinus, and Fabricius, it was nevertheless reserved to William Harvey fully and satisfactorily to demonstrate.

Mondino believed that the blood proceeds from the heart to the lungs through the *vena arterialis* or pulmonary artery, and that the aorta conveys the spirit into the blood through all parts of the body. This doctrine was adopted with little modification by Berenger, who further demonstrated the existence and operation of the tricuspid valves in the right ventricle, and of the sigmoid valves at the beginning of the pulmonary artery and aorta, and that there were only two ventricles separated by a solid impervious septum. These were afterwards described in greater detail by Vesalius, who nevertheless appears not to have been aware of the important use which might be made of this knowledge. It was the
Servetus. Spaniard Michael Servet or Servetus (born in 1509; burnt in 1553), who in his treatise *De Trinitatis Erroribus*, published at Haguenau in 1531, first maintained the imperviousness of the septum, and the transition of the blood by what he terms an unknown route, namely, from the right ventricle by the *vena arteriosa* (pulmonary artery) to the lungs, and thence into the *arteria venosa* or pulmonary vein and left auricle and ventricle, from which, he adds afterwards, it is conveyed by the aorta to all parts of the body.[1]

Though the leading outlines, not only of the pulmonary or small but even of the great circulation, were sketched thus early by one who, though a philosopher, was attached to the church, it was only in his work *De Re Anatomica*, published at Venice in 1559, that Columbus formally and distinctly announced the circular course of the blood as a discovery of his own; and maintained, in addition to the imperviousness of the septum, the fact that the *arteria venalis* (pulmonary vein) contains, not air, but blood mixed with air brought from the lungs to the left ventricle of the heart, to be distributed through the body at large.

Soon after, views still more complete of the small or 1570-93.
pulmonary circulation were given by Andrew Cæsalpinus of Arezzo, who not only maintained the analogy between the structure of the arterious vein or pulmonary artery and the aorta, and that between the venous artery or pulmonary veins and veins in general, but was the first to remark the swelling of veins below ligatures, and to infer from it a refluent motion of blood in these vessels. The discoveries of Aranzi and Eustachius in the vessels of the fœtus tended at first to perplex and afterwards to elucidate some of these notions. At length it happened that, between Harvey.
the years 1598 and 1600, a young Englishman, William Harvey, pursuing his anatomical studies at Padua under Fabricius of Acquapendente, learnt from that anatomist the existence of the valves in the veins of the extremities, and undertook to ascertain the use of these valves by experimental inquiry. It is uncertain whether he learnt from the writings of Cæsalpinus the fact observed by that author, of the tumescence of a vein below the ligature, but he could not fail to be aware, and indeed he shows that he was aware, of the small circulation as taught by Servetus and Columbus. Combining these facts already known, he, by a series of well-executed experiments, demonstrated clearly the existence, not only of the small, but of a general circulation from the left side of the heart by the aorta and its subdivisions, to the right side by the veins. This memorable truth was first announced in the year 1619.

It belongs not to this place either to consider the arguments and facts by which Harvey defended his theory, or to notice the numerous assaults to which he was exposed, and the controversies in which his opponents wished to involve him. It is sufficient to say, that after the temporary ebullitions of spleen and envy had subsided, the doctrine of the circular motion of the blood was admitted by all enlightened and unprejudiced persons, and finally was universally adopted as affording the most satisfactory explanation of many facts in anatomical structure which were either misunderstood or entirely overlooked. The inquiries to which the investigation of the doctrine gave rise produced numerous researches on the shape and structure of the heart and its divisions, of the lungs, and of the blood-vessels and their distribution. Of this description were the researches of Nicolas Steno on the structure of the heart, the classical work of Richard Lower, the dissertation of Pechlin, the treatise of Vieussens, the

[1] The passage of Servetus is so interesting that our readers may feel some curiosity in perusing it in the language of the author; and it is not unimportant to remark that Servetus appears to have been led to think of the course of the blood by the desire of explaining the manner in which the animal spirits were supposed to be generated:—"Vitalis spiritus in sinistro cordis ventriculo suam originem habet, juvantibus maxime pulmonibus ad ipsius perfectionem. Est spiritus tenuis, caloris vi elaboratus, flavo colore, ignea potentia, ut sit quasi ex puriore sanguine lucens, vapor substantiam continens aquæ, aeris, et ignis. Generatur ex facta in pulmone commixtione inspirati aeris cum elaborato subtili sanguine, quem dexter ventriculus sinistro communicat. Fit autem communicatio hæc, non per parietem cordis medium, ut vulgo creditur, sed magno artificio a dextro cordis ventriculo, longo per pulmones ductu agitatur sanguis subtilis; a pulmonibus præparatur, flavus efficitur, et a vena arteriosa in arteriam venosam transfunditur. Deinde in ipsa arteria venosa, inspirato aeri miscetur, et exspiratione a fuligine expurgatur; atque ita tandem a sinistro cordis ventriculo totum mixtum per diastolen attrahitur, apta supellex, ut fiat spiritus vitalis. Quod ita per pulmones fiat communicatio et præparatio, docet conjunctio varia, et communicatio venæ arteriosæ cum arteria venosa in pulmonibus. Confirmat hoc magnitudo insignis venæ arteriosæ, quæ nec talis nec tanta esset facta, nec tantam a corde ipso vim purissimi sanguinis in pulmones emitteret, ob solum eorum nutrimentum; nec cor pulmonibus hac ratione serviret, cum præsertim antea in embryone solerent pulmones ipsi aliunde nutriri, ob mem branulas illas seu valvulas cordis, usque ad horum nativitatem; ut docet Galenus, &c. Itaque ille spiritus a sinistro cordis ventriculo arterias totius corporis deinde transfunditur, ita ut qui tenuior est, superiora petit, ubi magis elaboratur, præcipue in plexu retiformi, sub basi cerebri sito, ubi ex vitali fieri incipit animalis, ad propriam rationalis animæ rationem accedens."—*De Trinitate*, lib. v.

work of Malpighi on the structure of the lungs, several sketches in the writings of Mayow, and other treatises of less moment. Systematic treatises of anatomy began to assume a more instructive form, and to breathe a more philosophical spirit. The great work of Adrian Spigelius, which appeared in 1627, two years after the death of the author, contains indeed no proof that he was aware of the valuable generalisation of Harvey; but in the institutions of Caspar Bartholin, as republished and improved by his son Thomas in 1651, the anatomical descriptions and explanations are given with reference to the new doctrine. A still more unequivocal proof of the progress of correct anatomical knowledge was given in the lectures delivered by Peter Dionis, at the Jardin Royal of Paris, in 1673 and the seven following years, in which that intelligent surgeon gave most accurate demonstrations of all the parts composing the human frame, and especially of the heart, its auricles, ventricles, and valves, and the large vessels connected with it and the lungs. These demonstrations, first published in 1690, were so much esteemed that they passed through seven editions in the space of thirty years, and were translated into English.

The progress of anatomical discovery continued in the meantime to advance. In the course of the 16th century Eustachius, in studying minutely the structure of the vena azygos had recognised in the horse a white vessel full of watery fluid, connected with the internal jugular vein, on the left side of the vertebral column, corresponding accurately with the vessel since named *thoracic duct*. Fallopius also described vessels belonging to the liver distinct from arteries and veins; and similar vessels appear to have been noticed by Nicolaus Massa. The nature and properties of these vessels were, however, entirely unknown. On the
Asellius. 23d July 1622 Gaspar Asellius, professor of anatomy at Pavia, while engaged in demonstrating the recurrent nerves in a living dog, first observed numerous white delicate filaments crossing the mesentery in all directions; and though he took them at first for nerves, the opaque white fluid which they shed quickly convinced him that they were a new order of vessels. The repetition of the experiment the following day showed that these vessels were best seen in animals recently fed; and as he traced them from the villous membrane of the intestines, and observed the valves with which they were liberally supplied, he inferred that they were genuine chyliferous vessels. By confounding them with the lymphatics, he made them proceed to the pancreas and liver,—a mistake which appears to have been first rectified by Francis De le Boe. The discovery of Asellius was announced in 1627; and the following year, by means of the zealous efforts of Nicolas Peiresc, a liberal senator of Aix, the vessels were seen in the person of a felon who had eaten copiously before execution, and whose body was inspected an hour and a half after. In 1629 they were publicly demonstrated at Copenhagen by Simon Pauli, and the same year the thoracic duct was observed by Mentel for the first time since it was described by Eustachius. Five years after (1634), John Wesling, professor of anatomy and surgery at Venice, gave the first delineation of the lacteals from the human subject, and evinced more accurate knowledge than his predecessors of the thoracic duct and the lymphatics. Highmore in 1637 demonstrated unequivocally the difference between the lacteals and the mesenteric veins; and though some perplexity was occasioned by the discovery of the pancreatic duct by Wirsung, this mistake was corrected by Thomas Bartholin; and the discovery by Pecquet in 1647 of the common trunk of the lacteals and lymphatics, and of the course which the chyle follows to reach the blood, may be regarded as the last of the series of isolated facts by the generalisation of which the extent, distribution, and uses of the most important organs of the animal body were at length developed.

To complete the history of this part of anatomical science one step yet remained,—the distinction between the lacteals and lymphatics, and the discovery of the termination of the latter order of vessels. The honour of this discovery is divided between Jolyffe, an English anatomist, and Olaus Rudbeck, a young Swede. The former, according to the testimony of Glisson and Wharton, was aware of the distinct existence of the lymphatics in 1650, and demonstrated them as such in 1652. It is nevertheless doubtful whether he knew them much before the latter period; and it is certain that Rudbeck observed the lymphatics of the large intestines, and traced them to glands, on the 27th January 1651, after he had, in the course of 1650, made various erroneous conjectures regarding them, and, like others, attempted to trace them to the liver. The following year he demonstrated them in presence of Queen Christina, and traced them to the thoracic duct, and the latter to the subclavian vein. Their course and distribution were still more fully investigated by Thomas Bartholin, Wharton, Swammerdam, and Blaes, the last two of whom recognised the existence of valves; while Antony Nuck of Leyden, by rectifying various errors of his predecessors, and adding several new and valuable observations, rendered this part of anatomy much more precise than formerly.

After this period anatomists began to study more minutely the organs and textures. Francis Glisson distin- 1654.
guished himself by a minute description of the liver, and a clearer account of the stomach and intestines, than had yet been given. Thomas Wharton investigated the structure 1656.
of the glands with particular care; and though rather prone to indulge in fanciful generalisation, he developed some interesting views of these organs; while Charleton, who appears to have been a person of great genius, though addicted to hypothesis, made some good remarks on the communication of the arteries with the veins, the fœtal circulation, and the course of the lymphatics. But the circumstance which chiefly distinguished the history of anatomy at the beginning of the seventeenth century was the appearance of Thomas Willis, who rendered himself Willis.
eminent not only by good researches on the brain and nerves, but by many judicious observations on the structure of the lungs, the intestines, the blood-vessels, and the glands. His anatomy of the brain and nerves is so minute and elaborate, and abounds so much in new information, that the reader is struck by the immense chasm between the vague and meagre notices of his predecessors, and the ample and correct descriptions of Willis. This excellent work, however, is not the result of his own personal and unaided exertions; and the character of Willis derives additional lustre from the candid avowal of his obligations to Wren and Millington, and, above all, to the diligent researches of his fellow-anatomist Richard Lower.

Willis was the first who numbered the cranial nerves in the order in which they are now usually enumerated by anatomists. His observation of the connection of the eighth pair with the slender nerve which issues from the beginning of the spinal chord is known to all. He remarked the parallel lines of the mesolobe, afterwards minutely described by Vicq d'Azyr. He seems to have recognised the communication of the convoluted surface of the brain and that between the lateral cavities beneath the fornix. He described the *corpora striata* and *optic thalami;* the four orbicular eminences, with the bridge, which he first named *annular protuberance;* and the white mammillary eminences, behind the infundibulum. In the cerebellum he remarks the arborescent arrangement of the white and grey matter, and gives a good account of the

internal carotids, and the communications which they make with the branches of the basilar artery.

About the middle of the 17th century Rt. Hooke and Nehemiah Grew employed the simple microscope in the minute examination of plants and animals; and the Dutch philosopher Leeuwenhoeck with great acuteness examined microscopically the solids and fluids of the body, recognised the presence of scales in the cuticle, and discovered the corpuscles in the blood and milk, and the spermatozoa in
Malpighi. the seminal fluid. The researches of Malpighi also tended greatly to improve the knowledge of minute structure. He gave the first distinct ideas on the organisation of the lung, and the mode in which the bronchial tubes and vessels terminate in that organ. By the microscope he traced the transition of the arteries into the veins, and saw the movements of the blood corpuscles in the capillaries. He endeavoured to unfold, by dissection and microscopic observation, the minute structure of the brain. He studied the structure of bone, he traced the formation and explained the structure of the teeth; and his name is to this day associated with the discovery of the deeper layer of the cuticle and the Malpighian bodies in the spleen and kidney. In these difficult inquiries the observations of Malpighi are in general faithful, and he may be regarded as the founder of histological anatomy.

1660. Nicolas Steno described with accuracy the lacrymal gland and passages, and rediscovered the parotid duct. Bellini studied the structure of the kidneys, and described the tongue and tonsils with some care; and Drelincourt laboured to investigate the changes effected on the uterus by impregnation, and to elucidate the formation of the fœtus. The science might have derived still greater advantages from the genius of Regnier de Graaf, who investigated with accuracy the structure of the pancreas and of the organs of generation in both sexes, had he not been cut off at the early age of thirty-two. Lastly, Wepfer, though more devoted to morbid anatomy, made, nevertheless, some just observations on the anatomical disposition of the cerebral vessels, the glandular structure of the liver, and the termination of the common duct in the duodenum.

Ruysch. The appearance of Frederic Ruysch, who was born in 1638, and became professor of anatomy at Amsterdam in 1665, gave a new impulse to anatomical research, and tended not only to give the science greater precision, but to extend its limits in every direction. The talents of Ruysch are said to have been developed by accident. To repel the audacious and calumnious aspersions with which De Bils attacked De le Boe and Van Horne, Ruysch published his tract on the valves of the lymphatics, which completely established his character as an anatomist of originality and research. This, however, is the smallest of his services to the science. The art of injecting, which had been originally attempted by Eustachi and Varoli, and was afterwards rudely practised by Glisson, Bellini, and Willis, was at length carried to greater perfection by De Graaf and Swammerdam, the former of whom injected the spermatic vessels with mercury and variously-coloured liquors; while the latter, by employing melted wax with other ingredients, made the first approach to the refinements of modern anatomy. By improving this idea of using substances which, though solid, may be rendered fluid at the period of injecting, Ruysch carried this art to the highest perfection.

By the application of this happy contrivance he was enabled to demonstrate the arrangement of minute vessels in the interior of organs which had escaped the scrutiny of previous anatomists. Scarcely a part of the human body eluded the penetration of his syringe; and his discoveries were proportionally great. His account of the valves of the lymphatics, of the vessels of the lungs, and their minute structure; his researches on the vascular structure of the skin, of the bones, and their epiphyses, and their mode of growth and union; his observations on the spleen, the glans penis, the clitoris, and the womb impregnated and unimpregnated, were but a limited part of his anatomical labours. He studied the minute structure of the brain; he demonstrated the organisation of the choroid plexus; he described the state of the hair when affected with Polish plait; he proved the vascular structure of the teeth; he injected the dura mater, the pleura, the pericardium, and peritoneum; he unfolded the minute structure of the conglomerate glands; he investigated that of the synovial apparatus placed in the interior of the joints; and he discovered several curious particulars relating to the lacteals, the lymphatics, and the lymphatic glands.

Meanwhile, Meibomius rediscovered the palpebral glands, 1670.
which were known to Casserius; Swammerdam studied the action of the lungs, described the structure of the human uterus, and made numerous valuable observations on the cœca and pancreatoid organs of fishes; and Kerckringius laid the foundation of a knowledge of the process of ossification. John Conrad Brunner, in the course of 1687.
experiments on the pancreas, discovered the glands of the duodenum named after him, and Conrad Peyer described 1677-81.
the solitary and agminated glands of the intestinal canal. Leonard Tassin, distinguished for original observation, 1678.
rendered the anatomical history of the brain more accurate than heretofore, and gave particular accounts of the intestinal tube, the pancreatic duct, and the hepatic ligaments.

That France might not be without participation in the glory of advancing the progress of anatomical knowledge, the names of Duverney and Vieussens are commemorated with distinction. Duverney, born in 1648, and first intro- Duverney.
duced into public life in 1676 in the Royal Academy of Sciences, decorated with the honorary title of professor of anatomy to the Dauphin, and appointed in 1679 professor at the Jardin Royal, distinguished himself by the first accurate account of the organ of hearing, and by his dissections of several animals at the academy, supplied valuable materials for the anatomical details of the natural history of animals published by that learned body. He appears to have been the first who demonstrated the fact that the cerebral sinuses open into the jugular veins, and to have been aware that the former receive the veins of the brain, and are the venous receptacles of the organ. He understood the cerebral cavities and their mode of communication; distinguishes the posterior pillars of the vault from the pedes hippocampi; recognises the two plates of the septum lucidum; and, what is still more remarkable, he first indicates distinctly the decussation of the anterior pyramids of the medulla oblongata—a fact afterwards verified by the researches of Mistichelli, Petit, and Santorini. He studied the ganglions attentively, and gives the first distinct account of the formation, connections, and distribution of the intercostal nerve. It is interesting to remark that his statement that the veins or sinuses of the spinal chord terminate in the vena azygos was verified by the more recent researches of Dupuytren and Breschet, which show that the vertebral veins communicate by means of the intercostal and superior lumbar veins with the azygos and demi-azygos. His account of the structure of bones, and of the progress of ossification, is valuable. He recognised the vascular structure of the spleen, and described the excretory ducts of the prostate gland, the verumontanum, and the anteprostates.

One of the circumstances which at this time tended considerably to the improvement of anatomical science was the attention with which Comparative Anatomy was beginning to be cultivated. In ancient times, and at the revival of letters the dissection of the lower animals

was substituted for that of the human body; and the descriptions of the organs of the latter were too often derived from the former. The obloquy and contempt in which this abuse involved the study of animal anatomy caused it to be neglected, or pursued with indifference, for more than two centuries, during which anatomists confined their descriptions, at least very much, to the parts of the human body. At this period, however, the prejudice against Comparative Anatomy began to subside; and animal dissection, though not substituted for that of the human body, was employed, as it ought always to have been, to illustrate obscurities, to determine doubts, and to explain difficulties, and, in short, to enlarge and rectify the knowledge of the structure of animal bodies generally.

For this revolution in its favour, Comparative Anatomy was in a great measure indebted to the learned societies which were established about this time in the different countries of Europe. Among these, the Royal Society of London, embodied by charter by Charles II. in 1663, and the Academy of Sciences of Paris, founded in 1665 by Colbert, are undoubtedly entitled to the first rank. Though later in establishment, the latter institution was distinguished by making the first great efforts in favour of Comparative Anatomy; and Perrault, Pecquet, Duverney, and Mery, by the dissections of rare animals obtained from the royal menagerie, speedily supplied valuable materials for the anatomical naturalist. In England, Nehemiah Grew, Edward Tyson, and Samuel Collins cultivated the same department with diligence and success. Grew has left an interesting account of the anatomical peculiarities of the intestinal canal in various animals; Tyson in the dissection of a porpoise, an opossum, and an ourang outang, adduces some valuable illustrations of the comparative differences between the structure of the human body and
Collins. 1685. that of the lower animals; Collins has the merit of conceiving, and executing on an enlarged plan, a comprehensive system, embodying all the information then extant. With the aid of Tyson and his own researches, which were both extensive and accurate, he composed a system of anatomical knowledge in which he not only gives ample and accurate descriptions of the structure of the human body, and the various morbid changes to which the organs are liable, but illustrates the whole by accurate and interesting sketches of the peculiarities of the lower animals. The matter of this work is so excellent that it can only be ascribed to ignorance that it has received so little attention. Though regarded as a compilation, and though indeed much of the human anatomy is derived from Vesalius, it has the advantage of the works published on the Continent at that time, that it embodies most of the valuable facts derived from Malpighi, Willis, and Vieussens. The Comparative Anatomy is almost all original, the result of personal research and dissection; and the pathological observations, though occasionally tinged with the spirit of the times, show the author to have been endowed with the powers of observation and judicious reflection in no ordinary degree.

About this time also we recognise the first attempts to study the minute constitution of the tissues, by the combination of the microscope and the effects of chemical agents. Bone furnished the first instance in which this method was put in use; and though Gagliardi, who undertook the inquiry, had fallen into some mistakes which it required the observation of Malpighi to rectify, this did not deter Clopton Havers and Nesbitt, in England, and Courtial, Du Hamel, and Delasone, and afterwards Herissant, in France, from resuming the same train of investigation. The mistakes into which these anatomists fell belong to the imperfect method of inquiry. The facts which they ascertained have been verified by recent experiment, and constitute no unessential part of our knowledge of the structure of bone.

Ten years after the publication of the work of Collins, 1695.
Henry Ridley, another English anatomist, distinguished himself by a monograph on the brain, which, though not free from errors, contains, nevertheless, some valuable observations. Ridley is the first who distinguishes by name the restiform processes, or the posterior pyramidal eminences. He recognised the figure of the four eminences in the human subject; he remarked the mammillary bodies; and he discovered the sinus which passes under his name.

Raymond Vieussens, by the publication of his great work Vieussens.
on neurography in 1684, threw new light on the configuration and structure of the brain, the spinal chord, and the nerves; and gave a description of the arrangement and distribution of the latter more precise than heretofore. Of the formation and connections of the sympathetic nerve especially he gave views which have been generally adopted by subsequent anatomists. His new arrangement of the vessels, published in 1705, contains several curious opinions. His observations on the structure of the heart, published in 1706, and enlarged in 1715, exhibit the first correct views of the intimate structure of an organ which afterwards was most fully developed by the labours of Lancisi and Senac.

To the same period belong the rival publications of 1685-97.
Godfrey Bidloo and William Cowper, the latter of whom, however, stained a reputation otherwise good by publishing as his own the engravings of the former. Cowper further distinguished himself by a minute account of the urethral glands, already known to Columbus and Mery; a good description of the intestinal glands, discovered by Brunner and Peyer; and by demonstrating the communication of the arteries and veins of the mesentery.

The anatomical genius of Italy, which had slumbered since the death of Malpighi, was destined once more to revive in Lancisi, Valsalva, and his illustrious pupils Santorini and Morgagni. Valsalva especially distinguished himself by his description of the structure of the ear, which, in possessing still greater precision and minuteness than that of Duverney, is valuable in setting the example of rendering anatomy altogether a science of description. Santorini, who was professor at Venice, was no unworthy Santorini.
friend of Valsalva and Morgagni. His anatomical observations, which relate to the muscles of the face, the brain, and several of the nerves, the ducts of the lacrymal gland, the nose and its cavities, the larynx, the viscera of the chest and belly, and the organs of generation in the two sexes, furnish beautiful models of essays, distinguished for perspicuity, precision, and novelty, above anything which had then appeared. These observations, indeed, which bear the impress of accurate observation and clear conception, may be safely compared with any anatomical writings which have appeared since. Those on the brain are particularly interesting. Morgagni, though chiefly Morgagni.
known as a pathological anatomist, did not neglect the healthy structure. His *Adversaria*, which appeared between 1706 and 1719, and his *Epistles*, published in 1728, contain a series of observations to rectify the mistakes of previous anatomists, and to determine the characters of the healthy structure of many parts of the human body. Many parts he describes anew, and indicates facts not previously observed. All his remarks show how well he knew what true anatomical-description ought to be. In this respect, indeed, the three anatomists now mentioned may be said to have anticipated their contemporaries nearly a century; for, while other authors were satisfied with giving loose and inaccurate or meagre notices of parts, with much fanciful supposition, Valsalva, Santorini, and Morgagni laboured to determine with precision the anatomical characters of the parts which they describe.

Winslow. The same character is due to Winslow, a native of Denmark, but, as pupil and successor of Duverney, as well as a convert to Catholicism, naturalised in France, and finally professor of anatomy at the Royal Gardens. His exposition of the structure of the human body is distinguished for being not only the first treatise of descriptive anatomy, divested of physiological details and hypothetical explanations foreign to the subject, but for being a close description derived from actual objects, without reference to the writings of previous anatomists. About the same time Cheselden in London, the first Monro in Edinburgh, and Albinus in Leyden, contributed by their several treatises to render anatomy still more precise as a descriptive science. The *Osteographia* of the first-mentioned was of much use in directing attention to the study of the skeleton and the morbid changes to which it is liable. This work, however, magnificent as it was, was excelled by that of Albinus, who, in 1747, published
Albinus. engravings descriptive of the bones and muscles, which perhaps will never be surpassed either in accuracy of outline or beauty of execution. The several labours of this author, indeed, constitute an important era in the history of the science. He was the first who classified and exhibited the muscles in a proper arrangement, and applied to them a nomenclature which is still retained by the consent of the best anatomists. He gives a luminous account of the arteries and veins of the intestines, represents with singular fidelity and beauty the bones of the fœtus, inquires into the structure of the skin and the cause of its colour in different races; represents the changes incident to the womb in different periods of pregnancy, and describes the relations of the thoracic duct and the vena azygos with the contiguous parts. Besides these large and magnificent works, illustrated by the most beautiful engravings, six books of Academical Annotations were the fruits of his long and assiduous cultivation of anatomy. These contain valuable remarks on the sound structure and morbid deviations of numerous parts of the human body.

Albinus found a worthy successor in his pupil Albert
Haller. Von Haller, who, with a mind imbued with every department of literature and science, directed his chief attention, nevertheless, to the cultivation of anatomical and physiological knowledge. Having undertaken at an early age (twenty-one) to illustrate, with commentaries, the physiological prelections of his preceptor Boerhaave, he devoted himself assiduously to the perusal of every work which could tend to facilitate his purpose; and as he found numerous erroneous or imperfect statements, and many deficiencies to supply, he undertook an extensive course of dissection of human and animal bodies to obtain the requisite information. During the seventeen years he was professor at Göttingen, he dissected 400 bodies, and inspected their organs with the utmost care. The result of these assiduous labours appeared at intervals in the form of dissertations by himself, or under the name of some one of his pupils, finally published in a collected shape, between 1746 and 1751 (*Disputationes Anatomicæ Selectiores*), and in eight numbers of most accurate and beautiful engravings, representing the most important parts of the human body, *e.g.*, the diaphragm, the uterus, ovaries, and vagina, the arteries of the different regions and organs, with learned and critical explanatory observations. He verified the observations that in the fœtus the testicles lie in the abdomen, and showed that their descent into the scrotum may be complicated with the formation of congenital hernia. Some years after, when he had retired from his academical duties at Göttingen, he published, between 1757 and 1765, the large and elaborate work which, with singular modesty, he styled *Elements of Physiology*. This work, though professedly devoted to physiology, rendered, nevertheless, the most essential services to anatomy. Haller, drawing an accurate line of distinction between the two, gave the most clear, precise, and complete descriptions of the situation, position, figure, component parts, and minute structure of the different organs and their appendages. The results of previous and coeval inquiry, obtained by extensive reading, he sedulously verified by personal observation; and though he never rejected facts stated on credible authorities, he in all cases laboured to ascertain their real value by experiment. The anatomical descriptions are on this account not only the most valuable part of his work, but the most valuable that had then or for a long time after appeared. It is painful, nevertheless, to think that the very form in which this work is composed, with copious and scrupulous reference to authorities, made it be regarded as a compilation only; and that the author was compelled to show, by a list of his personal researches, that the most learned work ever given to the physiologist was also the most abundant in original information.

With the researches of Haller it is proper to notice those of his contemporaries, John Frederick Meckel, J. N. Lieberkühn, and his pupil John Godfrey Zinn. The first, who was professor of anatomy at Berlin, described 1748-51.
the Casserian ganglion, the first pair of nerves and its distribution, and that of the facial nerves generally, and discovered the spheno-palatine ganglion. He made some original and judicious observations on the tissue of the skin and the mucous net; and above all, he recognised the 1753-57.
connection of the lymphatic vessels with the veins,—a doctrine which, after long neglect, was revived by Fohmann and Lippi. He also collected several valuable observations on the morbid states of the heart and brain. Lieberkühn published in 1745 a dissertation on the villi and glands of the small intestines. Zinn, who was professor of medicine at Göttingen, published a classical treatise on the eye, which demonstrated at once the defects 1755.
of previous inquiries, and how much it was possible to elucidate, by accurate research and precise description, the structure of one of the most important organs of the human frame. It was republished after his death by Wrisberg. 1780.
About the same time Weitbrecht gave a copious and minute account of the ligaments, and M. Lieutaud, who had already laboured to rectify many errors in anatomy, described with care the structure and relations of the heart and its cavities, and rendered the anatomy of the bladder very precise, by describing the triangular space and the mammillary eminence at its neck.

The study of the minute anatomy of the tissues, which had originally been commenced by Leeuwenhoeck, Malpighi, and Ruysch, began at this period to attract more general attention. De Bergen had already demonstrated the 1732.
general distribution of cellular membrane, and showed that it not only incloses every part of the animal frame, but forms the basis of every organ,—a doctrine which was adopted, and still more fully expanded, by his friend Haller, in 1757.
opposition to what was asserted by Albinus, who maintains that each part has a proper tissue. William Hunter at the W. Hunter.
same time gave a clear and ingenious statement of the difference between cellular membrane and adipose tissue, in which he maintained the general distribution of the former, and represented it as forming the serous membranes, and regulating their physiological and pathological pro- 1757.
perties,—doctrines which were afterwards confirmed by his brother John Hunter. A few years after, the department of general anatomy first assumed a substantial form in the systematic view of the membranes and their mutual connections traced by Andrew Bonn of Amsterdam. In his A. Bonn.
inaugural dissertation *De Continuationibus Membranarum*,

published at Leyden in 1763, this author, after some preliminary observations on membranes in general and their structure, and an exposition of that of the skin, traces its transition into the mucous membranes and their several divisions. He then explains the distribution of the cellular membrane, the aponeurotic expansions, and the periosteum and perichondrium, by either of which, he shows, every bone of the skeleton is invested and connected. He finally gives a very distinct view of the arrangement of the internal membranes of cavities, those named serous and fibro-serous, and the manner of their distribution over the contained organs. This essay, which is a happy example of generalisation, is remarkable for the interesting general views of the structure of the animal body which it exhibits; and to Bonn belongs the merit of sketching the first outlines of that system which it was reserved for the genius of Bichat to cómplete and embellish. Lastly,
1767. Bordeu, in an elaborate essay on the mucous tissue, or cellular organ, as he terms it, brought forward some interesting views of the constitution, nature, and extent of the cellular membrane.

Though anatomy was hitherto cultivated with much success as illustrating the natural history and morbid states of the human body, yet little had been done for the elucidation of local diseases, and the surgical means by which they may be successfully treated. The idea of applying anatomical knowledge directly to this purpose appears to have originated with Bernardin Genga, a Roman surgeon, who published in 1672, at Rome, a work entitled *Surgical Anatomy, or the Anatomical History of the Bones and Muscles of the Human Body, with the Description of the Blood-vessels.* This work, which reached a second edition in 1687, is highly creditable to the author, who appears to have studied intimately the mutual relations of different
1718-26. parts. It is not improbable that the example of Genga led Palfyn, a surgeon at Ghent, to undertake a similar task about thirty years after. For this, however, he was by no means well qualified; and the work of Palfyn, though bearing the name of *Surgical Anatomy*, is a miserable compilation, meagre in details, inaccurate in description, and altogether unworthy of the honour of being republished, as it afterwards was by Antony Petit.

While these two authors, however, were usefully employed in showing what was wanted for the surgeon, others were occupied in the collection of new and more accurate facts. Albinus, indeed, ever assiduous, had, in his account of the operations of Rau, given some good sketches of the relative anatomy of the bladder and urethra; and Cheselden had already, in his mode of cutting into the urinary bladder, shown the necessity of an exact knowledge of the relations of contiguous parts. The first decided application, however, of this species of anatomical research it was reserved for a Dutch anatomist of the 18th century to make. Peter
Camper. 1760. Camper, professor of anatomy at Amsterdam, published in 1760 and 1762 his anatomico-pathological demonstrations of the parts of the human arm and pelvis, of the diseases incident to them, and the mode of relieving them by operation, and explained with great clearness the situation of the blood-vessels, nerves, and important muscles. His remarks on the lateral operation of lithotomy, which contain all that was then known on the subject, are exceedingly interesting and valuable to the surgeon. It appears, further, that he was the first who examined anatomically the mechanism of ruptures, his delineations of which were published in 1801 by Sömmering. Camper also wrote some important memoirs on Comparative Anatomy, and he was the author of a well-known work on the *Relations of Anatomy to the Fine Arts.*

The attention of anatomists was now directed to the elucidation of the most obscure and least explored parts of the human frame—the lymphatic vessels and the nerves. Although, since the first discovery of the former by Asellius, Rudbeck, and Pecquet, much had been done, especially by Ruysch, Nuck, Meckel, and Haller, many points, notwithstanding, relating to their origin and distribution in particular organs, and in the several classes of animals, were imperfectly ascertained or entirely unknown. William Hunter investigated their arrangement, and pro- W. and J. Hunter. 1746-51.
posed the doctrine that they are absorbents; and John Hunter, who undertook to demonstrate the truth of this hypothesis by experiment, discovered, in 1758, lymphatics in the neck in birds. As the doctrine required the existence of this order of vessels, not only in quadrupeds and birds, but in reptiles and fishes, the inquiry attracted attention among the pupils of Hunter; and William Hewson at Hewson.
length communicated, in December 1768, to the Royal Society of London, an account of the lacteals and lymphatics in birds, fishes, and reptiles, as he had discovered and demonstrated them. The subject was about the same time investigated by the second Monro, who indeed claimed the merit of discovering these vessels in the classes of animals now mentioned. But whatever researches this anatomist may have instituted, Hewson, by communicating his observations to the Royal Society, must be allowed to possess the strongest as well as the clearest claim to discovery. The same author, in 1774, gave the first complete account of the anatomical peculiarities of the lymphatic system in man and other animals, and thereby supplied an important gap in this department. Hewson is the first who distinguishes the lymphatics into two orders—the superficial and the deep—both in the extremities and in the internal organs. He also studied the structure of the intestinal villi, in which he verified the observations of Lieberkühn; and he made many important observations on the corpuscles of the lymph and blood. He finally applied his anatomical discoveries to explain many of the physiological and pathological phenomena of the animal body. Ten years after, John Sheldon, another pupil of Hunter, gave a second history and description of the lymphatics, which, though divested of the charm of novelty, contains many interesting anatomical facts. He also examined the structure of the villi.

Lastly, Cruikshank, in 1786, published a valuable Cruikshank. 1786.
history of the anatomy of the lymphatic system, in which he maintains the accuracy of the Hunterian doctrine, that the lymphatics are the only absorbents; gave a more minute account than heretofore of these vessels, of their coats and valves; and explained the structure of the lymphatic glands. He also injected the villi, and examined them microscopically, verifying most of the observations of Lieberkühn. The origin of the lymphatics he maintains rather by inference than direct demonstration. To these three works, though in other respects very excellent, it is a considerable objection that the anatomical descriptions are much mixed with hypothetical speculation and reasonings on properties, and that the facts are by no means always distinguished from mere matters of opinion. At the same time Haase published an account of the lymphatics of the skin and intestines, and the plexiform nets of the pelvis.

To complete this sketch of the history of the anatomy of the lymphatic system, it may be added that Mascagni, Mascagni
who had been engaged from the year 1777 to 1781 in the same train of investigation, first demonstrated to his pupils several curious facts relating to the anatomy of the lymphatic system. When at Florence in 1782 he made several preparations, at the request of Peter Leopold, Grand Duke of Tuscany; and when the Royal Academy of Sciences at Paris announced the anatomy of this system for their prize essay appointed for March 1784, Mascagni resolved on communicating to the public the results of

his researches—the first part of his commentary, with four engravings. Anxiety, however, to complete his preparations detained him at Florence till the close of 1785; and from these causes his work did not appear till 1787. These delays, however, unfavourable as they were to his claims of priority to Sheldon and Cruikshank, were on the whole advantageous to the perfection of his work, which is not only the most magnificent, but also the most complete that ever was published on the lymphatics. In his account of the vessels and their valves he confirms some of Hewson's observations, and rectifies others. Their origin he proves by inference much in the same manner as Cruikshank; but he anticipates this author in the account of the glands, and he gives the most minute description of the superficial and deep lymphatics, both in the members and in the internal organs.

General accounts of the nerves had been given with various degrees of accuracy by Willis, Vieussens, Winslow, and the first Monro; and the subject had been much rectified and improved by the indefatigable Haller. The first example of minute descriptive neurography was given in 1748 by John Frederick Meckel, whose account of the fifth pair, and of the nerves of the face, will long remain a lasting proof of accuracy and research. The same subject was investigated in 1765 by Hirsch, and in 1777 by Wrisberg. In 1766 Metzger examined the origin, distribution, and termination of the first pair, —a point which was afterwards very minutely treated by Scarpa in his anatomical disquisitions, published in 1780; and the internal nerves of the nostrils were examined in 1791 by Haase. The optic nerve, which had been studied originally by Varoli, and afterwards by Mery, Duverney, Henkel, Moeller, Hein, and Kaldschmid, was examined with extreme accuracy, with the other nerves of the organ of vision, by Zinn, in his elaborate treatise. The phrenic nerves and the œsophageal branches of the eighth pair were studied by Haase; the phrenic, the abdominal, and the pharyngeal nerves, by Wrisberg; those of the heart most minutely by Andersch; and the origins, formation, and distribution of the intercostal nerve, by Iwanoff, Ludwig, and Girardi. The labours of these anatomists, however, were eclipsed by the splendid works of Walter on the nerves of the chest and belly;
1783. and those of Scarpa on the distribution of the 8th pair,
1794. and splanchnic nerves in general. In minuteness of description and in beauty of engraving these works have not yet been equalled, and will never perhaps be surpassed. About the same time, Scarpa, so distinguished in every branch of anatomical research, investigated the minute structure of the ganglions and plexuses. The anatomy of the brain itself was also studied with great attention by
1780. the second Monro, Malacarne, and Vicq d'Azyr.

Lastly, the anatomy of the gravid uterus, which had been originally studied by Albinus, Roederer, and Smellie, was again illustrated most completely by William Hunter,
1774. whose engravings will remain a lasting memorial of scientific zeal and artistic talent.

19th century. The perfection which anatomical science attained in the last ten years of the eighteenth and during the present century is evinced not only in the improved character of the systems published by anatomists, but in the enormous advance which has taken place in the knowledge of the minute structure of the animal tissues, of the development of the tissues and organs, and of the modifications in form and structure exhibited by various groups of animals.

The first who gave a good modern system was Sabatier; but his work was speedily eclipsed by the superior merits of the treatises of Sömmering, Bichat, and Portal. The excellent work by Samuel Thomas Sömmering, originally published in the German language, between the years Sömmering.
1791 and 1796; then in the Latin language, between the years 1794 and 1800; and in a second edition in the German language in 1800 and 1801, maintaining the high character which it first possessed for clear arrangement, accurate description, and general precision, was, between the years 1841 and 1844, republished in eight volumes at Leipsic by Bischoff, Henle, Huschke, Theile, Valentin, Vogel, and Wagner, with suitable additions, and a large amount of new and accurate information. In this edition Rudolph Wagner gives, in the first division of the first volume, the life, correspondence, and literary writings of Sömmering; and in the second volume the anatomy of the bones and ligaments. The third volume contains the anatomy of the muscles and the vascular system by Theile. Valentin devotes one volume, the fourth, to the minute anatomy of the nervous system and its parts, as disclosed by careful examination by the microscope; and it must be allowed that the author has been at great pains to present just views of the true anatomy of the brain, the spinal cord, the nervous branches, and the ganglia. In the fifth volume, Huschke of Jena gives the anatomical history of the viscera and the organs of the senses, a department which had been left in some degree incomplete in the original, but for one division of which the author had left useful materials in his large figures already mentioned. In the sixth volume, an entire and complete system of general anatomy, deduced from personal observation and that of other careful observers, the materials being in general new, and in all instances confirmed and rectified, is given by Prof. Henle. The seventh volume contains the history of the process of development in mammalia and man, by Th. L. W. Bischoff. The eighth volume treats of the pathological anatomy of the human body, by Julius Vogel, but contains only the first division, relating to the generalities of the subject. This, which is probably the most accurate as it is the most elaborate system of anatomical knowledge up to the date of its publication in 1844, was translated into the French language by Jourdan, and published in 1846 under the name of *Encyclopédie Anatomique*. The eighth volume was translated into English in the year 1847.

The *Anatomie Générale* of Bichat is a monument of his Bichat.
philosophical genius which will last as long as the structure and functions of the human body are objects of interest. His *Anatomie Descriptive* is distinguished by clear and natural arrangement, precise and accurate description, and the general ingenuity with which the subject is treated. The physiological observations are in general correct, often novel, and always highly interesting. It is unfortunate, however, that the ingenious author was cut off prematurely during the preparation of the third volume. The later volumes are, however, pervaded with the general spirit by which the others are impressed, and are highly creditable to the learning, the judgment, and the diligence of MM. Roux and Buisson. The system of Portal is a valuable French systematic anatomists.
and correct digest of anatomical and pathological knowledge, which, in exact literary information, is worthy of the author of the *Histoire de l'Anatomie et de la Chirurgie*, and, in accuracy of descriptive details, shows that M. Portal trusts not to the labours of his predecessors only. Boyer published in 1803 a complete treatise on Descriptive Anatomy. Cloquet formed, on the model of the *Anatomie Descriptive* of Bichat, a system in which he avails himself of the literature and precision of Sömmering and the details of Portal. An English translation of this work was prepared by Dr Knox. Cruveilhier published in 1834–35 a good general treatise on Descriptive Anatomy, which was translated into English, and published as a part of *The Library of Medicine*. Cruveilhier's treatise

has passed through several editions. About the same time Blandin published an elementary work on Descriptive Anatomy, and a useful treatise on Topographical Anatomy. But the most elaborate system of human anatomy which has proceeded from the French school is the great treatise of Bourgery, illustrated by numerous large and beautifully-coloured plates of the parts and organs. It consists of two divisions, one on Medical and Physiological Anatomy; the other on Surgical Anatomy.

German systematic anatomists.

J. F. Meckel published between 1815 and 1820 a manual of Descriptive Anatomy which combines the philosophical generalisations of Bichat with the precise description and pathological knowledge of Portal. During the succeeding thirty years excellent systematic treatises in the German language were prepared by Rosenmüller, C. F. P. Krause, Frederick Hildebrand (the 4th edition of which was edited in 1830 by the eminent anatomist E. H. Weber), and Fred. Arnold. In 1846 Joseph Hyrtl published a system of Human Anatomy, and in the following year a manual of Topographical and Surgical Anatomy, both of which, but more especially the latter, have gone through several editions. Luschka, the professor of anatomy in Tübingen, has prepared a valuable treatise on Regional Anatomy, in which attention is particularly directed to the relations of the parts which are of interest to the physician and surgeon. The text-book by Hermann Meyer of Zurich is also worthy of mention as a work in which the mechanical construction and uses of parts are described with great care. Henle's treatise on Human Anatomy, the publication of which was commenced in 1855, though the last volume was not completed until 1873, is, however, the most complete work on the subject which has as yet issued from the German press during the latter half of the present century. It is remarkable not only for the elaborate description of the organs and tissues of the body, and the ample references to the labours of other observers, but for the number and beauty of the wood engravings.

British systematic anatomists.

In Great Britain systematic treatises on Human Anatomy were published in the earlier part of the present century by Andrew Fyfe, John Bell, the third Monro, and John Gordon, all of whom were teachers in the Edinburgh school. In London, Jones Quain prepared an excellent text-book, which, under a succession of editors, who have kept each new edition on a level with the advancing tide of anatomical knowledge, has been much esteemed not only for the clearness of its descriptions, but for the soundness of its information on the various branches of human Systematic Anatomy. The 7th edition, under the editorial superintendence of Professors Sharpey, Allen Thomson, and Cleland, appeared between 1864 and 1867. The passing of the Anatomy Act in 1832, by affording facilities for the pursuit of practical anatomy, gave a great stimulus to its study in this country, and to facilitate the acquisition of a knowledge of the subject many text-books have been published. The most important are Harrison's *Dublin Dissector*, and the well-known *Demonstrations of Anatomy* by Prof. Ellis. The increased importance attached by surgeons to a precise acquaintance with the knowledge of those regions in which operations have most frequently to be performed, has led to the production of valuable special works on their anatomy. The treatise of Allen Burns on the head and neck, those of Sir Astley Cooper and Sir W. Lawrence on hernia, Morton's *Anatomy of the Surgical Regions*, the excellent plates on Surgical Anatomy by Joseph Maclise, and the beautiful drawings by Ford from the dissections of Prof. Ellis, with descriptive letterpress, are highly creditable to British anatomists; whilst the treatise on hernia by Scarpa, and Cloquet's and Hesselbach's works on the same subject, reflect credit on the Italian, French, and German schools.

Special treatises

But special treatises have also been written on other departments of human descriptive anatomy. Innes, Sandifort, and Barclay published works on the muscles generally; and Sir Charles Bell, in his classical treatise on the Anatomy of Expression, described with care the attachments and action of the muscles of the face. Of late years the variations in the usually described arrangements in the muscular system in man have been carefully inquired into, and numerous memoirs have been written, more especially by M'Whinnie, Hallett, W. Gruber, John Wood, W. Turner, and M'Alister. F. O. Ward published a work on Human Osteology which is characterised by the minuteness and accuracy of its description; G. M. Humphry, a treatise in which the physical, physiological, and pathological aspects of the skeleton are dwelt upon; and Luther Holden, a profusely-illustrated work on the same subject, in which the surfaces for muscular attachments are carefully delineated. Sir Charles Bell's engravings of the arteries, Tiedemann's more elaborate plates, and Harrison's admirable description of these vessels, all deserve notice. But the most complete work on the Anatomy of the Arteries which has yet appeared is that by Richard Quain, which consists of eighty-seven large plates, with 543 pages of descriptive letterpress. It will long continue a standard work on the subject.

Numerous treatises on the anatomy of the nervous system have been published. In Germany the brothers Wenzel, Reil, Tiedemann, Gall and Spurzheim, Arnold, and Reichert have prepared works on the descriptive anatomy of the great nerve centres, not only in man but in various animals; and by Tiedemann, Reichert, and Ecker, the development of the brain has been especially studied. In Italy the memoirs of Rolando on the anatomy of the brain, and of Bellingeri on the spinal cord and its nerves, are of importance. From the French school the writings of Serres, of Foville, of Leuret and Gratiolet, have thrown much new light on the structure of the brain. In Great Britain, Sir Charles Bell, in his great work on the nervous system, developed and established the truth of the separate nature of the nerves of sensation and motion. In 1836, and again in 1847, Samuel Solly published an instructive treatise on the anatomy of the brain. Between 1830 and 1834 Joseph Swan published a valuable series of engravings in illustration of the distribution of the nerves, and Robert Lee has especially investigated the arrangement and distribution of the nerves of the heart and uterus. In the *Cyclopædia of Anatomy and Physiology*, under the editorial superintendence of Dr Robert B. Todd, original memoirs, not only on human but comparative anatomy, by eminent writers, have appeared, and have done much to diffuse a knowledge of anatomical science.

Improvements in microscope.

The improvement which has been effected in the construction of the compound microscope during the fifty years subsequent to 1822, has contributed in no small degree to enable anatomists to obtain more correct information on the intimate structure of different organs and tissues of the animal body. For the first twenty years of the nineteenth century, opticians and instrument-makers had at intervals endeavoured to render the compound microscope at once an instrument of greater power and more free from sources of error and optical illusion than it had hitherto been possible to obtain it. Two defects, however, still adhered to the compound microscope. The instrument was not achromatic; and a considerable degree of spherical aberration uncorrected rendered the image indistinct.

Between 1812 and 1815 Professor Amici of Modena had attempted to construct an achromatic object-glass of one single lens, but found that this was impracticable. M. Selligues of Paris, in 1823, after various trials, found that this could be done by making the object-glass consist of four achromatic compound lenses, each of which was composed of two single lenses. This method was carried

into practice and improved by the two MM. Chevalier of Paris. About the same time Dr Goring in London, with the aid of Mr Tulley and Mr Pritchard, constructed compound microscopes upon a similar principle.

By the labours of these practical opticians, and the suggestions of various scientific persons, as Sir John Herschel, Sir Richard Airy, Mr Barlow, one great defect of the compound microscope was obviated. The effects of spherical aberration were in the next place overcome in a very simple manner by the experiments of Mr Joseph Jackson Lister, who had early observed that the combined achromatic object-glasses devised by Selligues were fixed in their cells with the convex side foremost, a most improper position, as it renders the spherical errors very great. This gentleman found, after various trials, that by placing three or more achromatic glasses with their plane surfaces directed foremost, it was possible to correct completely all spherical aberration.

This fact was made known in the beginning of the year 1830; and by its application the compound microscope was brought to a high degree of perfection as an achromatic instrument in 1831 and 1832, and became the means of affording valuable assistance in anatomical inquiries. The use of the microscope in anatomy, which had in the times of Malpighi, Leeuwenhoeck, William Cowper, Baker, Fontana, Hewson, and the second Monro, been much cultivated, but had afterwards, from the imperfection of the instrument and the illusions to which it not unfrequently gave rise, been neglected, now became so general and so necessary, that since the year 1832 minute structural anatomy has been, if not created anew, at least most thoroughly revised. The amount of knowledge has been enormously increased; that which was already possessed has been rendered greatly more accurate and precise.

Microscopic anatomy. It is impossible in this place to name the authors of all the valuable monographs which have appeared during the past forty years, but those who have especially advanced the progress of our knowledge of the minute structure of the tissues and organs may be referred to. Johannes Müller in 1830 published an elaborate commentary on the minute structure of the glands, the first work in which the anatomy of these organs was examined and elucidated in a comprehensive and systematic manner. Ehrenberg explained the structure of numerous infusoria, and disclosed the peculiarities of many other structures, animal, vegetable, and mineral, which had previously eluded the most skilful researches. Francis Kiernan, in 1833, gave the first correct account of the minute anatomy of the liver. Schleiden in 1838, and Schwann in 1839, published most important generalisations on the cellular structure of vegetable and animal organisms. Martin Barry communicated new facts on the structure of the ovum and on the structure of cells generally. John Goodsir laid great emphasis on the office of the nucleus in the nutrition, growth, and reproduction of cells, and on the arrangement of the cells within an organism into departments or territories. Virchow, by his researches into the connective tissues, has still further developed the idea of the cellular structure of the animal organism, and the importance of cells in the performance of physiological and pathological processes. Lionel Beale attributed both to the nucleus and to the substance of the cell immediately surrounding it important functional properties. Max Schultze showed the identity in nature between the sarcode substance of the lower animal organisms and the contents of the cells in the higher animals, and applied to these substances the common term protoplasm, which had previously been introduced by Hugo von Mohl to designate a similar material in the vegetable cell.

The minute structure and development of bone has been carefully investigated by J. Goodsir, W. Sharpey, H. Müller, C. Gegenbaur, and A. Kölliker; that of muscle by Bowman, Kölliker, and Sharpey; of nerve by Schwann, Remak, Stilling, Gerlach, Lockhart Clarke, and Deiters; of cartilage by Schwann and Schultze; of the blood and blood-vessels by Henle, Gulliver, Quekett, Paget, and Wharton Jones; of the mucous membranes by Bowman; of the serous membranes by Henle, Recklinghausen, Ludwig, and Klein; of the teeth by Retzius, A. Nasmyth, J. Goodsir, J. Tomes, R. Owen, Czermak, Huxley, and Waldeyer. The structure of the lungs has been investigated by Addison, Rainey, and Rossignol; of the kidney by Bowman, Henle, and Schweiggerseidel; of the liver by Beale and Hering; of the spleen by Sanders, Gray, Billroth, and W. Müller; of the testicle by A. Cooper, Kölliker, and Henle; of the ovary by Pflüger and Waldeyer; of the thymus by A. Cooper and Simon; of the stomach and intestines by Kölliker, Brinton, and Frey; of the placenta by Eschricht, Reid, Sharpey, Goodsir, Van der Kolk, Virchow, Farre, Priestley, Rolleston, Ercolani, and Turner; of the organs of sense by Henle, Bowman, His, H. Müller, Schultze, Corti, Reissner, and Deiters.

The general results of the labours of these and other investigators have been from time to time incorporated into systematic treatises on microscopic anatomy, of which reference may more especially be made to those prepared by J. Berres, F. Gerber, A. Hill Hassall, A. Kölliker, W. Sharpey, W. Bowman, F. Leydig, Frey, and S. Stricker. Side by side with these inquiries into the structure and development of the tissues, the evolution of the embryo out of the fertilised ovum has been carried on. Purkinje, Von Baer, Coste, Wharton Jones, Valentin, R. Wagner, Rathke, J. Müller, Prevost and Dumas, Martin Barry, Reichert, Bischoff, Kölliker, Vogt, Allen Thomson, Owen, Von Siebold, Dujardin, Milne-Edwards, Claparède, Agassiz, Huxley, Kitchen Parker, and Kowalevsky have all contributed important memoirs on various branches of embryology.

Comparative anatomy. Comparative Anatomy, which during the 18th century was diligently cultivated by Daubenton, Pallas, Haller, Buffon, John Hunter, and the second Monro, has become during the present century a subject of increased interest, from its intimate connection with the sciences of zoology, physiology, and geology. It has consequently been studied with great zeal and assiduity, and multitudes of monographs, as well as numerous systematic treatises on the anatomy both of the vertebrata and invertebrata, have been published.

To name even a tithe of the workers and authors who have added to our knowledge of the facts of comparative anatomy would occupy considerable space. It may suffice to refer to those whose writings have contributed most materially to the advance of the science. In France, Cuvier, Dumeril, the Saint-Hilaires, Blanchard, De Blainville, H. and Alphonse Milne-Edwards, Gervais, and Gratiolet; in Germany, Meckel, Tiedemann, Von Baer, Spix, Martius, Bojanus, Otto, Carus, J. Müller, Leuckart, Gegenbaur, and Haeckel; in Sweden and Denmark, Retzius and Eschricht; in Holland and Belgium, Van der Kolk, Vrolik, and Van Beneden; in America, Agassiz, Wyman, and Burmeister; in Great Britain, E. Home, A. Carlisle, R. Grant, Richard Owen, J. Barclay, R. Knox, J. Goodsir, G. Busk, Rymer Jones, W. B. Carpenter, T. H. Huxley, G. J. Allman, W. H. Flower, St George Mivart, and J. Murie are names identified with one or more branches of the subject.

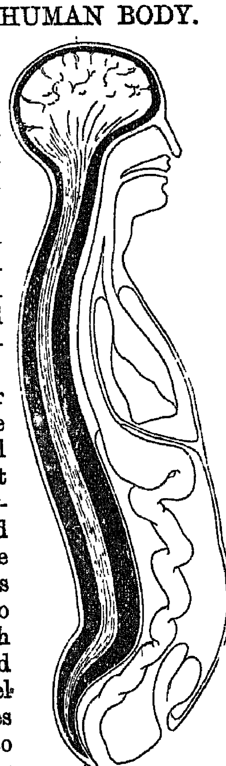
The investigations into the form and structure of animals have led anatomists to search for parts in one animal which correspond with parts in other animals in their mode of development and arrangement, and to evolve from their researches general doctrines of organic forms. The conception entertained by Goethe of the presence of a pre-maxillary element in the human upper

jaw because it exists in other vertebrates, and the announcement of the theory of the vertebrate nature of the skull by Goethe and Oken, directed anatomists into a line of inquiry which has been productive of fruitful results, and has exercised a great influence on the progress and direction of biological science. Geoffroy St Hilaire and C. Martins in France; Spix, Carus, Gegenbaur, and Haeckel in Germany; and Owen, Goodsir, Humphry, Huxley, Parker, and Cleland in Great Britain, have all published important memoirs in this department of anatomical research.

The formation of anatomical museums in connection with universities, and elsewhere, by enabling specimens to be accumulated for observation and comparison, has contributed in no small degree to the progress of anatomical science. Pre-eminent amongst these is the collection originally formed by the genius, energy, and self-devotedness of John Hunter, which, under the fostering care of the council of the Royal College of Surgeons of England, has been materially augmented in all its departments by a succession of curators—Clift, Owen, Quekett, and Flower. The aid which has been afforded to anatomists in the publication of their researches, more especially in providing plates and other expensive means of illustration, by the learned societies of Europe, and the circulation which has been given to their memoirs through the *Transactions* and *Proceedings* of these societies, and through the *Journals* devoted to anatomical and physiological science, have materially contributed to the diffusion of a knowledge of discoveries, and to the general advance of the science.

SPECIAL ANATOMY OF THE HUMAN BODY.

Man, zoologically speaking, belongs to the Mammalian class of the Vertebrate sub-kingdom, *i.e.*, his young are brought forth alive, and nourished during infancy on milk secreted in mammary or milk-forming glands. In common with all vertebrate organisms, he possesses a spine or vertebral column and a skull, in which are contained the brain and the spinal marrow, and on the ventral surface of the spinal column are situated the several subdivisions of the alimentary canal.



V

FIG. 1.—Diagrammatic section through the human head and trunk. The skull and spine, darkly shaded, and containing the cerebro-spinal nervous axis, are dorsal, or at the back. The alimentary and respiratory tubes, seen in outline, are ventral, or at the front. The dotted line V represents the vertical axis of the trunk.

But man possesses certain special or distinctive anatomical characters. The most noticeable, as seen on an external inspection of his body, is his erect position. He is, indeed, the only living creature that can walk or stand erect, *i.e.*, with the axis of the spine vertical; with the hip and knee joints capable of being fully extended, so that the leg is brought into line with the thigh; with the foot so planted on the ground that it rests on the heel behind and on the roots of the toes in front; with the upper limbs so arranged as to act, not as instruments of progression, but of prehension; and with the head so balanced on the top of the spine that the face and eyes look directly to the front. His bones, joints, and muscles are constructed and arranged so as to enable him to preserve the erect attitude without fatigue. In other vertebrata the axis of the spine is oblique or horizontal, the hip and knee joints are permanently bent at a more or less acute angle, the limbs corresponding to the human upper extremities, are, in the form of legs, wings, or fins, instruments of progression, and the head is articulated with the spine at or near the hinder end of the skull. Owing to the oblique or horizontal attitude of the body in the vertebrata generally, and its erect position in man, the terms which are employed in describing the relative position of different parts are not used in the same sense by the human and comparative anatomist. Thus, parts which are superior, or above other parts, in the human body, are anterior, or in front, in other vertebrata; and parts which are posterior, or behind other parts in man, are superior to them in other vertebrata. To obviate the confusion which must necessarily arise when comparing the human body with that of other vertebrates, certain descriptive terms have been recommended which may be employed whether the position of the body be erect or non-erect. Thus, the aspect of parts directed towards the region where the atlas or first vertebra is situated is *atlantal*, that directed towards the sacrum is *sacral*, that towards the back is *dorsal*, that towards the front is *ventral* or *hæmal*. Quite recently the term *præ-axial* has been introduced as equivalent to atlantal, and *post-axial* to sacral.

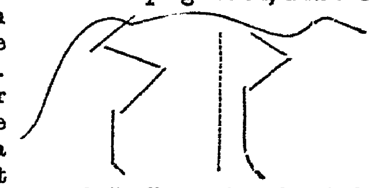


FIG. 2.—Outline diagram of a quadruped; the axis of the spine is almost at right angles to the vertical dotted line. (*After Goodsir.*)

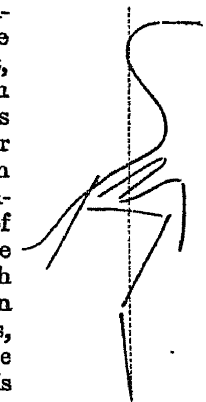


FIG. 3.—Outline diagram of a bird. The axis of the spine lies obliquely to the vertical dotted line. (*After Goodsir.*)

The body may be considered as divided by an imaginary plane, the *mesial plane*, into two lateral and similar halves, a right and left, so that it exhibits a bilateral symmetry; and the constituent parts are described as being *external* or *internal* to each other, according to their relative position to this plane. For descriptive purposes, also, we may subdivide the body into AXIAL and APPENDICULAR portions. The AXIAL part is the stock or stem of the body, and consists of the Head, the Neck, and the Trunk. The trunk is again subdivided into the chest or Thorax, and the belly or Abdomen; and the abdomen is again subdivided into the abdomen proper and the Pelvis. The axial part contains the organs essential to the preservation of life. In the head is lodged the brain, from which the spinal marrow is prolonged down the spinal canal. At the sides of the head are the ears, and opening on to the face are the eyes, nostrils, and mouth. Prolonged down the neck are the gullet and windpipe, with the latter of which is associated the organ of voice. Within the chest lie the heart, lungs, and gullet; and in the abdomen are contained the stomach, intestine, liver, spleen, pancreas, kidneys, and other organs concerned in the urinary and generative functions. The APPENDICULAR part forms the limbs, which do not contain organs essential to life. In man the limbs are called Upper and Lower—the former are instruments of prehension, the latter of progression. The subdivisions of the body are not homogeneous in structure, but are built up of several systems of organs, each system being characterised

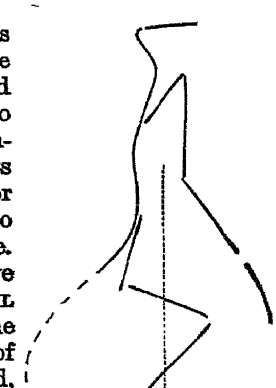


FIG. 4.—Outline diagram of a monkey in the semi-erect position. The axis of the spine lies obliquely to the vertical dotted line. (*After Goodsir.*)

not only by peculiarities in form, appearance, and structure, but by possessing special functions and uses. Thus the bones collectively form the Osseous system; the joints the Articulatory system; the muscles, which move the bones at the joints, the Muscular system; and these several systems collectively constitute the organs of Locomotion. The blood and lymph vessels form the Vascular system; the brain, spinal marrow, and nerves, the Nervous system, with which is intimately associated the organs of Sense; the lungs and windpipe, the Respiratory system; the alimentary canal, with the glands opening into it, the Digestive system; the kidneys, bladder, and urethra, the Urinary system; the testicles, spermatic ducts, and penis in the male, with the ovaries, uterus, and clitoris in the female, the Generative or Reproductive system; the skin, with the hair and nails, the Tegumentary system. These various systems are so arranged with reference to each other as to form an organic whole.

Anatomy of the Organs of Locomotion.

The organs of locomotion consist of the muscles or active organs, and the bones and joints or passive organs. The anatomy of the bones will first attract our attention.

Skeleton.

Osseous System—Osteology—Skeleton.—The word Skeleton (from σκέλλω, *to dry*) signifies literally the dry or hard parts of the body. When used in a limited sense it is applied merely to the bones, but when used in a wider and more philosophic sense it comprises not only the bones or osseous skeleton, but the cartilages and fibrous membranes which complete the framework of the body. The first evidence of a skeleton in the embryo is the appearance of membranes in many parts of which cartilage is developed, and in course of time this cartilage is converted into bone. In some animals, however, as in the cartilaginous fish, the osseous conversion does not take place, and the skeleton remains permanently cartilaginous; and in the very remarkable fish called Lancelet, or *Amphioxus*, the skeleton consists almost entirely of fibrous membrane.

The skeleton serves as a basis of support for the soft parts, as affording surfaces of attachment for muscles and as a protection for many delicate organs. In the vertebrata the osseous skeleton is clothed by the muscles and skin, and is technically called an *endo-skeleton*. In invertebrata the skeleton is not unfrequently on the surface of the body, and is termed an *exo-* or *dermo-skeleton*. In some vertebrates (*e.g.*, the armadillo, tortoise, and sturgeon), in addition to the proper endo-skeleton, skeletal plates are developed in connection with the integument, so that they possess a dermo-skeleton likewise. In some vertebrates, also, a partial skeleton is formed within the substance of some of the viscera—*e.g.*, in ruminant animals a bone is situated in the heart; in the walrus and other carnivora, in rodents, bats, and some monkeys, a bone lies in the penis; and in the leopard, jackal, and other carnivora, a cartilaginous style lies in the middle of the tongue. These parts form a *splanchno-* or visceral skeleton. By some anatomists the teeth, which are unquestionably hard parts of the body, are also referred to the splanchno-skeleton, though they are special modifications of the papillæ of the mucous membrane of the gum. In man, the teeth being excluded, there is neither exo- nor splanchno-skeleton, but only an endo-skeleton.

In each of the great subdivisions of the body an endoskeleton exists, so that we may speak of an Axial Skeleton and an Appendicular Skeleton. The Axial Skeleton consists of the bones of the spine and head, the ribs, and the breastbone; the Appendicular Skeleton, of the bones of the limbs. The number of bones in the skeleton varies at different periods of life. In the adult there are about 200, but in the child they are more numerous; for in the process of consolidation of the skeleton certain bones originally distinct become fused together. In Plates XII., XIII., and XIV., front, back, and side views of the entire skeleton are given, together with figures of the skull and several of its constituent bones.

We shall commence the description of the Axial Skeleton by giving an account of the bones of the spine.

Spine.

The Spine, Spinal or Vertebral Column, chine, or backbone, consists of a number of superimposed bones which are named Vertebræ, because they can move or turn somewhat on each other. It lies in the middle of the back of the neck and trunk; has the cranium at its summit; the ribs at its sides, which in their turn support the upper limbs; whilst the pelvis, with the lower limbs, is jointed to its lower end. The spine consists in an adult of twenty-six bones, in a young child of thirty-three, certain of the bones in the spine of the child becoming ankylosed or blended with each other in the adult. These blended bones lose their mobility, and are called *false* vertebræ; whilst those which retain their mobility are the *true* vertebræ. In the vertebrata the bones of the spine are arranged in groups, which may be named from their position—vertebræ of the neck or cervical; of the chest, dorsal or thoracic; of the loins, lumbar; of the pelvis, sacral; and of the tail, coccygeal or caudal; and the number of vertebræ in each group may be expressed in a formula. In man the formula is as follows:—$C_7D_{12}L_5S_5Coc_4 = 33$ bones, as seen in the child; but the five sacral vertebræ fuse together into a single bone—the sacrum—and the four coccygeal into the single coccyx. Hence the sacrum and coccyx of the adult are the false, whilst the lumbar, dorsal, and cervical are the true vertebræ.

Vertebra.

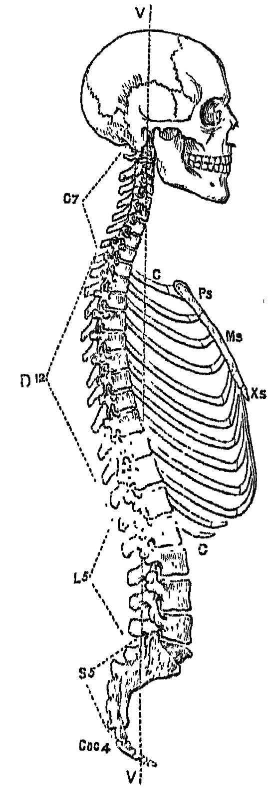
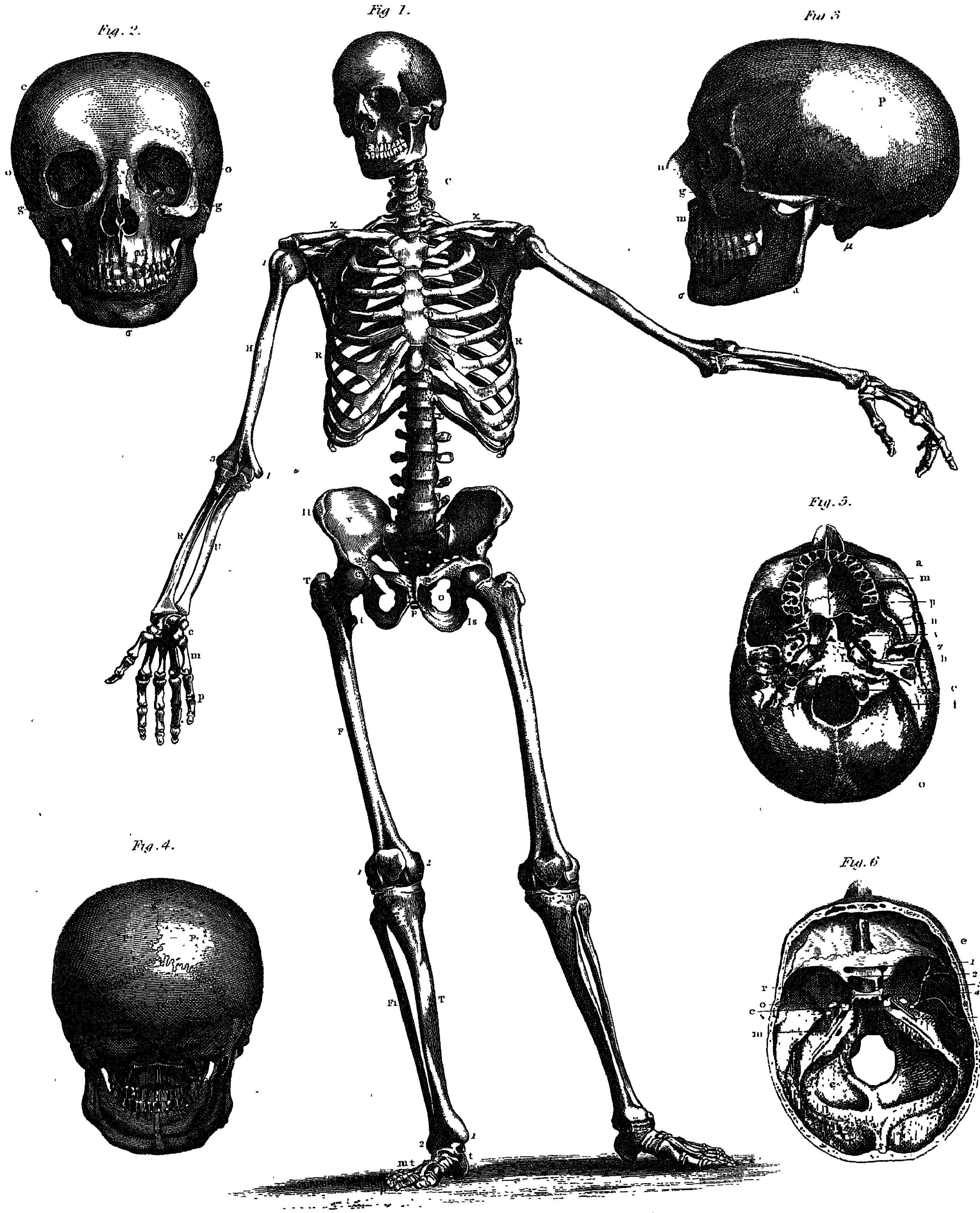


Fig. 5.—The Axial Skeleton. C_7, the cervical vertebræ; D_{12}, the dorsal; L_5, the lumbar; S_5, the sacral; Coc_4, the coccygeal; CC, the series of twelve ribs on one side; Ps, the præ-sternum; Ms, the meso-sternum; Xs, the xiphisternum. The dotted line VV represents the vertical axis of the spine.

The vertebræ are irregularly-shaped bones, but as a rule have certain characters in common. Each possesses a body and an arch, which enclose a ring, with certain processes and notches. The Body, or Centrum, is a short cylinder, which by its upper and lower surfaces is connected by means of fibro-cartilage with the bodies of the vertebræ immediately above and below. The collective series of vertebral bodies forms the great column of the spine. The Arch, also called Neural Arch, because it encloses the spinal marrow or nervous axis, springs from the back of the body, and consists of two symmetrical halves united behind in the middle line. Each half consists of an anterior part or pedicle, and a posterior part or lamina. The Rings collectively form the spinal canal. The Processes usually spring from the arch. The spinous process projects backwards from the junction of the two laminæ, and the collective series of these processes gives to the entire column the spiny character from which has arisen the



W&A.K. Johnston

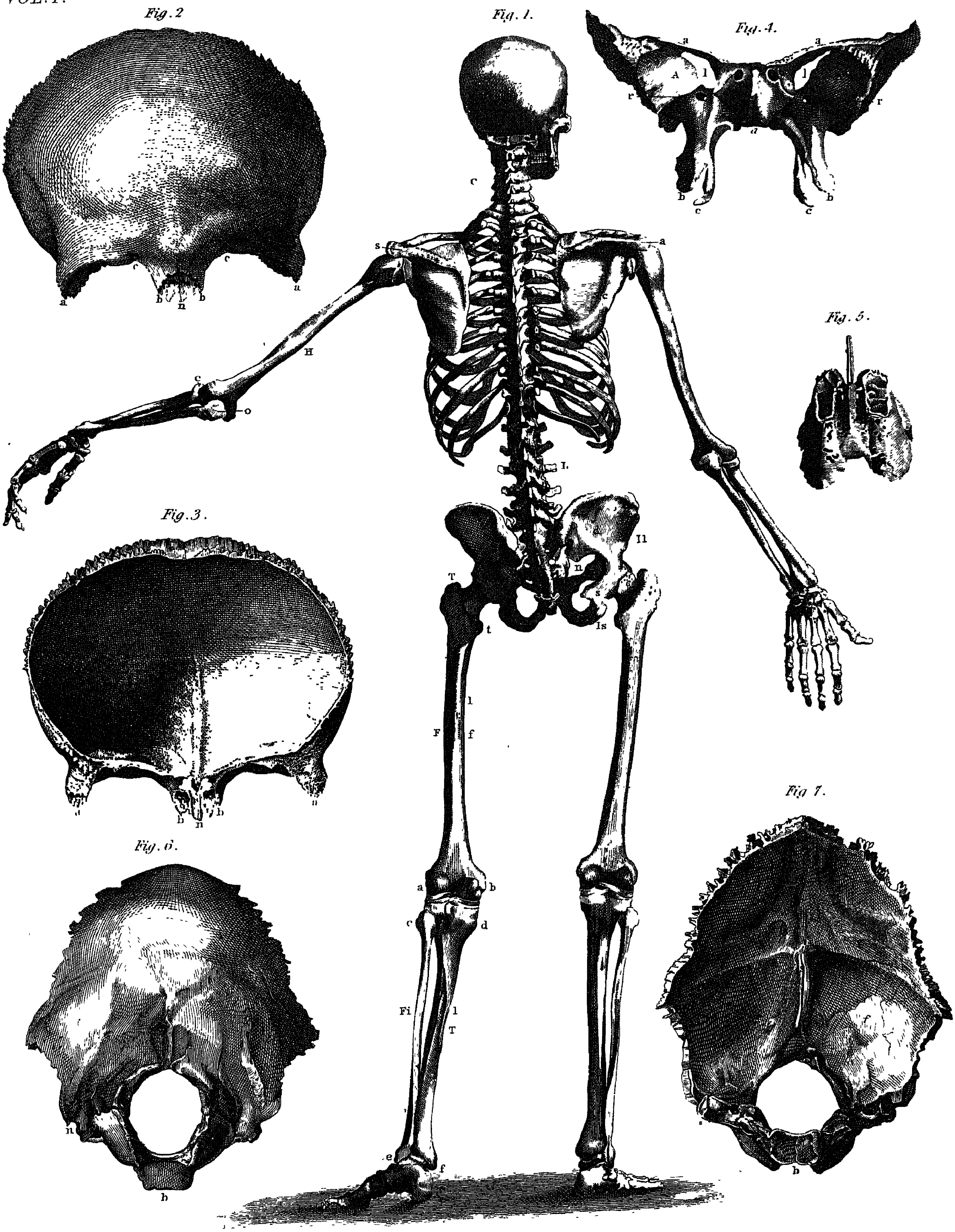


Fig. 2
Fig. 1.
Fig. 4.
Fig. 5.
Fig. 3.
Fig. 6.
Fig 7.


Fig. 1
Fig. 2
Fig. 3
Fig. 4
Fig. 5
Fig. 6
Fig. 7
Fig. 8
Fig. 9

term Spine, applied to it. The transverse processes project outwards, one from each side of the arch. The articular processes project, two upwards and two downwards, and are for connecting adjacent vertebræ together. The Notches, situated on the upper and lower borders of the pedicles, form in the articulated spine the intervertebral foramina through which the nerves pass out of the spinal canal.

Cervical vertebræ.

The vertebræ in each group have characters which specially distinguish them. In man and all mammals, with few exceptions, whatever be the length of the neck, the Cervical Vertebræ are seven in number. The exceptions are the three-toed sloth, which has nine, and Hoffmann's sloth and the manatee, in which there are only six. In many whales the seven cervicals are fused in the adult into a single bone. In man the body of a cervical vertebra is comparatively small, and its upper surface is transversely concave; the arch has long and obliquely sloping laminæ; the ring is large and triangular; the spine is short, bifid, and horizontal; the transverse process consists of two bars of bone, the anterior springing from the side of the body, the posterior from the arch, and uniting externally to enclose a foramen, through which, as a rule, the vertebral artery passes; the articular processes are flat and oblique, and the upper pair of notches are deeper than the lower. The first, second, and seventh cervical vertebræ have characters which specially distinguish them. The first, or *Atlas*, has no body or spine: its ring is very large, and on each side of the ring is a thick mass of bone, the *lateral mass*, by which it articulates with the occipital bone above and the second vertebra below. The second vertebra, *Axis*, or *Vertebra dentata*, has its body surmounted by a thick tooth-like *odontoid* process, which is regarded as the body of the atlas displaced from its proper vertebra and fused with the axis. This process forms a pivot round which the atlas and head move in turning the head from one side to the other; the spine is large, thick, and deeply bifid. The seventh, called *Vertebra prominens*, is distinguished by its long prominent spine, which is not bifid, and by the small size of the foramen at the root of the transverse process. In the human spine the distinguishing character of all the cervical vertebræ is the foramen at the root of the transverse process, but amongst mammals this is not an invariable character, for in the cetacea the transverse process of the atlas is imperforate, and in the horse, ruminants, and many quadrumana, the seventh cervical vertebra has no foramen at the root of its transverse process.

Dorsal vertebræ.

The Dorsal Vertebræ, more appropriately called costal or thoracic, are twelve in number in the human spine; but amongst mammals they range from eleven in the armadillo to twenty-two in the Cape hyrax and Hoffmann's sloth. They are intermediate in size and position to the cervical and lumbar vertebræ, and are all distinguished by having one or two smooth surfaces on each side of the body for articulation with the head of one or two ribs. The arch is short and with imbricated laminæ; the ring is nearly circular; the spine is oblique, elongated, and bayonet-shaped; the transverse processes are directed back and out, not bifid, and with an articular surface in front for the tubercle of a rib; and the articular processes are flat and nearly vertical. The first, twelfth, eleventh, tenth, and sometimes the ninth, dorsal vertebræ are distinguished from the rest. The first is in shape like the seventh cervical, but has no foramen at the root of the transverse process, and has two articular facets on each side of the body; the ninth has sometimes only one facet at the side of the body; the tenth, eleventh, and twelfth have invariably only a single facet on the side of the body, but the eleventh and twelfth have stunted transverse processes, and the twelfth has its lower articular processes shaped like those of a lumbar vertebra.

Lumbar vertebræ.

The Lumbar Vertebræ in man are five in number, but amongst mammals they range from two in the platypus to eight in the hyrax or agouti. They are the lowest of the true vertebræ, and also the largest, especially in the body. The arch has short and deep laminæ; the ring is triangular; the spine is massive and hatchet-shaped; the transverse processes are long and pointed; the articular are thick and strong, the superior pair concave, the inferior convex, and the inferior notches, as in the dorsal vertebræ, are deeper than the superior. In the lumbar vertebræ and in the lower dorsal an accessory process projects from the base of each transverse process, and a mammillary tubercle from each superior articular process. In man these are small and rudimentary; but in some mammals, as the kangaroo, armadillo, and scaly ant-eater, the mammillary tubercles are large, and in the baboon, dog, cat, and beaver, the accessory processes are well developed. The fifth lumbar vertebra has its body much thicker in front than behind; its spine is less massive, and its lower articular processes are flat.

Sacrum.

The Sacrum is composed of five originally separate vertebræ fused into a single bone. In the bandicoot it consists of a single vertebra, whilst it has as many as eight in the armadillo. The relative size and completeness of the sacrum are associated with the development of the haunch bones and of the lower limbs. In whales, where the pelvic bones are rudimentary and there are no hind limbs, there is no sacrum. It forms the posterior wall of the pelvis, is triangular in form, and possesses two surfaces, two borders, a base, and an apex. The anterior or pelvic surface is concave, and is marked by four transverse lines, which indicate its original subdivision into five bones, and by four pairs of foramina, through which are transmitted the anterior sacral nerves. Its posterior surface is convex; in the middle line are tubercles or rudimentary spines, and on each side of these are two rows of tubercles, the inner of which are the conjoined articular and mammillary processes, the outer the transverse processes of the originally distinct vertebræ; in addition, four pairs of foramina are found which transmit the posterior sacral nerves from the sacral canal, which extends through the bone from base to apex, and forms the lower end of the spinal canal. By its borders the sacrum is articulated with the haunch-bones—by its base with the last lumbar vertebra, by its apex with the coccyx. The human sacrum is broader in proportion to its length than in other mammals; this great breadth gives solidity to the lower part of the spine, and, conjoined with the size of the lateral articular surfaces, it permits a more perfect junction with the haunch-bones, and is correlated with the erect position. Owing to the need in woman for a wide pelvis, the sacrum is broader than in man.

Coccyx

The Coccyx consists of only four vertebræ in the human spine. It is the rudimentary tail, but instead of projecting back, as in mammals generally, is curved forwards, and is not visible externally, an arrangement which is also found in the anthropoid apes and in Hoffmann's sloth. In the spider monkeys as many as thirty-three vertebræ are found in the tail, and in the long-tailed pangolin the number reaches forty-six. Not only is the tail itself rudimentary in man, but the vertebræ of which it is composed are small, and represent merely the bodies of the true vertebræ. As there are no arches, the ring is not formed, and the spinal canal does not extend, therefore, beyond the apex of the sacrum. The first coccygeal vertebra, in addition to a body, possesses two processes or horns, which are jointed with two corresponding processes from the last sacral vertebra.

The Human Spine is more uniform in length in persons of the same race than might be supposed from the individual differences in stature, the variation in the height of the body in adults being due chiefly to differences in the length of the lower limbs. The average length of the spine is 28 inches; its widest part is at the base of the sacrum, from which it tapers down to the tip of the coccyx. It diminishes also in breadth from the base of the sacrum upwards to the region of the neck. Owing to the projection of the spines behind and the transverse processes on each side, it presents an irregular outline on those aspects; but in front it is more uniformly rounded, owing to the convex form of the antero-lateral surfaces of the bodies of its respective vertebræ. In its general contour two series of curves may be seen, an antero-posterior and a lateral. The antero-posterior is the more important. In the infant at the time of birth the sacro-coccygeal part of the spine is concave forwards, but the rest of the spine, except a slight forward concavity in the series of dorsal vertebræ is almost straight. When the infant begins to sit up in the arms of its nurse, a convexity forwards in the region of the neck appears, and subsequently, as the child learns to walk, a convexity forwards in the region of the loins. Hence in the adult spine a series of convexo-concave curves are found, which are alternate and mutually dependent, and are associated with the erect attitude of man. In the human spine alone are the lumbar vertebræ convex forward. A lateral curve, convex to the right, opposite the third, fourth, and fifth dorsal vertebræ, with compensatory curve convex to the left immediately above and below, is due apparently to the much greater use of the muscles of the right arm over those of the left, drawing the spine in that region somewhat to the right. In disease of the spine its natural curvatures are much increased, and the deformity known as humpback is produced. As the spine forms the central part of the axial skeleton, it acts as a column to support not only the weight of the body, but of all that can be carried on the head, back, and in the upper limbs: by its transverse and spinous processes it serves also to give attachment to numerous muscles, and the transverse processes of its dorsal vertebræ are also for articulation with the ribs.

Thorax. The THORAX, PECTUS, or CHEST is a cavity or enclosure the walls of which are in part formed of bone and cartilage. Its skeleton consists of the sternum in front, the twelve dorsal vertebræ behind, and the twelve ribs, with their corresponding cartilages, on each side.

Sternum The Sternum or Breast Bone is an elongated bone which inclines downwards and forwards in the front wall of the chest. It consists of three parts—an upper, called manubrium or præ-sternum; a middle, the body or meso-sternum; and a lower, the ensiform process or xiphi-sternum. Its anterior and posterior surfaces are marked by transverse lines, which indicate not only the subdivision of the entire bone into three parts, but that of the meso-sternum into four originally distinct segments. Each lateral border of the bone is marked by seven depressed surfaces for articulation with the seven upper ribs: at each side of the upper border of the præ-sternum is a sinuous depression, where the clavicle, a bone of the upper limb, articulates with this bone of the axial skeleton. The xiphi-sternum remains cartilaginous up to a late period of life, and from its pointed form has been named the ensiform cartilage.

The Ribs or Costæ, twenty-four in number, twelve on each side of the thorax, consist not only of the bony ribs, but of a bar of cartilage continuous with the anterior end of each bone, called a *costal cartilage*, so that they furnish examples of a cartilaginous skeleton in the adult human body; in aged persons these cartilages usually become converted into bone. The upper seven ribs are connected by their costal cartilages to the side of the sternum, and are called *sternal* or *true* ribs; the lower five do not reach the sternum, and are named *a-sternal* or *false*, and of these the two lowest, from being comparatively unattached in front, are called *free* or *floating*. All the ribs are articulated behind to the dorsal vertebræ, and as they are symmetrical on the two sides of the body, the ribs in any given animal are always twice as numerous as the dorsal vertebræ in that animal. They form a series of osseo-cartilaginous arches, which extend more or less perfectly around the sides of the chest. A rib is an elongated bone, and as a rule possesses a head, a neck, a tubercle, and a shaft. The head usually possesses two articular surfaces, and is connected to the side of the body of two adjacent dorsal vertebræ; the neck is a constricted part of the bone, uniting the head to the shaft; the tubercle, close to the junction of the shaft and neck, is the part which articulates with the transverse process of the vertebra. The shaft is compressed, possesses an inner and outer surface, and an upper and lower border, but from the shaft being somewhat twisted on itself, the direction of the surfaces and borders is not uniform throughout the length of the bone. The ribs slope from their attachments to the spine, at first outwards, downwards, and backwards, then downwards and forwards, and where the curve changes from the backward to the forward direction an *angle* is formed on the rib. The first, tenth, eleventh, and twelfth ribs articulate each with only a single vertebra, so that only a single surface exists on the head: the surfaces of the shaft of the first rib are almost horizontal; those of the second very oblique; the eleventh and twelfth ribs are rudimentary, have neither neck nor tubercle, and are pointed anteriorly. The ribs are by no means uniform in length: they increase from the first to the seventh or eighth, and then diminish to the twelfth; the first and twelfth are therefore the shortest ribs. The first and second costal cartilages are almost horizontal, but the others are directed upwards and inwards.

In its general form the chest may be likened to a truncated cone. It is rounded at the sides and flattened in front and behind, so that a man can lie either on his back or his belly. Its truncated apex slopes downwards and forwards, is small in size, and allows of the passage of the windpipe, gullet, large veins, and nerves into the chest, and of several large arteries out of the chest into the neck. The base or lower boundary of the cavity is much larger than the apex, slopes downwards and backwards, and is occupied by the diaphragm, a muscle which separates the chest from the cavity of the abdomen. The transverse diameter is greater than the antero-posterior, and the antero-posterior is greater laterally, where the lungs are lodged, than in the mesial plane, which is occupied by the heart.

The HEAD forms the summit of the axial part of the body. It consists of two portions—the Cranium and the Face.

The SKULL, or skeleton of the head, is composed of 22 bones, 8 of which form the skeleton of the cranium, 14 that of the face. Except the lower jaw, which is moveable, the bones are all firmly united by immovable joints. The 8 bones of the cranium are so united together by their edges as to form the walls of a box or cavity, the cranial cavity, in which the brain is lodged. The box of the cranium possesses a base or floor, a vault or roof, an anterior, a posterior, and two lateral walls. The posterior wall is formed by the *occipital* bone, which also extends for some distance forwards along the middle of the base; in front of the basal part of the occipital is the *sphenoid*, which also sends a process upwards on each side of the Skull

skull; in front of the basal part of the sphenoid is the *ethmoid;* mounting upwards in front of the ethmoid is the

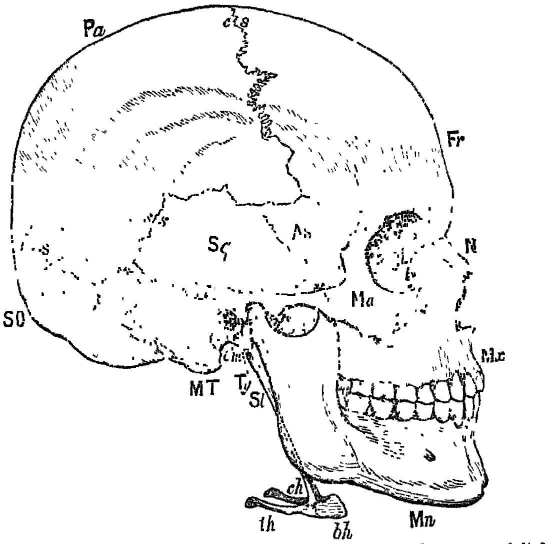


FIG. 6.—Profile of the skull. Fr, frontal bone; Pa, parietal; SO, supra-occipital; Sq, squamous-temporal; MT, mastoid-temporal; Ty, tympanic; St, styloid-temporal; As, ali-sphenoid; E, os planum of ethmoid; L, lachrymal; N, nasal; Mx, superior maxilla; Ma, malar; Mn, mandible; *bh*, basi-hyal; *th*, thyro-hyal; *ch*, cerato-hyal; *em*, external meatus; *cs*, coronal suture; *ls*, lambdoidal suture; *ss*, squamous suture.

frontal, which forms the forehead, and closes in the front of the cranial box; forming the vault and side walls are the two *parietal* bones; completing the side walls, and extending for a short distance along the side of the floor, are the two *temporal* bones; the *vertex* of the skull is at the junction of the two parietal bones with each other.

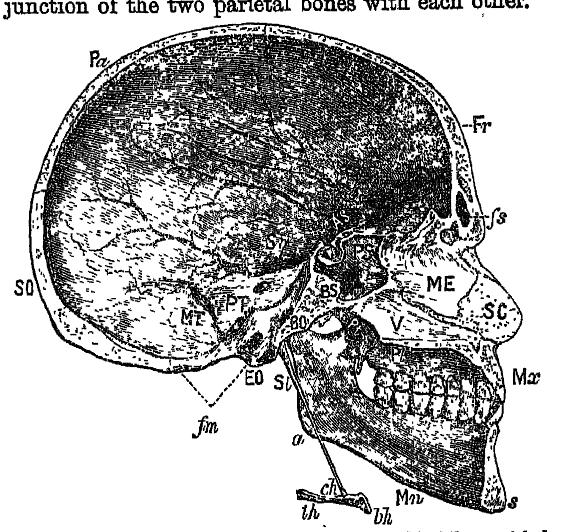


FIG. 7.—Section through the skull immediately to the right of the mesial plane. The lettering as in Fig. 6, with, in addition, BO, basi-occipital; EO, ex-occipital; PT, petrous-temporal; BS, basi-sphenoid; PS, pre-sphenoid (the letters are placed in the sphenoidal sinus); OS, orbito-sphenoid; ME, mes-ethmoid; SC, septal cartilage of nose; V, vomer; Pl, palate; Pt, pterygoid of sphenoid; *fs*, frontal sinus; Pf, pituitary fossa; *fm*, foramen magnum; *a*, angle; and *s*, symphysis of lower jaw.

The fourteen bones of the face, which are situated below and in front of the cranium, enter into the formation of the walls of cavities which open on the front of the face; thus they complete, along with the frontal, sphenoid, and ethmoid, the walls of the two orbits in which the eye-balls are lodged; along with the ethmoid and sphenoid, the walls of the nostrils; and they form the osseous walls of the mouth. As a general rule, the cranial bones are expanded, and plate-like in form. The *outer* surface of each bone assists in forming the exterior of the cranium, and not unfrequently is marked by ridges or processes for the attachment of muscles. The *inner* surface, again, is smooth, and pitted with depressions, in which the convolutions of the brain are lodged, and also marked by grooves for the lodgment of dilated veins called blood sinuses, and of arteries termed meningeal. The two surfaces of a cranial bone, dense in structure, are called its *tables*, outer and inner, and are separated from each other by bone, looser and more spongy in its texture, called *diploë*. In some localities, more especially in certain of the bones which form the walls of the nostrils, the diploë disappears, and comparatively wide interspaces separate the two tables which contain air, and are called *air-sinuses*. The margins of the bones are denticulated, and it is by the interlocking of the denticulations of adjacent bones that they are jointed together, the joints being named *sutures*. The bones are pierced by holes or foramina, and similar holes exist between the adjacent margins of some of the bones. These foramina are mostly situated in the floor of the skull, and transmit arteries into the cranial cavity to supply the brain and the inner table with blood, and veins and nerves out of the cavity. The largest of these holes is called *foramen magnum*. It lies in the occipital bone, immediately above the ring of the atlas; through it the spinal marrow becomes continuous with the brain, and the vertebral arteries pass to supply the brain with blood.

The Occipital, or bone of the Back of the Head (Figs. 6 Occipital.
and 7, and Plate XIII.), consists of four originally distinct pieces fused into a curved plate-like bone. Its subdivisions are arranged around the foramen magnum—the basilar part, basi-occipital, in front; the condyloid parts, ex-occipitals, one on each side; and the tabular part, or supra-occipital, behind. The anterior surface of the supra-occipital is subdivided into four fossæ, in the two upper of which are lodged the occipital lobes of the cerebrum, in the two lower the cerebellum; the upper and lower pairs of fossæ are separated by a groove for the lodgment of the lateral venous sinus. The posterior surface is marked by a protuberance and by curved lines for the attachment of muscles; by its margin the supra-occipital articulates with the parietal and temporal bones. Each ex-occipital has on its under surface a smooth condyle for articulation with the atlas; in front of the condyle is a foramen which transmits the last or ninth cranial nerve, called hypoglossal, and behind it a foramen for the transmission of a vein sometimes exists. The basi-occipital articulates and, in the adult skull, is fused with the body of the sphenoid (Fig. 7). The upper surface of the basi-occipital is grooved for the lodgment of the medulla oblongata.

Sometimes the part of the supra-occipital situated above the protuberance and upper curved line ossifies as an independent bone, called *interparietal*. In some mammals, as the sheep, the existence of an interparietal in the young skull is the rule and not the exception.

The Sphenoid or Wedge-shaped bone (Fig. 7, and Plate Sphenoid.
XII.), lies at the base of the skull; it articulates behind with the occipital; in front it is jointed to the ethmoid and frontal, and by its lateral processes or wings to the frontal, parietal, and temporal bones. From its position, therefore, it binds together all the bones of the cranium, and, moreover, articulates with many of those of the face. For constructive purposes it is the most important bone of the head. It consists of a centrum or body, with which four pairs of processes are connected. The body has a deep depression on its upper surface, compared in shape to a Turkish saddle, in which is lodged the pituitary body; hence it is called *pituitary fossa*. In front of this fossa is a ridge which marks the place of union of the *pre-* and *post-sphenoidal* subdivisions of the body of this bone; the body is grooved laterally for the internal carotid artery and the cavernous blood sinuses, and it is hollowed out in its interior to form the sphenoidal air-sinuses: these air-

sinuses are partially closed in front by a pair of small bony plates called *sphenoidal spongy bones*, or bones of Bertin. Behind the pituitary fossa is a pair of processes called posterior clinoid, from which the bone slopes back to the basi-occipital; this slope is called the *dorsum sellæ*, and on it rests the pons Varolii. From the posterior part of each side of the body the great wings, or *ali-sphenoids*, pass outwards and upwards to the sides of the skull, and each sends off a plate-like process to enter into the formation of the outer wall of the orbit. From the anterior part of each side of the body the lesser wings, *orbito-sphenoids*, pass outwards, and assist in forming the roof of each orbit; each orbito-sphenoid ends internally in a knob-like process called *anterior clinoid*, and at its root is a *foramen* called *optic*, which transmits the second nerve, or nerve of sight, into the orbit. From the great wings on each side, close to its junction with the body, a pair of *pterygoid* processes, called internal and external, project downwards, and the internal process ends in a slender hook termed the *hamular* process. The ali-sphenoid is pierced by foramina called *rotundum*, *ovale*, and *spinosum*, the two former of which transmit divisions of the fifth cranial nerve, the last an artery to the membranes of the brain; between the orbito- and ali-sphenoids is a fissure which transmits the third, fourth, sixth, and first divisions of the fifth cranial nerve into the orbit; and at the root of the pterygoid processes is the vidian canal, for the transmission of a nerve of the same name.

Ethmoid. The Ethmoid, or Sieve-like bone (Fig. 7, and Plate XIII., fig. 5), is situated between the two orbital plates of the frontal, and in front of the body of the sphenoid. It is cuboidal in shape, and is composed of a central portion and two lateral masses, which are connected together by a thin horizontal plate pierced with holes like a sieve, and called *cribriform*. This cribriform plate forms a part of the floor of the cranial cavity; on it rest the two olfactory bulbs, and the branches of the nerves of smell, called olfactory or first cranial nerves, pass from the bulbs through the holes in this plate into the nose. The central portion of the bone is a mesial perpendicular plate, *mes-ethmoid*, and forms a part of the septum which subdivides the nose into the right and left nostrils. Each lateral mass consists of an external smooth plate, *os planum*, which assists in forming the inner wall of the orbit; and an internal convoluted part, called *superior* and *middle spongy* bones or *turbinals*, which enter into the formation of the outer wall of the nostril. These turbinals are associated with the distribution of the nerves of smell; in the toothed whales, where there are no olfactory nerves, the turbinals are absent, whilst in some mammals, as the crested seal, they assume a highly convoluted form. The lateral masses are hollowed out into air-sinuses, called ethmoidal cells, which communicate with the nostrils and with corresponding sinuses in the sphenoid and frontal bones.

Frontal. The Frontal, or bone of the Forehead (Figs. 6 and 7, and Plate XIII.), consists originally of a right and left lateral half, united by the frontal suture in the middle line of the forehead. As a rule, this suture disappears in early life, and a single greatly curved bone is formed. The bone is convex forwards, to form the rounded forehead, and presents two *eminences*, the centres of ossification of the bone; at the root of the nose is an elevation called *glabella*, extending outwards, from which, on each side, is the *supra-ciliary ridge*, corresponding to the position of the eyebrow. In the crania of some races, *e.g.*, the Australian, the forward projection of the glabella and supra-ciliary ridges is considerable; and in the well-known skull from the valley of the Neander it has reached a remarkable size. These ridges and the glabella mark the position of the air-sinuses in the frontal bone. The upper border of each orbit, which ends internally and externally in a process of bone called angular, forms the lower boundary of the forehead. The cerebral surface of the bone is deeply concave, for the reception of the frontal lobes of the brain; the concavity is deepened by the backward projection of two thin plates of bone which form the roofs of the orbits, which plates are separated from each other by the deep notch in which the ethmoid bone is lodged; along the margins of this notch may be seen the openings into the frontal air-sinuses.

The Parietal bones, two in number (Figs. 6 and 7, and Plate XIV.), form the greater part of the side wall of the skull, and mount upwards to the vertex, where they unite together along the line of the *sagittal* suture. Each bone possesses about the centre of its outer surface an *eminence*, the centre of ossification of the bone, with which a hollow on the cerebral surface, lodging a convolution of the parietal lobe of the brain, corresponds. The bone is quadrilateral in form. Three of its margins are strongly denticulated, for junction with the occipital, frontal, and corresponding parietal; the fourth is scale-like, for union with the temporal, and forms the *squamous* suture; near the upper margin on the cerebral surface is a groove for the lodgment of the *superior longitudinal* venous *sinus*. The anterior inferior angle articulates with the ali-sphenoid, and is marked by a groove for the meningeal artery; the posterior inferior is grooved for the *lateral* venous *sinus*, and articulates with the mastoid of the temporal. Parietal.

The Temporal bones, two in number (Figs. 6 and 7, and Plate XIV.), are placed at the side and base of the skull, and are remarkable for containing in their interior the organs of hearing. Each bone consists originally of four subdivisions—a squamoso-zygomatic, a tympanic, a petro-mastoid, and a styloid—which in course of time fuse together to form an irregular-shaped bone. The squamous part of the squamoso-zygomatic is a thin plate which forms that part of the side of the skull familiarly known as the "temple." The zygoma extends horizontally forwards as a distinct arched process, to join the malar or cheek-bone. At the root of the zygoma is a smooth fossa, called *glenoid*, which receives the condyle of the lower jaw, and assists in forming the temporo-maxillary joint. The tympanic portion forms in the fœtus a ring, which enlarges subsequently into a curved plate that forms the wall of the *external auditory meatus*, or passage into the tympanum or middle ear. The tympanic and squamoso-zygomatic parts of the bone fuse together; but a fissure, called *Glaserian*, situated behind the glenoid fossa, marks their original separation; in this fissure the slender process of the malleus (one of the bones of the tympanum) is lodged. The petro-mastoid or periotic part of the temporal contains the organ of hearing, and is complicated in its internal anatomy. It extends forwards and inwards along the floor of the skull, and forms on the exterior of the skull the large nipple-shaped *mastoid* process. This process is rough on its outer surface, for the attachment of muscles, and is hollowed out internally into the mastoid cells or air-sinuses, which communicate with the tympanum or middle ear. The petrous-temporal is distinguished by its stony hardness, and has the form of a three-sided pyramid. Its apex lies in relation to the side of the body of the sphenoid; its base corresponds to the tympanic cavity and external meatus; its under surface is rough, and forms a part of the under surface of the skull; its anterior and posterior surfaces are smooth and in relation to certain parts of the brain. The petrous part of the bone is traversed by a canal which transmits the internal carotid artery and sympathetic nerve into the cranial cavity; in its posterior surface is a passage, *internal meatus*, down which the seventh cranial nerve proceeds; at the bottom of the meatus the auditory part of that nerve enters the internal ear, whilst the part of the nerve Temporal.

which goes to the muscles of the face traverses a canal in the bone, called *aqueduct of Fallopius*, which ends externally, between the styloid and mastoid processes, in the *stylo-mastoid foramen.* The styloid process is a slender part of the bone which projects downwards from the tympanic plate, and is connected with the small cornu of the hyoid bone by the stylo-hyoid ligament. It does not unite with the rest of the bone until a comparatively late period. Between the petrous-temporal and ex-occipital is the *jugular foramen,* which transmits out of the skull the eighth cranial nerve and the internal jugular vein.

Bones of the face. The fourteen bones of the Face are, as a rule, much smaller than those of the Cranium; some have the form of thin scales, others are more irregular in shape. They are named as follows:—Two superior maxillary, two palate, two malar, two nasal, two lachrymal, two inferior turbinal, a vomer, and an inferior maxilla.

Upper jaw. The Superior Maxillæ, or bones of the Upper Jaw (Figs. 6 and 7, and Plate XIV.), form the skeleton of a large part of the face, and enter into the formation of the walls of the cavities of the nose, mouth, and orbit; around them the other bones of the face are grouped. The facial surface of each bone presents in front a large foramen for the transmission of the infra-orbital branch of the fifth cranial nerve, and behind, several small foramina for the transmission of nerves to the teeth in the upper jaw. On the same surface is a rough process for articulation with the malar bone. The orbital surface is smooth, forms the floor of the orbit, and possesses a canal in which the infra-orbital nerve lies. The nasal surface forms a part of the outer wall and floor of the nostril, and presents a hole leading into a large hollow in the substance of the bone, called the *antrum,* or superior maxillary air-sinus. The nasal surface articulates with the inferior turbinal and palate bones. The nasal and facial surfaces become continuous with each other at the anterior aperture of the nose, and from them a strong process ascends to join the frontal bone close to the glabella; this process also articulates with the lachrymal and nasal bones. The palatal surface forms a part of the bony roof of the mouth, and presents in front a small hole (the *incisive foramen*) which communicates with the nose. In the sheep and many other mammals this hole is of large size; the palatal surface is bounded externally by a thick elevated border, in which are the sockets, or *alveoli,* for the lodgment of the fangs of the teeth; internally this surface articulates by a narrow border with the other superior maxilla and with the vomer, and, posteriorly, with the palate-bone.

Palate-bone. The Palate-bone (Fig. 7, and Plate XIV.) lies in contact with the inner surface and posterior border of the superior maxilla, and separates it from the sphenoid. It is in shape not unlike the capital letter L, the horizontal limb forming the hinder part of the bony roof of the mouth by its lower surface, and the back part of the floor of the nose by its upper. The ascending limb assists in forming the outer wall of the nose, and subdivides into an anterior, or *orbital,* and a posterior, or *sphenoidal,* process. At the junction of the two limbs is the *pyramidal* process, which articulates with the lower ends of the pterygoid processes of the sphenoid.

Vomer. The Vomer (Fig. 7), shaped like a ploughshare, lies vertically in the mesial plane of the nose, and forms a large part of the partition which separates one nostril from the other. It articulates above with the under surface of the body of the sphenoid and the mes-ethmoid; below with the palatal processes of the superior maxillæ and palate-bones; in front with the septal cartilage of the nose, whilst the posterior border is free, and forms the hinder edge of the nasal septum.

Inferior turbinated. The Inferior Turbinated is a slightly convoluted bone situated on the outer wall of the nose, where it articulates with the superior maxilla and palate a little below the middle turbinal of the ethmoid.

Lachrymal. The Lachrymal (Fig. 6) is a small scale-like bone, in shape not unlike a finger-nail, placed at the inner wall of the orbit, and fitting between the ethmoid, superior maxilla, and frontal bones. It has a groove on the outer surface, in which is lodged the lachrymal sac.

Nasal. The Nasal (Fig. 6) is a thin, somewhat elongated bone, which, articulating with its fellow in the middle line, forms with it the bony bridge of the nose; above, it articulates with the frontal, and by its outer border with the ascending process of the superior maxilla.

Malar. The Malar bone (Fig. 6), irregular in shape, forms the prominence of the cheek, and completes the outer wall of the orbit. It rests upon the superior maxilla; by its orbital plate it articulates with the great wing of the sphenoid; by its ascending process with the external angular process of the frontal; by its posterior process with the zygomatic process of the temporal, so as to complete the zygomatic arch.

Mandible. The Inferior Maxilla, Lower Jaw, or Mandible (Figs. 6 and 7, and Plate XIV., fig. 9), is a large horse-shoe shaped bone, which has the distinction of being the only movable bone of the head. It consists originally of two separate halves, which unite during the first year of life into a single bone at the *symphysis* or chin. A characteristic feature of the human lower jaw is the forward slope of the bone at the chin, for in other mammals the symphysis inclines backwards. In the upper border of this bone are the sockets for the lower series of teeth. At the posterior end of the horse-shoe curve on each side the bone ascends almost vertically, and terminates in two processes—an anterior, or *coronoid,* which is for the insertion of the temporal muscle, and a posterior, or *condyle,* which is for articulation with the glenoid fossa of the temporal bone. Where the ascending and horizontal limbs of the bone are continuous, it forms the *angle,* which is almost a right angle. On the inner surface of the ascending limb is a large foramen, communicating with a canal which traverses the bone below the sockets for the teeth. In this canal are lodged the nerves and blood-vessels for these teeth.

Hyoid. The Hyoid bone lies in the neck, on the same plane as the lower border of the inferior maxilla (Figs. 6 and 7). It is shaped like the letter U, and consists of a body, or *basi-hyal,* from which two long horns, or *stylo-hyals,* project backwards. At the junction of the body and horns two smaller cornua, or *cerato-hyals,* project upwards, and are connected with the styloid processes of the temporal bones, or *stylo-hyals,* by the stylo-hyoid ligaments, or *epi-hyals.* The hyoid is the bone from which the muscles of the tongue arise, and it is situated immediately above the thyroid cartilage of the larynx, to which it is attached by ligaments.

General form and size of the skull. In its general form the Skull is ovoid, with the long axis extending antero-posteriorly, the frontal and occipital ends rounded, and the sides somewhat flattened. Its average length in the people of the British Islands is a little more than 7 inches; its greatest breadth about $5\frac{1}{2}$ inches; and its height, from the plane of the foramen magnum to the vertex, about $5\frac{1}{4}$ inches. Its greatest circumference is about 21 inches. The breadth of the face across the zygomatic arches is about 5 inches. The average capacity of the brain cavity is 92 cubic inches. The British skull is dolicho-cephalic and orthognathic. (See ANTHROPOLOGY.)

The lateral regions of the skull are called the *temporal fossæ,* and give origin to the temporal muscles. Under cover of each zygomatic arch is the *zygomatic fossa.* At the bottom of this is a hollow between the superior maxilla

and sphenoid, called *spheno-maxillary fossa*, from which the *pterygo-maxillary fissure* extends downwards between the pterygoid and superior maxillary; and the *spheno-maxillary fissure* extends upwards into the orbit. The orbit is a four-walled pyramidal cavity, with the base directed forward to the face, and the apex backward to the brain cavity. At the apex are the foramina in the sphenoid, through which the nerve of sight and other nerves pass from the brain to the eyeball, muscles, and other soft structures within the orbit.

The nostrils open on the front of the face by a large opening situated between the two superior maxillæ, and bounded above by the two nasals. The sides of the opening pass down almost vertically to join the floor, and are not rounded off as in the ape's skull; from the centre of the floor a sharp process, the *nasal spine* of the superior maxillæ projects forwards, and forms a characteristic feature of the human skull. Attached to the sides of the opening are the lateral cartilages of the nose, which form the wings of the nostrils, and so modify the position of their openings that in the face they look downwards. The nostrils are separated from each other by a vertical mesial partition composed of the mes-ethmoid, vomer, and triangular nasal cartilage, the last-named of which projects forward beyond the anterior surface of the upper jaw, and contributes materially to the prominence of the nose. The outer wall of each nostril presents the convoluted turbinals, which are separated from each other by horizontal passages extending antero-posteriorly; the *superior* passage or *meatus* lies between the superior and middle turbinals of the ethmoid, and is continued into the sphenoidal and posterior ethmoidal air-sinuses; the *middle meatus* lies between the middle and inferior turbinals, and is continued into the frontal, anterior ethmoidal, and maxillary air sinuses. These sinuses are therefore extensions of the nasal chamber or respiratory passage, and correspond with the air cavities which exist in so many of the bones of birds; the *inferior meatus* lies between the inferior turbinal and floor of the nose; into its anterior part opens the nasal duct which conveys the tears from the front of the eyeball. The posterior openings of the nose are separated from each other by the hinder edge of the vomer, and are placed between the internal pterygoid plates of the sphenoid.

The skull varies in appearance at different periods of life. In infancy the face is small, about $\frac{1}{8}$th of the size of the entire head, for the teeth are still rudimentary and the jaws are feeble; the centres of ossification of the cranial bones are prominent; the forehead projects; the skull is widest at the parietal eminences; the air-sinuses, and bony ridges corresponding to them, have not formed. In the adult the face is about half the size of the head, and its vertical diameter greatly elongated, from the growth of the antrum, the nose, and the dental borders of the jaws; and the angle of the lower jaw is almost a right angle. In old age the teeth fall out, the jaws shrink in, their dental borders become absorbed, the angle of the lower jaw, as in infancy, is obtuse; the vertex and floor of the skull also become flattened, and the sides bulge outwards,—changes due to gravitation and the subsidence of the bones by their own weight.

The skull of a woman is smaller and lighter, with the muscular ridges and projections due to the air sinuses less strongly marked than in a man, but with the eminences or centres of ossification more prominent. The more feeble air sinuses imply a more restricted respiratory activity and a less active mode of life than in a man. The internal capacity is about 10 per cent. less than that of the male. The face is smaller in proportion to the cranium; the cranium is more flattened at the vertex, and the height is consequently not so great in proportion to the length as in the man. In the female skull, therefore, the infantile characters are less departed from than is the case in the male.

Upper Limb.

Turning now to the APPENDICULAR SKELETON, we shall consider first that of the SUPERIOR or THORACIC or PECTORAL EXTREMITY, or UPPER LIMB. The Upper Limb may be subdivided into a proximal part or shoulder, a distal part or hand, and an intermediate shaft, which consists of an upper arm or *brachium*, and a fore-arm or *antibrachium*. In each of these subdivisions certain bones are found: in the shoulder, the clavicle and scapula; in the upper arm, the humerus; in the fore-arm, the radius and ulna, the bone of the upper arm in man being longer than the bones of the fore-arm; in the hand, the carpal and metacarpal bones and the phalanges. The scapula and clavicle together form an imperfect bony arch, the Scapular Arch or Shoulder Girdle; the shaft and hand form a free divergent Appendage. The shoulder girdle is the direct medium of connection between the axial skeleton and the divergent part of the limb; its anterior segment, the clavicle, articulates with the upper end of the sternum, whilst its posterior segment, the scapula, approaches, but does not reach, the dorsal spines.

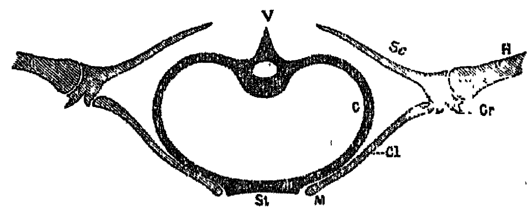


FIG. 8.—Diagrammatic section to represent the relations of the shoulder girdle to the trunk. V, a Dorsal Vertebra; C, a Rib; St, the Sternum; Sc, the Scapula; Cr, the Coracoid; Cl, the Clavicle; M, the Meniscus at its sternal end; H, the Humerus.

Clavicle.

The Clavicle, or Collar Bone (Fig. 9), is an elongated bone which extends from the upper end of the sternum horizontally outwards, to articulate with the acromion process of the scapula. It presents a strong sigmoidal curve, which is associated with the transverse and horizontal direction of the axis of the human shoulder. It is slender in the female, but powerful in muscular males; its sternal end thick and somewhat triangular; its acromial end, flattened from above downwards, has an oval articular surface for the acromion. Its shaft has four surfaces for the attachment of muscles; and a strong ligament, connecting it with the coracoid, is attached to the under surface, near the outer end, whilst near the inner a strong ligament passes between it and the first rib. The clavicle is absent in the hoofed quadrupeds, in the seals and whales, and is feeble in the carnivora; but is well formed, not only in man, but in apes, bats, and in many rodents and insectivora.

Scapula.

The Scapula, or Shoulder Blade (Fig. 9), is the most important bone of the shoulder girdle, and is present in all mammals. It lies at the upper and back part of the wall of the chest, reaching from the second to the seventh rib. Its form is plate-like and triangular, with three surfaces, three borders, and three angles. The fundamental form of the scapula, as seen in the mole, is that of a three-sided prismatic rod, and its assumption of the plate or blade-like character in man is in connection with the great development of the muscles which rotate the humerus at the shoulder joint. Its costal or ventral surface is in relation to the ribs, from which it is separated by certain muscles: one, called subscapularis, arises from the surface itself, which is often termed *subscapular fossa*. The dorsum or back of the scapula is traversed from behind forwards by a prominent *spine* (Pl. XIV., fig. 1, S), which lies in the proper axis of the scapula, and subdivides this aspect of the bone into a surface above the spine, the

supra- or *præ-spinous fossa*, and one below the spine, the *infra-* or *post-spinous fossa*. The spine arches forwards, to end in a broad flattened process, the *acromion*, which has an oval articular surface for the clavicle; both spine and acromion are largely developed in the human scapula in correlation with the great size of the trapezius and deltoid muscles, which are concerned in the elevation and abduction of the upper limb. The borders of the scapula, directed upwards, backwards, and downwards, give attachment to several muscles. The angles are inferior, supero-posterior, and supero-anterior. The supero-anterior is the most important; it is truncated, and presents a large, shallow, oval, smooth surface, the *glenoid fossa*, for articulation with the humerus, to form the shoulder joint. Overhanging the glenoid fossa is a curved beak-like process, the *coracoid*, which is of importance as corresponding with the separate coracoid bone of birds and reptiles. The line of demarcation between it and the scapula proper is marked on the upper border of the scapula by the supra-scapular notch.

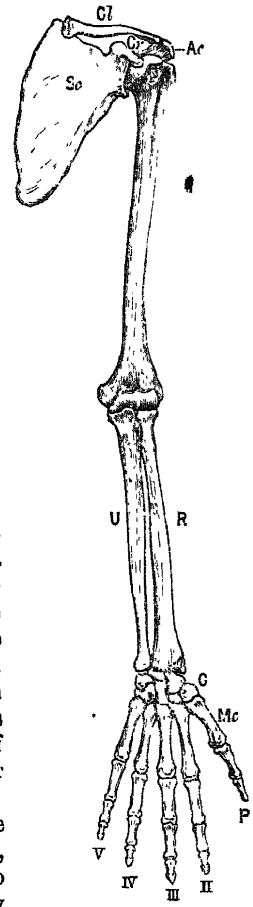


FIG. 9.—The Appendicular Skeleton of the Left Upper Limb. Cl, clavicle; Sc, scapula, Ac, acromion process; Cr, coracoid process of scapula; H, humerus; R, radius; U, ulna; C, opposite the eight carpal bones; Mc, opposite the five metacarpal bones; P, pollex, or thumb; II. index, III. middle, IV. ring, V. little finger.

Humerus. The Humerus, or bone of the Upper Arm (Fig. 9), is a long bone, and consists of a shaft and two extremities. The upper extremity of this bone possesses a convex spheroidal smooth surface, the *head*, for articulation with the glenoid fossa of the scapula; it is surrounded by a narrow constricted *neck*, and where the neck and shaft become continuous with each other, two processes or *tuberosities* are found, to which are attached the rotator muscles arising from the scapular fossæ. Between the tuberosities is a groove in which the long tendon of the biceps rests. A line drawn through the head of the humerus perpendicular to the middle of its articular surface, forms with the axis of the shaft of the bone an angle of 40°. The shaft of the humerus is cylindriform above, but flattened and expanded below; about midway down the outer surface is a rough ridge for the insertion of the deltoid muscle, and on the inner surface another rough mark for the insertion of the coraco-brachialis. The demarcation between the cylindriform and expanded parts of the shaft is marked by a shallow groove winding round the back of the bone, in which the musculo-spiral nerve is lodged. The lower extremity of the humerus consists of an articular and a non-articular portion. The articular presents a small head or *capitellum* for the radius, and a pulley or *trochlea* for the movements of the ulna in flexion and extension of the limb. The non-articular part consists of two condyloid eminences, internal and external. From the external, or *epi-condyle*, a ridge passes for some distance along the outer border of the bone; it gives origin to the supinator and extensor muscles in the fore-arm. From the internal eminence, or *epi-trochlea*, a ridge passes up the inner border of the shaft of the bone; this eminence gives origin to the pronator and flexor muscles in the fore-arm. In nearly two per cent of the bodies examined in the anatomy-rooms in the university of Edinburgh, a hooked process has been seen projecting from the shaft of the bone, about 2 inches above the epi-trochlea; this process is connected to the epi-trochlea by a fibrous band, so as to form a foramen, which has been called *supra-condyloid*. In these cases the median nerve invariably passes through the foramen, and not unfrequently is accompanied by the brachial artery. In the feline carnivora and some other mammals a foramen constantly occurs in this part of the humerus, through which, as a rule, both nerve and artery proceed, though in the common seal it transmits only the nerve.

Before describing the two bones of the fore-arm, the anatomist should note the range of movement which can take place between them. In one position, which is called *supine*, they lie parallel to each other, the radius being the more external bone, and the palm of the hand being directed forwards; in the other or *prone* position the radius crosses obliquely in front of the ulna, and the palm of the hand is directed backwards. Not only the bones of the fore-arm, but those of the hand are supposed to be in the supine position when they are described.

The Radius (Fig. 9) is the outer bone of the Fore-arm, and Radius. like all long bones possesses a shaft and two extremities. The upper extremity or *head* has a shallow, smooth cup for moving on the capitellum of the humerus; the outer margin of the cup is also smooth, for articulation with the ulna and annular ligament; below the cup is a constricted *neck*, and immediately below the neck a *tuberosity* for the insertion of the biceps. The shaft of the bone possesses three surfaces for the attachment of muscles, and a sharp inner border for the interosseous membrane. The lower end of the bone is much broader than the upper, and is marked posteriorly by grooves for the lodgment of tendons passing to the back of the hand: from its outer border a pointed *styloid* process projects downwards; its inner border has a smooth shallow fossa for articulation with the ulna, and its broad lower surface is smooth and concave, for articulation with the scaphoid and semilunar bones of the wrist.

The Ulna (Fig. 9) is also a long bone. Its upper end is Ulna. subdivided into two strong processes by a deep fossa, the *greater sigmoid cavity*, which possesses a smooth surface for articulation with the trochlea of the humerus. The anterior or *coronoid* process is marked by an oblique ridge for the insertion of the brachialis anticus, whilst the posterior or *olecranon* process gives insertion to the large triceps muscle of the upper arm. Immediately below the outer border of the great sigmoid cavity is the *small sigmoid cavity* for articulation with the side of the head of the radius. The shaft of the bone possesses three surfaces for the attachment of muscles, and a sharp outer border for the interosseous membrane. The lower end, much smaller than the upper, has a pointed *styloid* process and a smooth articular surface, the outer portion of which is for the lower end of the radius, the lower part for moving on a cartilage of the wrist joint called the triangular fibro-cartilage.

The Hand consists of the Carpus or wrist, of the Meta- Hand. carpus or palm, and of the free Digits, the thumb and four fingers. Anatomists describe it with the palm turned to the front, and with its axis in line with the axis of the fore-arm.

The Carpal or Wrist bones (Fig. 9) are eight in number Carpus. and small in size: they are arranged in two rows, a *proximal*,—*i.e.* a row next the fore-arm,—consisting of the scaphoid, semilunar, cuneiform, and pisiform; and a *distal*, —*i.e.* a row next the bones of the palm,—consisting of a trapezium, trapezoid, os magnum, and unciform; the bones in each row being named in the order they are met with,

from the radial or outer to the ulnar or inner side of the wrist. It is unnecessary to give a separate description of each bone. Except the pisiform or pea-shaped bone, which articulates with the front of the cuneiform, each carpal bone is short and irregularly cuboidal in shape; its anterior (or palmar) surface and its posterior (or dorsal) being rough, for the attachment of ligaments; its superior and inferior surfaces being invariably smooth, for articulation with adjacent bones; whilst the inner and outer surfaces are also smooth, for articulation, except the outer surfaces of the scaphoid and trapezium (the two external bones of the carpus), and the inner surfaces of the cuneiform and unciform (the two internal bones). Occasionally a ninth or supernumerary bone may arise from the subdivision of the scaphoid, semilunar, or trapezoid, into two pieces; more rarely a distinct bone is found in the human wrist intercalated between the trapezoid, os magnum, semilunar, and scaphoid, which corresponds in position to the os intermedium, found constantly in the wrist of the orang, gibbon, the tailed apes, and many rodents and insectivora.

Metacarpus. The Metacarpal bones, or bones of the Palm of the Hand, are five in number (Fig. 9). They are miniature long bones, and each possesses a shaft and two extremities. The metacarpal of the thumb is the shortest, and diverges outwards from the rest: its carpal extremity is saddle-shaped, for articulation with the trapezium; its shaft is somewhat compressed, and its phalangeal end is smooth and rounded, for the first phalanx of the thumb. The four other metacarpal bones belong to the four fingers: they are almost parallel to each other, and diminish in size from the second to the fifth. Their carpal ends articulate with the trapezoid, os magnum, and unciform: their shafts are three-sided: their phalangeal ends articulate with the first phalanges of the fingers.

Digits. The number of Digits in the hand is five, which is the highest number found in the mammalia. They are distinguished by the names of pollex or thumb, and index, middle, ring, and little fingers. Their skeleton consists of fourteen bones, named phalanges, of which the thumb possesses two, and each of the four fingers three. The phalanx next the metacarpal bone is the first, that which carries the nail is the terminal or ungual phalanx, whilst the intermediate bone is the second phalanx. Each is a miniature long bone, with two articular extremities and an intermediate shaft, except the terminal phalanges, which have an articular surface only at their proximal ends, the distal end being rounded and rough, to afford a surface for the lodgment of the nail.

Lower limb. The INFERIOR or PELVIC EXTREMITY, or LOWER LIMB, consists of a proximal part or haunch, a distal part or foot, and an intermediate shaft subdivided into thigh and leg. Each part has its appropriate skeleton: in the haunch, the pelvic or innominate bone; in the thigh, the femur; in the leg, the tibia and fibula (the thigh-bone in man being longer than the leg-bones); in front of the knee, the patella; in the foot, the tarsal and metatarsal bones and phalanges. The bone of the haunch forms an arch or Pelvic Girdle, which articulates behind with the side of the sacrum, and arches forward to articulate with the opposite haunch-bone at the pubic symphysis. It is the direct medium of connection between the axial skeleton and the shaft and foot, which form a free divergent Appendage.

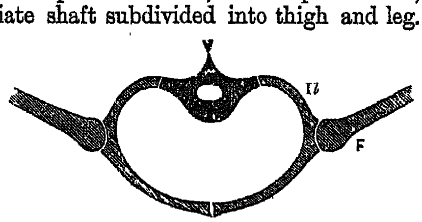


FIG. 10.—Diagrammatic section to represent the relations of the Pelvic Girdle to the Trunk. V, a sacral vertebra; Il, the ilium; P, the two pubic bones meeting in front at the symphysis; F, the femur.

Pelvic girdle. The Os Innominatum, or Haunch-bone, is a large irregular plate-like bone, which forms the lateral and anterior boundary of the cavity of the pelvis. In early life it consists of three bones—ilium, ischium, and pubis—which unite about the twenty-fifth year into a single bone. These bones converge, and join to form a deep fossa or cup, the *acetabulum* or *cotyloid cavity*, on the outer surface of the bone, which lodges the head of the thigh-bone at the hip-joint. One-fifth of this cup is formed by the pubes, and about two-fifths each by the ischium and ilium. At the bottom of the acetabulum is a depression, to the sides of which the *interarticular ligament* of the hip-joint is attached. From the acetabulum the ilium extends upwards and backwards, the ischium downwards and backwards, the pubis forwards and inwards. In front of the acetabulum is a large hole, the *obturator* or *thyroid foramen*, which is bounded by the ischium and pubes; behind the acetabulum is the deep *sciatic notch*, which is bounded by the ischium and ilium.

Ilium. The Ilium (Fig. 10) in man is a broad plate-like bone. In its most simple form, as in the kangaroo, it is a three-sided, prismatic, rod-like bone, one end of which enters into the formation of the acetabulum, whilst the other is free, and forms the iliac crest. In man, notwithstanding its expanded form, three surfaces may also be recognised, corresponding to the surfaces in the ilium of the kangaroo; and, as in that animal, the lower end aids in forming the acetabulum, while the upper end forms the iliac crest, which, in man, in conformity with the general expansion of the bone, is elongated into the sinuous crest of the ilium. This crest is of great importance, for it affords attachment to the broad muscles which form the wall of the abdominal cavity. One surface of the ilium is *external*, and marked by curved lines which subdivide it into areas for the origin of the muscles of the buttock; another surface is *anterior*, and hollowed out to give origin to the iliacus muscle; the third, or *internal*, surface articulates posteriorly with the sacrum, whilst anteriorly it forms a part of the wall of the true pelvis. The external is separated from the anterior surface by a border which joins the anterior end of the crest, where it forms a process, the *anterior superior spine*. About the middle of this border is the *anterior inferior spine*. Between the external and internal surfaces is a border on which are found the *posterior superior* and *inferior spines*; between the anterior and internal surfaces is the pectineal border, which forms part of the line of separation between the true and false pelvis.

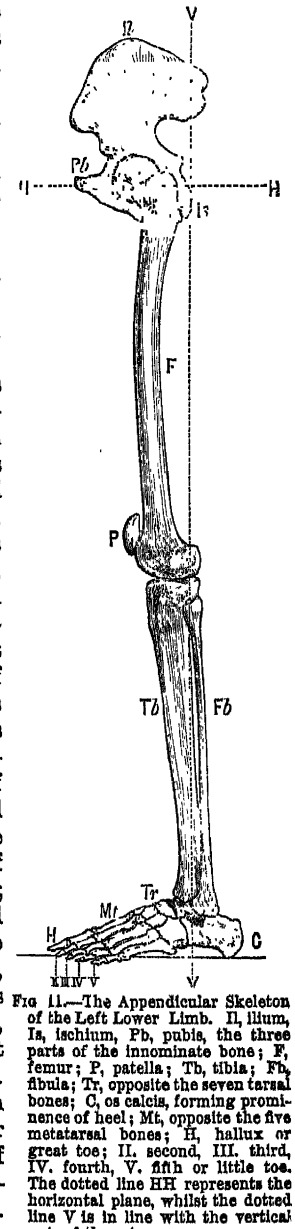


FIG. 11.—The Appendicular Skeleton of the Left Lower Limb. Il, ilium, Is, ischium, Pb, pubis, the three parts of the innominate bone; F, femur; P, patella; Tb, tibia; Fb, fibula; Tr, opposite the seven tarsal bones; C, os calcis, forming prominence of heel; Mt, opposite the five metatarsal bones; H, hallux or great toe; II. second, III. third, IV. fourth, V. fifth or little toe. The dotted line HH represents the horizontal plane, whilst the dotted line V is in line with the vertical axis of the spine.

The Pubis (Fig. 11) is also a three-sided, prismatic, rod-

Pubis. like bone, the fundamental form of which is obscured by the modification in shape of its inner end. In human anatomy it is customary to regard it as consisting of a *body* and of two branches, a *horizontal* and a *descending ramus.* The body and horizontal ramus form the fundamental prismatic rod, and the descending ramus is merely a special offshoot from the inner end of the rod. The outer end of the rod takes a part in the formation of the acetabulum; the inner end is expanded into the body of the pubis, and has a broad margin, or *symphysis*, for articulation with the corresponding bone on the opposite side of the pelvis. The three surfaces are—a *superior*, for the origin of the pectineus muscle; a *posterior*, which enters into the wall of the true pelvis; and an *inferior*, which forms the upper boundary of the obturator foramen. The descending ramus is merely a downward prolongation of the inner end of the bone which joins the ischium, and aids in forming the side of the pubic arch. The junction of the outer end of the pubis with the ilium is marked by the *pectineal eminence.* The superior and posterior surfaces are separated by the sharp *pectineal line*, which, starting from the *spine* of the pubis, runs outwards to aid in forming the brim of the true pelvis.

Ischium. The Ischium (Fig. 11), like the ilium and pubis, has the fundamental form of a three-sided prismatic rod. One extremity (the upper) completes the acetabulum, whilst the lower forms the large prominence, or *tuber ischii.* The surfaces of the bone are *internal* or pelvic, *external*, and *anterior.* The pelvic and external surfaces are separated from each other by a sharp border, on which is seen the *ischial spine.* The pelvic and anterior surfaces are separated by a border, which forms a part of the boundary of the obturator foramen; but the margin between the external and anterior surfaces is feebly marked. The tuberosity, a thick, rough, and strong process, gives origin to several powerful muscles: on it the body rests in the sitting posture; an offshoot, or ramus, ascends from it to join the descending ramus of the pubis, and completes both the pubic arch and the margin of the obturator foramen.

Pelvis. By the articulation of the two innominate bones with each other in front at the pubic symphysis, and with the sides of the sacrum behind, the osseous walls of the cavity of the PELVIS are formed. This cavity is subdivided into a false and a true pelvis. The false pelvis lies between the expanded wing-like portions of the two ilia. The true pelvis lies below the two pectineal lines and the base of the sacrum, which surround the upper orifice or brim of the true pelvis, or pelvic inlet; whilst its lower orifice or outlet is bounded behind by the coccyx, laterally by the ischial tuberosities, and in front by the pubic arch. In the erect attitude the pelvis is so inclined that the plane of the brim forms with the horizontal plane an angle of from 60° to 65°. The axis of the cavity is curved, and is represented by a line drawn perpendicularly to the planes of the brim, the cavity, and the outlet; at the brim it is directed upwards and forwards, at the outlet downwards and a little forwards. Owing to the inclination of the pelvis, the base of the sacrum is nearly 4 inches higher than the upper border of the pubic symphysis. The female pelvis is distinguished from the male by certain sexual characters. The bones are more slender, the ridges and processes for muscular attachment more feeble, the breadth and capacity greater, the depth less, the ilia more expanded, giving the greater breadth to the hips of a woman than a man; the inlet more nearly circular, the pubic arch wider, the distance between the tuberosities greater, and the obturator foramen more triangular in the female than in the male. The greater capacity of the woman's than the man's pelvis is to afford greater room for the expansion of the uterus during pregnancy, and for the expulsion of the child at the time of birth.

Femur. The Femur or Thigh-bone (Fig. 11) is the longest bone in the body, and consists of a shaft and two extremities. The upper extremity or *head* possesses a smooth convex surface, in which an oval roughened fossa, for the attachment of the inter-articular ligament of the hip, is found; from the head a strong elongated *neck* passes downwards and outwards to join the upper end of the shaft; the place of junction is marked by two processes or *trochanters:* the *external* is of large size, and to it are attached many muscles; the *internal* is much smaller, and gives attachment to the psoas and iliacus. A line drawn through the axis of the head and neck forms with a vertical line drawn through the shaft an angle of 30°; in a woman this angle is less obtuse than in a man, and the obliquity of the shaft of the femur is greater in the former than in the latter. The shaft is almost cylindrical about its centre, but expanded above and below; its front and sides give origin to the extensor muscles of the leg; behind there is a rough ridge, which, though called *linea aspera*, is really a narrow surface and not a line; it gives attachment to several muscles. The lower end of the bone presents a large smooth articular surface for the knee-joint, the anterior portion of which forms a *trochlea* or pulley for the movements of the patella, whilst the lower and posterior part is subdivided into two convex *condyles* by a deep fossa which gives attachment to the crucial ligaments of the knee. The inner and outer surfaces of this end of the bone are rough, for the attachment of muscles and the lateral ligaments of the knee.

Patella. The Patella or Knee-pan (Fig. 11) is a small triangular flattened bone developed in the tendon of the great extensor muscles of the leg. Its anterior surface and sides are rough, for the attachment of the fibres of that tendon; its posterior surface is smooth, and enters into the formation of the knee-joint.

Between the two bones of the leg there are no movements of pronation and supination as between the two bones of the fore-arm. The tibia and fibula are fixed in position; the fibula is always external, the tibia internal.

Tibia. The Tibia or Shin-bone (Fig. 11) is the larger and more important of the two bones of the leg; the femur moves and rests upon its upper end, and down it the weight of the body in the erect position is transmitted to the foot. Except the femur, it is the longest bone of the skeleton, and consists of a shaft and two extremities. The upper extremity is broad, and is expanded into two *tuberosities*, the external of which has a small articular facet inferiorly, for the head of the fibula; superiorly, the tuberosities have two smooth surfaces, for articulation with the condyles of the femur; they are separated by an intermediate rough surface, from which a short *spine* projects, which gives attachments to the inter-articular crucial ligaments and semilunar cartilages of the knee, and lies opposite the intercondyloid fossa of the femur. The shaft of the bone is three-sided; its inner surface is subcutaneous, and forms the shin; its outer and posterior surfaces are for the origin of muscles; the anterior border forms the sharp ridge of the shin, and terminates superiorly in a tubercle for the insertion of the extensor tendon of the leg; the outer border of the bone gives attachment to the inter-osseous membrane of the leg. The lower end of the bone, smaller than the upper, is prolonged into a broad process, *internal malleolus*, which forms the inner prominence of the ankle: its under surface is smooth for articulation with the astragalus; externally it articulates with the lower end of the fibula.

Fibula. The Fibula, or Splint-bone of the leg (Fig. 11), is a slender long bone with a shaft and two extremities. The upper end or *head* articulates with the outer tuberosity of

the tibia. The shaft is three-sided, and roughened for the origins of muscles; along the inner surface is a slender ridge for the attachment of the interosseous membrane. The lower end has a strong process (*external malleolus*) projecting downwards to form the outer prominence of the ankle, and possesses a smooth inner surface for articulation with the astragalus, above which is a rough surface for the attachment of ligaments which bind together the tibia and fibula.

Foot. The Foot consists of the Tarsus, the Metatarsus, and the five free Digits or Toes, which is the maximum number found in mammals. The human foot is placed in the prone position, with the sole or plantar surface in relation to the ground; the dorsum or back of the foot directed upwards; the axis of the foot at about a right angle to the axis of the leg; and the great toe or hallux, which is the corresponding digit to the thumb, at the inner border of the foot. The human foot, therefore, is a pentadactylous, plantigrade foot.

Tarsus. The bones of the Tarsus, or Ankle (Fig. 11, Tr), are seven in number, and are arranged in two transverse rows,—a proximal, next the bones of the leg, consisting of the astragalus, os calcis, and scaphoid; a distal, next the metatarsus, consisting of the cuboid, ecto-, meso-, and ento-cuneiform. If the tarsal bones be looked at along with those of the metatarsus and toes, the bones of the foot may be arranged in two longitudinal columns,—an outer, consisting of the os calcis, cuboid, and the metatarsal bones and phalanges of the fourth and fifth toes; an inner column consisting of the astragalus, scaphoid, three cuneiform, and the metatarsal bones and phalanges of the first, second, and third toes. The tarsal, like the carpal bones, are short and irregularly cuboidal; the dorsal and plantar surfaces are as a rule rough for ligaments, but as the astragalus is locked in between the bones of the leg and the os calcis, its dorsal and plantar surfaces, as well as the dorsum of the os calcis, are smooth for articulation; similarly, its lateral surfaces are smooth for articulation with the two malleoli. The posterior surface of the os calcis projects backwards to form the prominence of the heel. With this exception, the bones have their anterior and posterior surfaces smooth for articulation. Their lateral surfaces are also articular, except the outer surface of the os calcis and cuboid, which form the outer border; and the inner surface of the os calcis, scaphoid, and ento-cuneiform, which form the inner border of the tarsus. A supernumerary bone is sometimes found in the human tarsus, from a subdivision of either the ento-cuneiform, astragalus, os calcis, or cuboid into two parts. In some rodents and other mammals eight is the normal number of bones in the tarsus.

Toes. The Metatarsal bones and the Phalanges of the toes agree in number and general form with the metacarpal bones and the phalanges in the hand. The bones of the great toe or hallux are more massive than those of the other digits, and this digit, unlike the thumb or pollex, does not diverge from the other digits, but lies almost parallel to them.

Development and Homologies of the Skeleton.

It will now be advisable to consider briefly the mode of development of the skeleton, and along with the study of its genesis to compare its several parts with each other, in order to ascertain if correspondences in their arrangement and mode of origin exist, even if they differ in the function or office which they perform. When two or more parts or organs correspond with each other in structure, relative position, and mode of origin, we say they are homologous parts, or *homologues;* whilst parts which have the same function, but do not correspond in structure, relative position, and mode of origin, are analogous parts, or *analogues.* Homologous parts have therefore a morphological identity with each other, whilst analogous parts have a physiological agreement. The same parts may be both homologous and analogous, as the fore-limbs of a bat and a bird, both of which, with the same fundamental type of structure, are subservient to flight. In other cases analogous parts are not homologues, as is illustrated by the wing of the insect, which, though subservient to flight, is fundamentally different in structure from the wing of the bat or bird.

In the germinal area of the fertilised vertebrate ovum a longitudinal groove appears which marks the beginning of the cranial cavity and spinal canal of the young embryo. At the bottom of this *cranio-spinal groove* a slender rod is formed, called *chorda dorsalis* or *notochord.* Each side of the groove then becomes elevated as a thin membrane, to meet behind to enclose a canal in which the brain and spinal marrow are developed. Small dark masses, the primordial or *proto-vertebræ,* next form on each side of the chorda dorsalis. In these proto-vertebræ, about the sixth or seventh week of intra-uterine life of the human ovum, little masses of cartilage appear, which correspond in number and position to the future spinal vertebræ. The part of the cartilage which forms the body of the future vertebra is developed around the chorda dorsalis, which it encloses in its substance, whilst the cartilaginous neural arch forms in the membrane which closes in the spinal canal. The formation of these cartilaginous vertebræ is completed in the human embryo about the fourth month of intra-uterine life. The bodies of the cartilaginous vertebræ are connected together by plates or discs of intervening fibro-cartilage, which are also developed around the chorda dorsalis. After the enclosure of the rod-like chorda by the cartilaginous vertebræ and the inter-vertebral discs it disappears, no remains being found in the adult human body, or in that of the higher vertebrates, except perhaps some slight traces in the soft pulpy centres of the inter-vertebral discs; although in the cartilaginous fish it remains as a more or less complete structure throughout life.

In each of the cartilaginous vertebræ bone begins to form and to spread beyond its original point of formation, which is called a centre or nucleus of ossification; the greater part of the body is formed from one of these centres, and each half of the neural arch from another; whilst small ossific centres arise for the tips of the spinous, transverse, and mammillary processes, and a special plate appears for both the upper and lower surfaces of the body; the fusion of the various centres together to form a complete vertebra takes place between the twentieth and twenty-fifth year. The atlas has a separate centre for each lateral mass and one for the anterior boundary of the ring. The axis, in addition to the ossific centres found in the vertebræ generally, has one or two for the odontoid process. The seventh cervical vertebra has the anterior bar of its transverse process developed from a separate centre. Each coccygeal vertebra possesses only a single centre, which represents the body of the bone.

At the time when the cranio-spinal canal is being closed in by the development of its membranous walls, the germinal layers of the young embryo grow towards its anterior or ventral surface, and meet in the ventral mesial line, so as to enclose the cavities in which the thoracic and abdominal viscera are developed. In the membranous wall on each side of the thoracic cavity twelve cartilaginous rods, the future ribs, are developed; and, connected with the anterior ends of the seven pairs of upper ribs, the cartilaginous sternum is formed. Each rib ossifies from one centre for its shaft, and one each for the head and tubercle. The sternum ossifies in transverse segments,—one for the præ-sternum, one or sometimes two for each of the four subdivisions of the meso-sternum, and one for the xiphi-sternum. The complete ossification and fusion of the different parts of the sternum into a single bone does not take place until an advanced age.

The axial part of the skeleton, formed by the vertebræ, ribs, and sternum, is built up of a series of thirty-three transverse segments, equal in number, therefore, to the bones of the spine; so that each vertebra, according as it is, or is not, articulated with a pair of ribs and a segment of the sternum, constitutes a complete or incomplete transverse segment. These several segments are serially homologous with each other, but the homology is not so complete in some of the segments as in the others. In the coccygeal, sacral, and lumbar regions of man and most vertebrates, only the vertebral portion of each skeletal segment is represented, though in the abdominal wall of the crocodiles abdominal ribs and a sternum are developed. In the thoracic region the five lowest dorsal vertebræ have five pairs of ribs developed in connection with them; whilst the seven highest vertebræ have not only their corresponding pairs of ribs, but also a sternum, which bone, however, has only six transverse segments. In the cervical region seven vertebræ are found, but the anterior bar of the transverse process, although fused with the vertebral body, is homologous with a rib, for in man it sometimes develops as a distinct movable rib in connection with the seventh cervical; and in the crocodiles small movable ribs are regularly developed in connection with the different cervical vertebræ. The bodies and neural arches of the vertebræ are serially homologous with each other; as a rule this is also the case with their processes, but the articular processes of the atlas and the superior pair of the axis, although functionally analogous, are not homologous with the articular processes of the other vertebræ, but with the articular surfaces for the ribs on the bodies of the dorsal

vertebræ, for they lie in front of, and not behind, the vertebral notches through which the spinal nerves are transmitted. The development of the odontoid process of the axis shows it to be the body of the atlas displaced from its proper bone and fused with the body of the axis.

The development and homology of the skull is a much more difficult problem to solve than that of the spine. The chorda dorsalis extends along the floor of the skull as far forward as the posterior wall of the pituitary fossa. Cartilage is formed around it, without, however, the previous production of proto-vertebræ, and this cartilage is prolonged forward on each side of the fossa, forming two bars, the trabeculæ cranii; these bars then unite, and form the mes-ethmoid cartilage; at the same time the cartilage grows outwards for some distance in the membranous wall of the skull, but it does not mount upwards so as to close it in superiorly, so that the cartilage is limited to the floor of the skull; moreover, the cartilage is not segmented. The roof, side walls, and anterior wall of the cranium retain for a time their primordial membranous structure. This membrane is prolonged downwards into the face proper, where it forms a pair of maxillary lobes or processes, which pass forwards beneath the eyes to form the side parts of the face, and a mid- or frontal-nasal process, into which the cartilaginous mes-ethmoid extends. Immediately below each maxillary lobe four arches, called *branchial* or *visceral*, arise in the ventral aspect of the head, and in each of the three first of these arches a rod of cartilage is formed. The arches on opposite sides unite with each other in the ventral mesial line, but those on the same side are separated from each other by intermediate branchial clefts; these clefts all close up in course of time, except the upper part of the first, which remains as the external meatus of the ear, the tympanum, and the Eustachian tube; whilst the interval between the first visceral arch and the maxillary lobes forms the cavity of the mouth. The conversion of the primordial cartilaginous and membranous cranium into the bones of the head takes place by the formation in it of numerous centres of ossification. The basi-, ex-, and so much of the supra-occipital as lies below the superior curved line, are formed from distinct centres in the cartilaginous floor of the skull; whilst the part of the supra-occipital above the curved line arises from independent centres in the membranous cranium, the whole ultimately fusing together to form the occipital bone. The basi- or post-sphenoid, the pre- with the orbito-sphenoids, the ali-sphenoid with the external pterygoid and the internal pterygoid, also arise in the cartilaginous floor, and they, together with the sphenoidal spongy bones which are formed in the membranous cranium, fuse into the sphenoid bone. The palate is apparently formed by ossification of cartilage continuous with the bar in which the internal pterygoid arises. The central plate and each lateral mass of the ethmoid also arise in the cartilage by distinct centres. The inferior turbinal has also a distinct origin in cartilage. The petro-mastoid part of the temporal arises in cartilage from at least three centres, peri-, pro-, and opisth-otic, and soon blends with the squamous and tympanic elements which arise in the membranous cranium; subsequently the styloid process, which is ossified in the rod of cartilage in the second visceral arch, joins the temporal. The lower end of this same rod forms the lesser cornu of the hyoid; the upper end forms two small bones, the stapes and incus, situated within the cavity of the tympanum. The cartilage of the third visceral arch forms the great cornu and body of the hyoid bone. The name of Meckel's cartilage is applied to the rod found in the first visceral arch; its upper end is ossified into the malleus, a small bone situated in the tympanic cavity; whilst in the membrane surrounding the rest of the cartilage the lower jaw-bone is formed. The parietal and frontal bones arise altogether in the membranous vault; and the nasal, lachrymal, malar, and superior maxillæ arise in connection with the bones which form the face; the vomer is developed in the membrane investing the mes-ethmoid cartilage. The human superior maxilla represents not only the superior maxilla of other vertebrates, but the pre-maxillary bone also; but the two bones become fused together at so very early a period that it is difficult to recognise their original independence. In the deformity of hare-lip and cleft palate, they are not unfrequently separated by a distinct fissure.

Since the time when Oken and Goethe propounded the theory that the skull was built up of several vertebræ, the vertebral structure of the skull has led to much discussion amongst anatomists. Every one admits that the skull is in series with the spine, that the cranial cavity is continuous with the spinal canal, and that the cranial vault is formed in the wall of the embryonic cerebro-spinal canal. The skull also, like the spine, is transversely segmented, but whether we regard these segments as vertebræ or not will depend upon the conception we entertain of the meaning of the term vertebra. If with Owen we define a vertebra to be "one of those segments of the endo-skeleton which constitute the axis of the body and the protective canals of the nervous and vascular trunks," then we may support the vertebral nature of the cranial segments on the following grounds:—*1st*, The presence of a series of bones extending forwards from the foramen magnum along the basis cranii, in series with the bodies of the spinal vertebræ,—*e.g.*, the basi-occipital, basi-sphenoid, pre-sphenoid, mes-ethmoid (Fig. 7); *2d*, The presence of a series of neural arches which enclose and complete the wall of the cranial cavity, and lie in series with the neural arches of the spinal vertebræ,—*e.g.*, the ex- and supra-occipitals, which form the neural arches of the basi-occipital segment; the ali-sphenoids and parietals, which form the neural arches of the basi-sphenoid segment; the orbito-sphenoids and frontal, which form the neural arches of the pre-sphenoid segment; *3d*, The presence of a series of visceral arches of which the mandibular and hyoidean enclose the alimentary and vascular canals, just as the ribs enclose them in the thorax; and *4th*, The presence of foramina between the cranial segments like the inter-vertebral foramina between the spinal vertebræ for the transmission of nerves,—*e.g.*, the sphenoidal fissure and the jugular foramen.

But if we are to regard a vertebra as a segment of the axial skeleton, which in course of its formation passes through a definite series of developmental changes, then the cranial segments cannot be regarded as vertebræ in the same sense as the spinal segments; for, *1st*, The chorda dorsalis is not co-equal in length with the basis cranii, as with the bodies of the spinal vertebræ, so that if the basi-occipital and basi-sphenoid segments, the bodies of which are developed around it, were to be regarded as cranial vertebræ, the pre-sphenoidal and ethmoido-nasal would not be morphologically the same, as they are formed in front of the anterior end of the chorda. *2d*, Proto-vertebræ are formed in the spine, but not in the basis cranii. *3d*, The spine is transversely segmented in its cartilaginous stage of development, but the skull is not. *4th*, The transverse segmentation of the skull only appears when the bones are formed, but the individuality of the segments becomes again concealed by the fusion of the pre- and basi-sphenoids and the basi-occipital into a continuous bar of bone, a condition which is not found in the spine except in the sacro-coccygeal region. *5th*, The neural arches in the spine are, like the bodies, ossified in cartilage, but in the cranium they are for the most part ossified in membrane. These differences in the mode of development of the spine and basis cranii may be summarised as below:—

Spine.

1st Stage,	*2d Stage,*	*3d Stage,*	*4th Stage,*
Unsegmented chorda.	Proto-vertebræ.	Segmented cartilage.	Segmented bones.

Basis Cranii.

1st Stage,	*2d Stage,*	*3d Stage,*	*4th Stage,*
Unsegmented chorda in part.	Unsegmented cartilage.	Segmented bones.	Unsegmented bones.

It is evident, therefore, that, although both skull and spine are developed in the walls of the cerebro-spinal groove, yet, to quote the words of Huxley, "though they are identical in general plan of construction, the two begin to diverge as soon as the one puts on the special character of a skull and the other that of a vertebral column; the skull is no more a modified vertebral column than the vertebral column is a modified skull."

The limbs, at their first appearance, sprout like little buds or lappets from the sides of the trunk; cartilage forms within them, which assumes the shape of the future bones, and as the limbs grow outwards, manifestations of joints appear, and the subdivision of each limb into its several segments takes place. The clavicle, which ossifies before any of the other bones, begins to form, however, in fibrous membrane; and at a much later period the ends of the bone, which are formed in cartilage, unite with the intermediate shaft. The scapula ossifies from one centre for its expanded plate and spine, two small centres each for the acromion and vertebral border, and one for the coracoid. In many vertebrates, more especially birds and reptiles, the coracoid is a distinct bone from the scapula, but they articulate with each other to form the glenoid fossa. Each of the three rod-like bones of which the innominate bone is composed, ossifies from one centre for the shaft of the bone, and one for each extremity; in the ilium these terminal centres are situated at the crest and acetabulum; in the ischium, at the tuber and acetabulum; and in the pubis, at the symphysis and acetabulum. Each of the long bones of the shafts of the limbs ossifies from a single centre for the shaft, and one or more centres for each articular extremity. Each carpal and tarsal bone ossifies from a single centre, except the os calcis, which possesses an independent centre for its posterior surface. The metacarpal and metatarsal bones and the phalanges ossify each from two centres, one for the shaft and one for one of the extremities. In the metacarpal bones of the fingers and the four outer metatarsals, the distal end is that which ossifies independently; in the metacarpal of the thumb, in the metatarsal of the great toe, and in all the phalanges, the proximal end is that which ossifies independently. As the method of ossification of the first metacarpal and first metatarsal corresponds with that of the phalanges, some anatomists hold that these bones are really the first phalanges of their respective digits, and that the bone which is absent in these digits, when compared with the other digits, is not a phalanx, but a meta-carpal or tarsal bone. When the extremity

of a bone ossifies from a centre distinct from the centre from which the shaft arises, it is called an *epiphysis*. The epiphysis is united to the shaft of the growing bone by an intermediate plate of cartilage, and so long as any of this cartilage remains unossified the bone can continue to grow in length. The ossification is not completed in the different bones until from the twentieth to the twenty-fifth year. In the case of the long bones, the epiphysis situated at the end of the bone, towards which the canal in the shaft which transmits the nutrient artery is directed, ossifies to the shaft before the epiphysis at the other end. In the humerus, tibia, and fibula, where the canal is directed downwards, the epiphyses at the lower ends of the bones first unite with the shaft; whilst in the femur, radius, and ulna, where the canal is directed upwards, the ossification first takes place between the upper epiphysis and the shaft.

All anatomists hold that the bones of the shaft and distal part of a limb belong to the appendicular part of the skeleton, but there is a difference of opinion as to the place in the skeleton to which the bones of the shoulder girdle and haunch are to be referred. Owen considers that the scapular and pelvic arches belong to the axial skeleton, and are homologous with the ribs; the scapula and coracoid as the visceral or rib-arch of the occipital vertebra, the clavicle of the atlas, and the innominate bone of the upper sacral vertebræ. Goodsir objected to this conclusion of Owen's on the ground that the shoulder girdle was not in series with the visceral arches, but was developed outside the visceral wall, at the junction of the cervical and thoracic regions, from which region the upper limb receives its nerves, and not from the occipito-atlantal region, whence they would have proceeded had it been an appendage of the rib-arches of those segments. Owen's chief argument for regarding the scapula and coracoid as the costal arch of the occipital vertebra is because in fish the scapula is attached to the occipital bone by a bone which Cuvier called the supra-scapula, and which he believed to be homologous with the supra-scapular cartilage of many other vertebrates. Parker, however, has recently pointed out that the so-called supra-scapula of a fish is not homologous with the supra-scapula of a reptile or mammal, that it is not a cartilage bone, but is a splint or scale-like bone, developed as a part of the dermo-skeleton. Between the scapula and coracoid and the innominate bone, anatomists have long recognised homologies to exist; the scapula is generally admitted to be the homotype of the ilium and the coracoid of the ischium, so that if these elements of the shoulder girdle be not a costal arch, neither can those of the pelvic girdle. The clavicle has by some been regarded as the homotype of the pubis; but in all probability the pubis is homologous with the procoracoid bone which is found in the amphibia and some reptiles, but is absent in crocodiles, birds, and mammals; whilst the clavicle is represented in the pelvic girdle, not by a bone, but by a fibrous band called Poupart's ligament. Between the bones of the shafts of the limbs homologies exist: the humerus is the homotype of the femur, the radius of the tibia, the ulna of the fibula; whilst the patella has no representative in the human upper limb. The scaphoid and semilunar bones in the carpus are homotypes of the astragalus in the tarsus, the cuneiform is the homotype of the os calcis, the cuboid of the unciform; the trapezium of the ento-cuneiform, the trapezoid of the meso-, and the os magnum of the ecto-cuneiform. The tarsal scaphoid is not, as a rule, represented in the human carpus, but its homotype is the os intermedium, found in many mammals. The carpal pisciform is a sesamoid bone developed in the tendon of a muscle. The metacarpal bones and phalanges are homologous with the metatarsal bones and phalanges; the thumb with the great toe, and the fingers with the four outer toes. During the growth of the limbs outward, and their change from the simple lappet-like form to their elongated condition, a rotation of the proximal segment of the shaft takes place—that of the upper limb a quarter of a circle backward, that of the lower limb a quarter of a circle forward—to produce in the former case a supine position of the fore-arm and hand, with the thumb as the outermost digit; in the latter case, a prone condition of the leg and foot, with the great toe as the innermost digit. The range of movement at the radio-ulnar joints enables us, however, to pronate the hand and fore-arm by throwing the radius across the ulna, so as to make the thumb the innermost digit. In many quadrupeds the fore-leg is fixed in this position, so that these animals walk on the soles of both the fore and hind feet.

General Observations on the Articulatory and Muscular Systems.

Joints. A Joint or Articulation is the junction or union of any two adjacent parts of the body. Most usually the term is employed to signify the connection established between contiguous bones. It is by the joints that the various bones are knit together to form the skeleton. Joints may be either *immovable* or *movable*.

The immovable joints are divided into the *synchondroses* and the *sutures*. A *synchondrosis* is the junction of two bones by the interposition of an intermediate plate of cartilage, the fibrous membrane or periosteum which invests the bones being prolonged from one bone to the other over the surface of the cartilage. Synchondroses. A *suture* is the connection of two bones by the interlocking of adjacent toothed margins; the periosteal fibrous membrane is prolonged from one bone to the other, and is also interposed between their adjacent margins. Sutures. In a young skull the basi-occipital and basi-sphenoid are united by synchondrosis, but junction by sutures is the mode of union which prevails in the bones of the head. In old persons the sutures become obliterated by the ossification of the intermediate fibrous membrane, and the bones are permanently fused together. The cranial sutures may conveniently be arranged in three groups: *a*, Median longitudinal, consisting of the frontal suture, which connects the two halves of the frontal bone, and the sagittal suture, between the two parietal bones; *b*, Lateral longitudinal, consisting on each side of the head of the fronto-nasal, fronto-maxillary, fronto-lachrymal, fronto-ethmoidal, fronto-malar, fronto-sphenoidal, parieto-sphenoidal, parieto-squamous, parieto-mastoid sutures; *c*, Vertical transverse, consisting of the coronal or fronto-parietal, the lambdoidal or parieto-occipital, the sphenoido-malar, sphenoido-squamous and occipito-mastoid sutures. As the skull grows by ossification of the cartilage of the base and the membranous vault, the direction of growth is perpendicular to the margins of the bones and the sutures and synchondroses which connect them together. The growth of the skull in length is perpendicular, therefore, to the basi-cranial synchondrosis and the vertical transverse group of sutures; its growth, in breadth, to the median longitudinal group, and in height to the lateral longitudinal group. So long as any of the cartilage or membrane between the margins of the bones remains unossified, bone may continue to form, and the skull may increase in size. It sometimes happens that the cartilage or membrane is prematurely ossified in a particular locality, and the further growth of the skull put a stop to in that region; if the brain is still growing, the skull must increase in other directions to permit of the expansion of the cranial cavity, and deformities of the skull are thereby occasioned. One of the most usual of these deformities is due to premature closure of the sagittal suture, causing

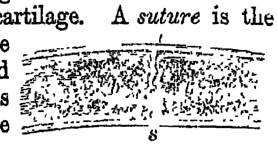


Fig. 12.—Vertical section through a cranial suture. *b*, *b*, the two bones; *s*, opposite the suture; *l*, the fibrous membrane, or periosteum, passing between the two bones, which plays the part of a ligament, and which is continuous with the interposed fibrous membrane.

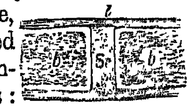


Fig. 13.—Vertical section through a synchondrosis. *b*, *b*, the two bones; Sc, the interposed cartilage; *l*, the fibrous membrane which plays the part of a ligament.

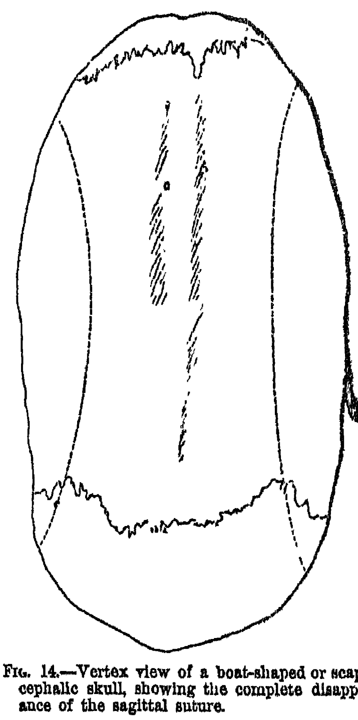


Fig. 14.—Vertex view of a boat-shaped or scaphocephalic skull, showing the complete disappearance of the sagittal suture.

stoppage of the growth of the skull in breadth, and, by way of compensation, great increase in its length, so as to produce a very elongated and somewhat boat-shaped cranium.

Amphiarthroses.

The movable joints are divided into the *amphiarthrodial* and the *diarthrodial* joints. An amphiarthrosis or half-joint has only a feeble range of movement. It consists of two bones, each of which has its articular surface covered by a plate of cartilage, and which plates are firmly connected together by an intermediate disc of fibro-cartilage. The centre of this disc is soft, or may even be hollowed out into a cavity, lined by a smooth synovial membrane, and containing a little fluid. Ligamentous bands, continuous with the periosteum investing the bones, invest the fibro-cartilage, and assist in binding the bones together. The best examples of amphiarthrodial joints are furnished by the articulations between the bodies of the true vertebræ.

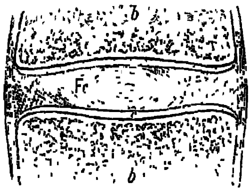


FIG. 15.—Vertical section through an amphiarthrodial joint. *b*, *b*, the two bones; *c*, *c*, the plate of cartilage on the articular surface of each bone; *Fc*, the intermediate fibro-cartilage; *l*, *l*, the external ligaments.

Diarthroses.

A diarthrosis admits of more or less perfect movement. In it the two articular surfaces are each covered by a plate of encrusting cartilage, the free surface of which is smooth and polished; between these surfaces is a cavity containing a glairy fluid, the *synovia*, for lubricating the smooth surfaces of the cartilage and facilitating the movements of the joint. This cavity is enclosed by ligaments, which are attached to the bones, and the inner surface of these ligaments is lined by a synovial membrane which secretes the synovia. Sometimes a plate or meniscus of fibro-cartilage is interposed between, without, however, being attached to the encrusting cartilages of a diarthrodial joint, so as more or less perfectly to subdivide the cavity enclosed by the ligaments into two spaces. The articular surfaces of diarthrodial joints are retained in apposition with each other, sometimes by investing ligaments, at others by surrounding muscles and tendons; at others by atmospheric pressure, aided by the adhesive character of the interposed synovia. The form of the articular or movable surfaces varies very materially in different examples of these joints, and the modifications in form determine the direction of the movements of the joints. In some, as the carpal and tarsal joints, the surfaces are almost flat, so that they glide on each other; the movement is comparatively slight, and about an axis perpendicular to the moving surfaces: these are called *plane-surfaced* joints. In other joints the articular surfaces may be regarded as produced by the rotation of a straight or curved line about an axis lying in the same plane; these are called *rotation joints*, and they present various modifications according to the direction and relation of the rotating line to the axis. One form of a rotation joint is the *pivot joint*, in which the movement takes place about the axis of one of the bones, which is the axis of rotation of the joint; examples of this joint are found in the joint between the atlas and odontoid process of the axis and the radio-ulnar joint. Another form is the *ginglymus* or *hinge joint*, in which the axis of rotation of the joint is perpendicular to the axis of the two bones; the movements of the hinge are called flexion when the angle between the two bones is diminished, and extension when the angle is increased. An important modification of the ginglymus is the *screwed-surfaced joint*, examples of which are found in the elbow and ankle; here the plane of flexion is not perpendicular, but oblique to the axis of the joint. The *saddle-shaped* and *oblong joints* are also modified hinges, but allow motion about two axes; in the oblong both axes are on the same side of the joint; but in the saddle-shaped there is an axis of rotation on each side of the joint. The best example of the saddle-shaped is found between the metacarpal bone of the thumb and the trapezium; of the oblong between the fore-arm and the carpus. In the *ball-and-socket joint* a spheroidal head fits into a cup, and rotation takes place about any diameter of the sphere; the joint therefore is multi-axial; the hip and shoulder joints are the best examples. Some joints, in which the forms of the articular surfaces are more complex, are called *composite;* in them the movements of a hinge and of a ball-and-socket joint may be combined; the knee may be cited as an example of this form of articulation. In a large number of movable joints only portions of the opposite articular surfaces are in contact with each other at a given time; but, as the joint describes its path of movement, different parts of the surfaces come into contact with each other successively, and it is not unusual to find the articular surface both of the cartilage and the subjacent bone mapped out into distinct areas or facets, which are adapted to corresponding facets on the opposite articular surface in particular positions of the joint. When the corresponding facets on opposite articular surfaces break contact with each other, the space between becomes occupied by synovia, or in some joints, more especially the knee, by folds of synovial membrane enclosing clumps of fat, which have been called synovial pads. In the simple hinge, in that with screwed surfaces, in the oblong and composite joints, the principal ligaments are situated at the sides of the joint, and are called *lateral;* they not only prevent lateral displacement of the bones, but, by a tightening of their fibres, check excessive movement forwards or backwards during flexion and extension. In the saddle-shaped and ball-and-socket joints, the joint is included within a bag-like ligament called *capsular*. In the pivot joints the cavity in which the pivot fits is completed by a *transverse* or a *ring-shaped* ligament.

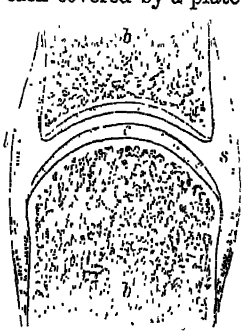


FIG. 16.—Vertical section through a diarthrodial joint. *b*, *b*, the two bones; *c*, *c*, the plate of cartilage on the articular surface of each bone; *l*, *l*, the investing ligament, the dotted line within which represents the synovial membrane. The letter *s* is placed in the cavity of the joint.

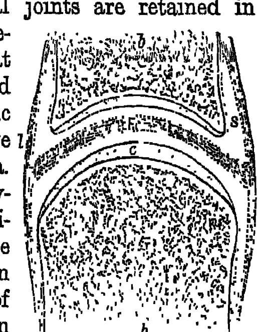


FIG. 17.—Vertical section through a diarthrodial joint, in which the cavity is subdivided into two by an interposed fibro-cartilage or meniscus, *Fc*. The other letters as in Fig. 16.

Muscles.

The MUSCLES are the organs which, by their contraction or shortening, move the bones on each other at the joints. The muscles constitute the flesh of the body. They are so arranged as to be capable not only of moving the various bones on each other, but the entire body from place to place. Hence the muscles are organs both of motion and locomotion. As they can be brought into action at the *will* of the individual, they are called voluntary muscles. Some of the muscles are engaged in the movement of other structures than the bones, such as the eye-ball, tongue, cartilages of the larynx, &c. About 400 muscles are usually enumerated, and the names applied to them express either their position, or relative size, or shape, or direction, or attachments, or mode of action. The word muscle is itself derived from the Latin *musculus*, a little mouse, from a fancied resemblance between that animal and some of the most simply formed muscles. It is customary to distinguish in a muscle a central part, or *belly*, and two ex-

tremities, one of which is the *head* or the *origin*, the other the *insertion*. The belly is the fleshy part of the muscle, and possesses a deep-red characteristic colour; it is the active contractile structure, the source of motor power. The two extremities are called the tendons of the muscle, or sinews; the tendons are bluish-white in colour, possess no power of contractility, and are merely, as it were, the ropes by which the belly of the muscle is attached to the bone or other structure which is moved by its contraction. The term tendon of origin, applied to one extremity of the muscle, signifies the fixed end of the muscle, that to which it draws during its contraction; as a rule this is the end nearest the trunk, the proximal end. The term tendon of insertion is applied to the end which is moved by the contraction; as a rule this is the end most removed from the trunk, the distal end. Entering the substance of each muscle is at least one artery, which conveys blood for its nutrition; this artery ends in a network of capillary blood-vessels, from which a vein arises and conveys the blood out of the muscle again; another small vessel, called a lymphatic, also arises within the muscle, and conveys the fluid lymph out of the muscle. Each muscle also is penetrated by a nerve, through which it is brought into connection with the brain, so as to be subject to the influence of the will. The will is the natural stimulus for exciting muscular action, which action is in many cases so rapid that scarcely an appreciable interval of time intervenes between willing and doing the action.

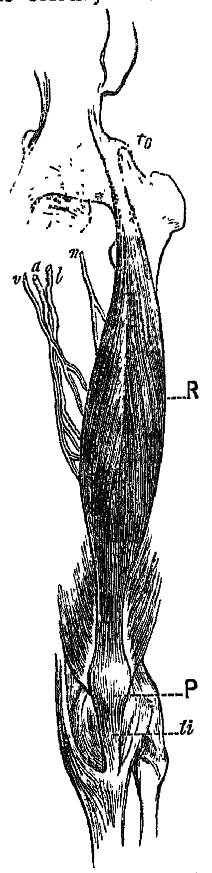


Fig. 18.—The rectus muscle of the thigh; to show the constituent parts of a muscle. R, the fleshy belly; *to*, tendon of origin; *ti*, tendon of insertion; *n*, nerve of supply; *a*, artery of supply; *v*, vein; *l*, lymphatic vessel; P, the patella.

The bones form a series of rod-like levers, and, in studying the mode of action of the muscles, the place of insertion of the muscle into the bone—that is to say, the point of application of the power which causes the movement—and its relations to the joint, or fulcrum, or centre of motion, and to the weight or resistance which is to be overcome, have to be kept in view. The relative positions of fulcrum, point of application of power, and resistance, are not the same in all the bony levers. As a rule, the muscles are inserted into bones between the fulcrum and the moveable point of resistance, and nearer the fulcrum than the movable point, as may be seen in the muscles which bend the fore-arm at the elbow-joint. Although from the weight-arm of the lever being in these cases much longer than the power-arm, the muscles, as regards the application of the power, act at a disadvantage, yet the movement gains in velocity. Sometimes the muscle is inserted, as is the case in the great muscle which straightens or extends the fore-arm, at one end of the lever, and the fulcrum or joint is placed between it and the movable point. At other times, as in the case of the chief depressor muscle of the lower jaw, whilst the muscle is attached to one end of the lever, the fulcrum is at the opposite end. When a muscle is so placed that its tendon of insertion is perpendicular to the bone to which it is attached, it acts to great advantage; when placed obliquely or nearly parallel, a loss of power occurs. Many muscles at the commencement of contraction lie obliquely to the bones which they move, but as contraction goes on they become more nearly perpendicular, so that they act with more advantage near the close than at the commencement of contraction. If a muscle passes over only one joint, it acts on that joint only; but if it passes over two or more joints, it acts on them in succession, beginning with the joint next the point of insertion. A given movement may be performed by the contraction of a single muscle, but as a rule two or more muscles are associated together, and they are not unfrequently so arranged that one muscle initiates the movement, which is then kept up and completed by the rest. Muscles producing movement in one direction have opposed to them muscles which by their contraction effect the opposite movement; when both groups act simultaneously and with equal force, they antagonise each other, and no motion is produced; when a muscle is paralysed or divided, its antagonistic muscle draws and permanently retains the part to its own side. The rapidity of action of a muscle is proportioned to the length of its fasciculi, its power of contraction to their number.

Each muscle is invested by a sheath formed of connective tissue. In the limbs and in the neck not only has each muscle a sheath, but a strong fibrous membrane envelopes the whole of the muscles, and assists materially in giving form and compactness to the region. This membrane is called generally a *fascia* or *aponeurosis*, but special descriptive names are given to it in the different regions—*e.g.*, cervical fascia, brachial aponeurosis, fascia lata, or fascia of the thigh. In some localities muscles arise from the fascia, and in others they are inserted into it. The fascia is separated from the skin by a layer of subcutaneous fatty tissue, and in this layer muscles are in some localities developed. In the fat of the inner border of the palm of the hand a small muscle, the *palmaris brevis*, is found, which is inserted into the skin covering the ball of the little finger; at each side of the neck, also, lies a thin muscle called *platysma myoides*, and the muscles on the face and scalp which move the skin of the face and head belong to the same category. These muscles form the group of subcutaneous or dermal muscles which, except in the localities above referred to, are not represented in the human body, but are well known in the bodies of the mammalia generally as the *panniculus carnosus*.

In arranging the muscles for descriptive purposes, either a morphological, a topographical, or a physiological method may be pursued. The morphological arrangement is to be preferred when the object is to compare the muscular system in man with that in different animals, and the basis of the arrangement should be into muscles of the axial, the appendicular, and the axi-appendicular skeletons, and sub-cutaneous muscles; a topographical arrangement is most suitable for the purposes of the practical surgeon; a physiological arrangement, when the object is to study the action of the muscles in connection with the movements of the joints. In Plates XV. and XVI., a front and back view of the voluntary muscles of the body is given.

JOINTS AND MUSCLES OF THE AXIAL SKELETON.

The *Intervertebral Joints* are complex in construction. The bodies of the true vertebræ are connected together by an amphiarthrodial joint: the fibro-cartilaginous plate or intervertebral disc is tough and fibrous in its peripheral part, but soft and pulpy within. (Fig. 15.) Remains of the chorda dorsalis are said to occur in the soft pulp, and sometimes a distinct cavity, lined by a synovial membrane, is found in the centre of the disc, which in the finner whales is expanded into a large central cavity containing many ounces of synovia. A diarthrodial joint connects the superior and inferior articular processes of adjacent vertebræ on each side. Elastic yellow ligaments, the *ligamenta subflava*,

Intervertebral joints.

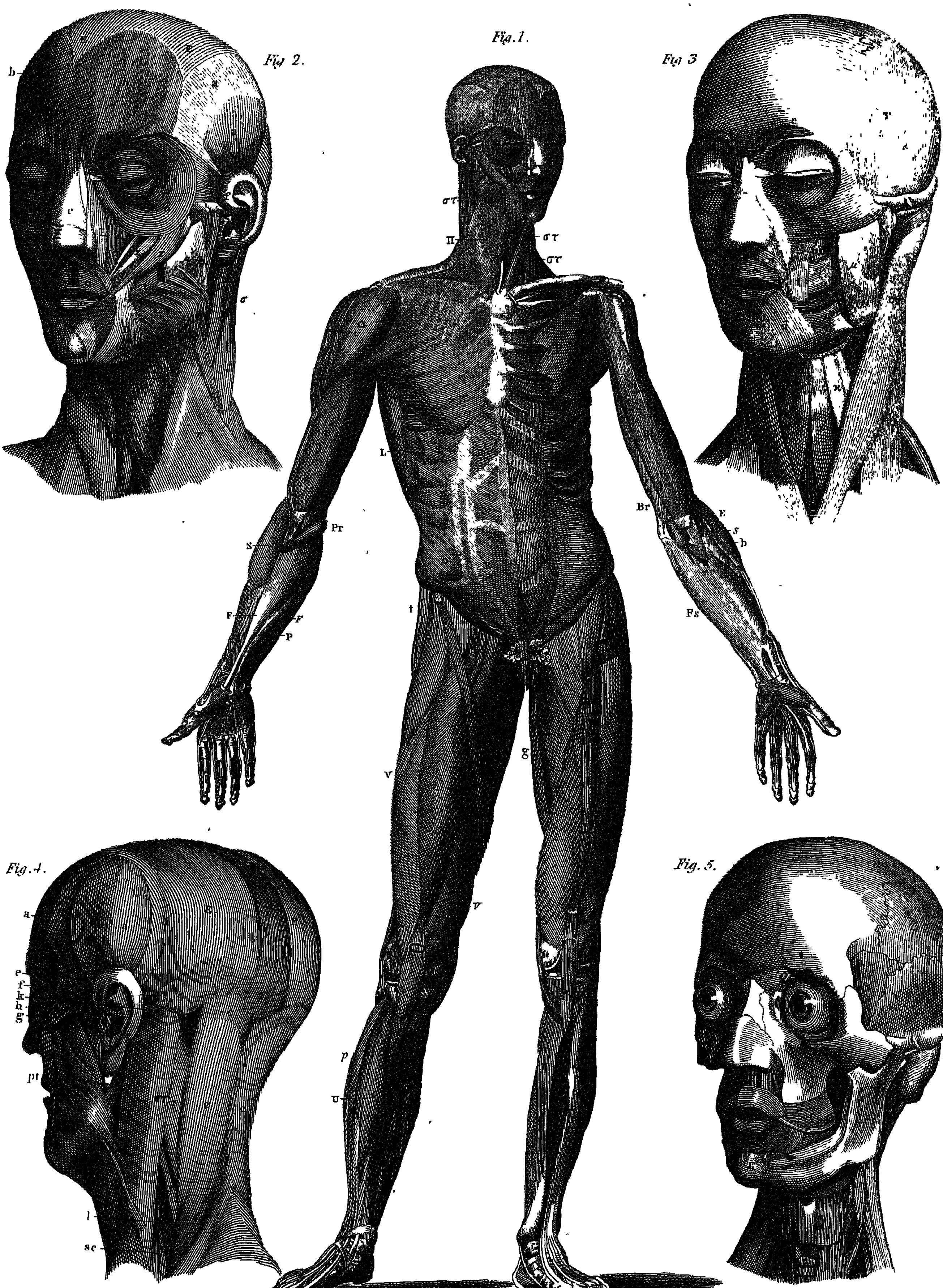


Fig. 1.
Fig. 2.
Fig. 3.
Fig. 4.
Fig. 5.
b
c
σ
στ
II
στ
στ
L
Pr
S
F
F
P
t
V
g
V
p
U
Br
E
S
b
Fs
a
e
f
k
h
g
pt
l
sc

pass between their laminæ. *Inter-* and *supra-spinous* ligaments connect adjacent spinous processes, and in the neck the supra-spinous ligament forms a broad band, the *ligamentum nuchæ*. In those mammals which possess big heads or heavy horns, this ligament of the back of the neck forms a powerful elastic band for the support of the head. The joints between the atlas and axis, and the atlas and occiput, are specially modified in connection with the movements of the head on the top of the spine. The intervertebral discs are absent, and the range of movement either from before backward, as in nodding the head, or from side to side, as in looking over the shoulder, are more extensive than between any of the other true vertebræ. The head rotates along with the atlas around the odontoid or pivot process of the axis, which is lodged between the anterior part of the atlas and a strong transverse ligament which lies behind the odontoid. Too great movement to one side or the other is prevented by the check ligaments, which pass from the top of the odontoid to the occipital bone, in front of the foramen magnum. The nodding movements take place between the occiput and atlas, and are permitted by the size and shape of the occipital condyles and hollow upper articular surfaces of the atlas. These joints are all diarthrodial. The spine is flexible and elastic; except in the joints above referred to, the range of movement between any two true vertebræ is very small, but the sum of the movement in the entire spine, owing to the number of bones, is considerable. The elasticity of the spine is partly due to the numerous diarthrodial joints between its articular processes, but more especially to the discs of fibro-cartilage interposed between the bodies of the vertebræ, which act like elastic pads or buffers to prevent shock. The spine and trunk may be bent either forwards or backwards, or to the right and left side; or without being bent, the spine may be screwed to the right or to the left, the screwing movement being permitted by the oblique direction of the articular processes.

The muscles which move the vertebræ on each other are principally situated on the back of the trunk. In the hollow on each side of the vertebral spines lies the great erector spinæ muscle, the fibres of which pass longitudinally upwards. When both muscles act together, the entire spine is bent back; but when the muscle of one side only contracts, then the spine is bent to that side. These muscles also act in raising the spine from the bent to the erect position, and they are assisted by small inter-spinal muscles, situated between the spines in the cervical and lumbar regions. The spine is bent forward by the psoæ and longi colli muscles; and the straight muscles of the abdomen, inserted into the lower true ribs, assist in this movement. The screwing movements of the spine are effected by a series of muscles, the fibres of which pass obliquely between the laminæ and spines of adjacent vertebræ, and are known as the semispinales, multifidi, and rotatores spinæ muscles.

The head is balanced on the summit of the spine, and is maintained in a quiescent position without any appreciable muscular action, but it can be moved in various directions by the muscles inserted into its bones. The nodding movements of the head on the atlas are due to the posterior recti, the two superior obliques, the two splenii, and the two complexus muscles, which draw it backwards, and the anterior recti and sterno-cleido-mastoid muscles, which draw it forwards. When the right splenius and greater posterior rectus and inferior oblique act along with the left complexus and sterno-mastoid, the head is rotated to the right shoulder; the opposite rotation being due to the action of the corresponding muscles on the other side of the body.

In the formation of the walls of the abdomen proper, bones and joints play but a small part. The lumbar vertebræ behind, the expanded wings of the iliac bones below, and the false ribs above, are the only bones to be considered. Three pairs of greatly expanded muscles—the external oblique, internal oblique, and transverse—lie at the sides and in front, and two pairs of muscles the recti and pyramidales—are situated wholly in front. The internal oblique and the transverse muscles are attached above to the ribs, behind to the lumbar spine, below to the iliac crest and to a strong band, Poupart's ligament, extending from the crest of the ilium to the pubic spine; the external oblique has similar connections above and below, but is not attached behind to the lumbar spine. The muscles all terminate in front in strong expanded tendons, called the *anterior abdominal aponeuroses*, which blend together in the middle line anteriorly to form the band called *linea alba*, which stretches longitudinally from the xiphi-sternum to the pubic symphysis. These expanded tendons enclose the recti muscles, which pass from the pubis upwards to the cartilages of the lower true ribs, and the pyramidal muscles, which pass from the pubis to be inserted into the linea alba. The entire arrangement is admirably adapted for completing the walls of the great abdominal chamber, and for enabling the muscles to compress the abdominal viscera, an action which takes place when the contents of the bowels and bladder are being expelled during defæcation and micturition.

Muscles of abdomen.

Bones and joints play a more important part in the formation of the walls of the thoracic than of the abdominal cavity. Not only are there thoracic vertebræ behind, and the sternum in front, but on each side the twelve ribs arch more or less completely forward from the spine; each rib is articulated behind to one or two vertebræ, and the seven upper ribs, through their costal cartilages, articulate with the sternum.

Costal joints.

The *Costo-vertebral Joints* are situated between the head of the rib and the vertebral body; also, except in the floating ribs, between the tubercle of the rib and the transverse process of the vertebra, the joints being diarthrodial, and completed in the usual manner by ligaments and synovial membrane. The *Costo-sternal Joints* are also diarthrodial (except the first costal cartilage, which is directly united to the præ-sternum), a capsular ligament, lined by a synovial membrane, connecting the cartilages of the true ribs to the sternum. The cartilages from the sixth to the ninth ribs are also united by ligamentous fibres.

The movements of the ribs and sternum at the costo-vertebral and costo-sternal joints are of the utmost importance in the process of breathing. Breathing or respiration consists of two acts—breathing in, or inspiration, and breathing out, or expiration. During inspiration, the air rushes through the nose or mouth down the windpipe, and dilates the air-cells of the lungs; together with the expansion of the lungs the walls of the chest rise, so that the capacity both of lungs and chest at the end of a full inspiration is nearly doubled. During inspiration the following changes occur in the walls of the chest: the ribs are elevated and rotated, the lower borders of their shafts are everted, while their surfaces are at the same time rendered more oblique, and the width of the intercostal spaces is thereby increased; the elevation and rotation of the ribs throw the sternum upwards and forwards, and make the thoracic part of the spinal column straighter; the diaphragm is depressed, and the antero-lateral walls of the abdomen are thrown forward. The muscles which cause these movements are as follows:—In each of the spaces between the different ribs a pair of intercostal muscles is situated; these elevate and rotate the ribs, and the movements are assisted by the levatores costarum, and, in the case of the upper and lower ribs, by the scaleni and serrati postici

muscles; and by these agents the transverse and antero-posterior diameter of the chest is increased. The increase in its vertical diameter is due to the action of the diaphragm or midriff, the great muscle which, arising by its circumference from the xiphi-sternum, six lower ribs, and bodies of the lumbar vertebræ, forms the floor of the thoracic and the roof of the abdominal cavity. It constitutes a great arch, with its convexity directed to the cavity of the chest. By the contraction of its fibres the arch is rendered less convex, and the floor of the chest is thereby depressed. Under circumstances which require more powerful efforts of inspiration, the muscles which pass from the walls of the chest to the upper limbs may, by taking their fixed points at the limbs, act as elevators of the ribs. During expiration the ribs are depressed, their lower borders inverted, the width of the intercostal spaces diminished, the sternum depressed, the spine more curved, and the dia-

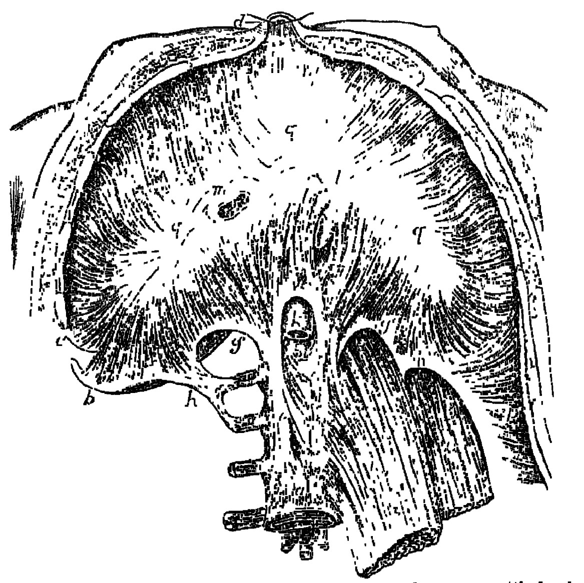


Fig. 19.—The concave abdominal surface of the diaphragm. *a*, 4th lumbar vertebra; *b*, *s*, 12th and 11th ribs; *d*, xiphi-sternum; *e*, *f*, crura of diaphragm; *g*, *h*, arched tendons of origin of diaphragm; *k*, aorta; *l*, œsophagus; *m*, inferior vena cava; *n*, psoas; *o*, quadratus muscle; *qqq*, central tendon of diaphragm, into which the muscular fibres are inserted.

phragm more convex. These movements are principally due to the recoil of the elastic tissue of the lungs previously rendered tense by the inflation of the air-cells, and to the untwisting of the ribs when the inspiratory muscles cease to elevate and rotate them. Muscular action plays but a small part in quiet expiration, but the expulsion of the air from the lungs may be facilitated by contracting the abdominal muscles, which, pressing the abdominal viscera against the under surface of the diaphragm, force that muscle upwards.

Joints and muscles of the head.

The *Temporo-maxillary Joints* are the only diarthrodial articulations in the head. The condyle of the lower jaw on each side is received into the glenoid fossa of the temporal bone; each joint is enclosed by a capsular ligament, and between the articular surfaces is a meniscus, which subdivides the interior of the joint into two cavities, each lined by a synovial membrane. The movements of the lower jaw take place simultaneously at both its articulations during mastication and speech, through the action of the several muscles which are inserted into it. This bone is elevated by the temporal muscles, inserted into the coronoid processes; and by the masseterics, inserted into the outer surface, and the internal pterygoids, into the inner surface of each angle. It is depressed partly by its own weight and partly by the action of the digastrics and genio-hyoids, inserted close to the symphysis; by the platysma, inserted into the outer surface of each horizontal ramus; and the mylo-hyoids, into their inner surfaces. The elevators of the jaw are much more powerful than the depressors, for they not only have to overcome the weight of the bone, but during mastication have to exercise force sufficient to cut or break down the food between the teeth. In carnivorous animals, more especially those which, like the tiger or hyæna, crack the bones of their prey, these muscles attain a great size. The lower jaw can be projected in front of the upper by the external pterygoid muscles, inserted into the neck of the bone on each side; but excessive movement forward is checked by the action of the stylo-maxillary ligaments, which pass from the styloid processes to the angles of the bone; when projected forward, the jaw is drawn back by the posterior fibres of the temporal muscles. When the elevator, depressor, protractor, and retractor muscles are successively brought into action, the lateral or grinding movements of the bone, so important in mastication, are produced.

Along with the movements of the lower jaw those of the hyoid bone and larynx must be considered, for the digastrics, the genio- and mylo-hyoids, which depress the lower jaw, act, when their action is reversed, along with the stylo-hyoid muscles in elevating the hyoid bone and larynx, which structures can be depressed or drawn downwards by the action of the sterno-hyoids, sterno-thyroids, thyro-hyoids, and omo-hyoids; the elevation of the hyoid, when drawn down by its depressor muscles, is effected by the elastic stylo-hyoid ligaments attached to its small cornua, which, by their recoil when the depressor muscles have ceased to contract, draw the bone up to its former position.

Numerous muscles are situated immediately beneath the skin of the scalp and face. They are not of so deep red a colour as the muscles of the trunk and limbs, and whilst they arise from one or other of the bones of the head, they are inserted into the deep surface of the skin itself. Hence when they contract they move the skin of the scalp and face, and as they are the instruments through which the various passions and emotions are expressed, they are grouped together as the *Muscles of Expression* (Plate XV., figs. 2 and 3). The occipito-frontalis, or great muscle of the scalp, passes from the occipital bone over the vertex to the forehead; when it contracts, the skin of the forehead is wrinkled transversely, the eyebrows are elevated, and an expression of amazement or surprise is produced. Some persons have a greater power over this muscle than others, and by the alternate contraction of its occipital and frontal portions can move the hairy scalp to and fro with great rapidity. A pair of muscles, the corrugatores supercilii, arises from the supraciliary ridges, on the frontal bone, to be inserted into the eyebrows: they draw the eyebrows downwards and inwards, wrinkle the skin of the forehead longitudinally, and contract with great vigour in the act of frowning. The auricle of the external ear has three small muscles inserted into it, one behind, the posterior, one above, the superior, one in front, the anterior auricular muscle: in man, as a rule, these muscles are feeble, and have little action; but in many mammals they are large, and by them the animal pricks its ears to detect the faintest sound of danger. The eyelids are drawn together, so as to close the eye as in the act of sleep, by the orbicularis palpebrarum, the fibres of which lie in the eyelids and on the borders of the orbit, and surround the fissure between the eyelids. This muscle is a characteristic specimen of the group of *sphincter* muscles, *i.e.*, muscles which surround orifices, and by their contraction close them. When the upper fibres of the muscle alone contract, the upper eyelid is depressed,—a movement which takes place almost involuntarily and with great frequency during our waking hours, so as to wash the tears over the exposed part of the eyeball and keep it moist. In expressing a "knowing wink," the

lower fibres alone of the orbicularis contract, and the lower lid is elevated. The elevation of the upper lid, as in opening the eye, is due to the levator palpebræ superioris, which, arising within the orbit, is inserted into the upper eyelid. Muscles are inserted into the framework of the nostrils so as to increase or diminish the size of their orifices, and thus to promote or impede the passage of air into the nose. The size of the orifice is increased by two elevator muscles inserted into the ala, or side of the nostril; and when violent exercise is being performed, or respiration is from any cause impeded, the nostrils are always widely dilated. One of these elevator muscles, which also sends a slip down to the upper lip, and is consequently called the common elevator, is the muscle by the contraction of which a sneer is expressed. A partial closure of the nostril can be effected by small muscles which depress and compress the alæ of the nose: in man these muscles are rudimentary as compared with the seal and other aquatic mammals, in which a powerful sphincter muscle closes the nostrils in the act of diving. The lips can be elevated or depressed so as to close or open the mouth; they can be protruded or retracted, or the corners of the mouth can be drawn to one side or the other, by the action of various muscles which are inserted into these movable folds of the integument. The orbicularis oris is a sphincter muscle, the fibres of which lie both in the upper and lower lips; by its contraction the mouth is closed and the lips pressed against the teeth, as when a firm resolution is intended to be expressed. The mouth is opened by the elevator muscles of the upper and the depressors of the lower lip; it is transversely elongated by the zygomatic and risorius muscles, which pass to its corners, and which are brought into action in the acts of smiling and laughing. But the muscles of the lips also play an important part in connection with the reception of food into the mouth, and with the act of articulation.

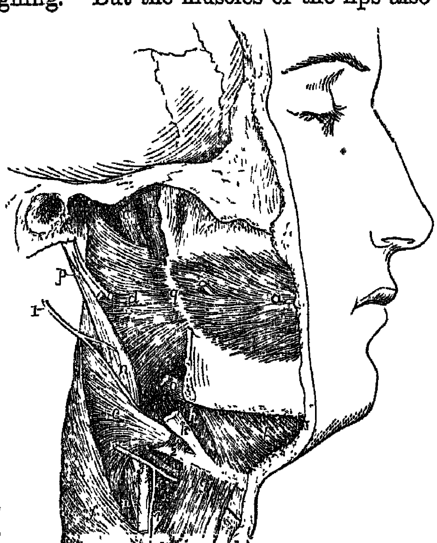


FIG. 20.—Profile of cheek and pharynx. *a*, buccinator; *b*, tensor; *c*, levator palati; *d*, *e*, *f*, superior, middle, and inferior constrictors; *g*, thyro-hyoid; *h*, hyo-glossus; *l*, mylo-hyoid; *m*, crico-thyroid; *n*, stylo-pharyngeus; *o*, stylo-glossus; *q*, fibrous band which gives origin to buccinator and superior constrictor; 1, glosso-pharyngeal nerve; 2, superior laryngeal artery; 3, superior laryngeal nerve; 4, its branch to crico-thyroid; 5, inferior laryngeal nerve and artery.

The cavity of the mouth forms the commencement of the alimentary canal, and is lined by a soft mucous membrane. In it the teeth and tongue are situated, and into it the secretion called saliva is poured. It opens behind into the pharynx. The side walls of the mouth are called the cheeks, and into the formation of each cheek a flattened quadrilateral muscle, the buccinator, enters. This muscle is attached above and below to the upper and lower jawbones, behind to a fibrous band, to which the upper constrictor muscle is also connected, so that the walls of the mouth and pharynx are continuous with each other, whilst in front the buccinator blends with the structures in the lips. It compresses the cheeks, and drives the air out of the cavity of the mouth as in playing a wind instrument; hence the name, "trumpeter's muscle."

The aperture of communication between the mouth and pharynx is named the *isthmus* of the *fauces*. It is bounded below by the root of the tongue, on each side by the tonsils, and above by the soft palate. The soft palate is a structure which hangs pendulous from the posterior edge of the hard bony palate. From its centre depends an elongated body, the *uvula*, and from each of its sides two folds extend, one downwards and forwards to the tongue, the other downwards and backwards to the pharynx. These folds are called the anterior and posterior pillars of the fauces or palate. Between the anterior and posterior pillar, on each side, the tonsil is seated. The soft palate and its pillars are invested by the mucous lining of the mouth and pharynx, and contain small but important muscles. The muscles of the soft palate and uvula, termed the elevators and tensors, raise and make them tense during the process of deglutition. The muscles of the posterior pillars, or palato-pharyngei, by their contraction, approximate the walls of the pharynx to the soft palate and uvula, whilst the muscles of the anterior pillars, or palato-glossi, diminish the size of the fauces.

Muscles of pharynx.

The pharynx is a tube with muscular walls, lined by a mucous membrane, which communicates above and in front with the cavities of the nose, mouth, and larynx, whilst below it is continuous with the œsophagus or gullet. It serves as the chamber or passage down which the food goes from the mouth to the œsophagus in the act of swallowing, and through which the air is transmitted from the nose or mouth to the larynx in the act of breathing. It lies immediately behind the nose, mouth, and larynx, and in front of the five upper cervical vertebræ. Its length is from $4\frac{1}{2}$ to $5\frac{1}{2}$ inches; its widest part is opposite the back of the mouth. The principal muscles in its walls are called the constrictors, and are named, from above downwards, superior, middle, and inferior. They are arranged in pairs, and arise from the cartilages of the larynx, from the hyoid bone, lower jaw, and internal pterygoid process of the sphenoid; whilst the superior also springs from the fibrous band to which the buccinator is attached; their fasciculi curve backwards to the middle line of the posterior wall of the pharynx, to be inserted into a tendinous band which extends longitudinally along this wall of the tube.

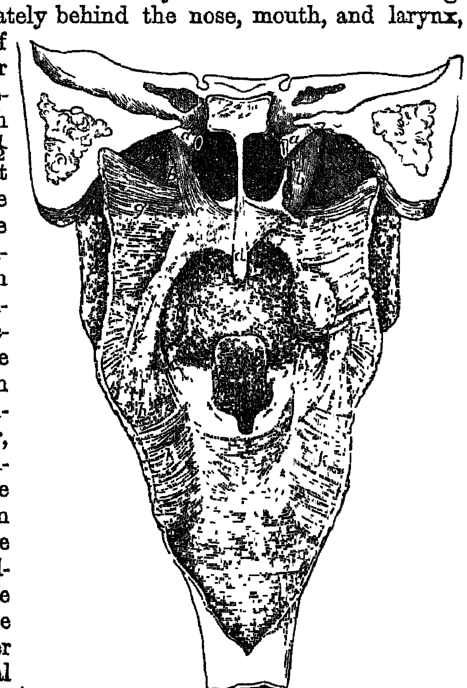


FIG. 21.—Interior of the pharynx, seen by opening its posterior wall. *a*, *a*, Eustachian tube; *b*, *b*, tensor; *c*, levator palati; *d*, levator uvulæ; *e*, *e*, palato-pharyngeus; *f*, palato-glossus; *g*, *h*, *k*, the three constrictors; *l*, *l*, tonsils.

The action of the muscles of the mouth, palate, and pharynx may now be considered in connection with the

Process of swallowing.

process of deglutition or swallowing. When the food is received into the mouth, it is moistened by the secretion of the salivary and other buccal glands, and is broken down by the grinding action of the molar teeth. The buccinator muscles press it from between the gums and the cheek, and, along with the movements of the tongue, aid in collecting it into a bolus on the surface of that organ. During the process of mastication the palato-glossi contract so as to close the fauces. When the bolus is sufficiently triturated and moistened, the palato-glossi relax, the tip of the tongue is pressed against the roof of the mouth, and by a heave backward of that organ the bolus is pressed through the posterior orifice of the mouth into the pharynx, where it is grasped by the superior constrictor muscles, and forced downwards by them and the other constrictor muscles into the œsophagus, and thence into the stomach. As both the nose and larynx open into the pharynx, the one immediately above, the other immediately below the orifice of the mouth, it is of great importance that none of the food should enter into these chambers, and obstruct the respiratory passages. To guard against any accident of this kind, two valvular structures are provided,—viz., the soft palate and the epiglottis,—which, whilst leaving the orifices into their respective chambers open during breathing, may effectually close them when deglutition is being performed. As the bolus is being projected through the fauces into the pharynx, the soft palate and uvula are elevated and made tense, and at the same time the wall of the pharynx is brought in contact with it by the contraction of the palato-pharyngei; the part of the pharynx into which the nose opens is thus temporarily shut off from that into which the mouth opens. If laughter, however, be excited at this time, the tension of the soft palate is destroyed, and part of the food may find its way upwards into the nose. The closure of the larynx by the epiglottis is due partly to the depression of that valve and partly to the elevation of the larynx. The backward heave of the tongue relaxes the ligaments which connect the front of the epiglottis to that organ, and enables the small epiglottidean muscles to depress the valve. The elevation of the hyoid and larynx is due to the action of the mylo-hyoid, digastric, and genio-hyoid muscles, which pass from the lower jaw to the hyoid, and of the thyro-hyoid, which pass from the hyoid to the thyroid cartilage of the larynx; preliminary to their action, the lower jaw must be fixed, which is done by the closure of the mouth prior to the act of swallowing. The aperture of the larynx is thus brought into contact with the depressed epiglottis, which is adapted more exactly to the opening by a change in its form due to the projection of a cushion-like pad from its posterior surface. By these ingenious arrangements the adaptation of a single chamber to the very different functions of breathing and swallowing is effectually provided for.

Joints and Muscles of the Upper Limb.

The upper limb is jointed to the trunk at the *sterno-clavicular articulation.* This is a diarthrodial joint: the bones are retained together by investing ligaments; a meniscus is interposed between the articular surfaces, so that the joint possesses two synovial membranes. A strong ligament, which checks too great upward movement, connects the clavicle and first rib. The two bones of the shoulder girdle articulate with each other at the diarthrodial *acromio-clavicular joint;* but, in addition, a strong ligament, which checks too great displacement of the bones, passes between the clavicle and coracoid. The movements of the upper limb on the trunk take place at the sterno-clavicular joint, and consist in the elevation, depression, and forward and backward movement of the shoulder. The movements at the acromio-clavicular joint occur when the scapula is rotated on the clavicle in the act of elevating the arm above the head. The muscles which cause these movements are inserted into the bones of the shoulder girdle; the trapezius into the clavicle, acromion, and spine of the scapula; the rhomboid, levator anguli scapulæ, and serratus magnus into the vertebral border of the scapula; the pectoralis minor into the coracoid; and the subclavius into the clavicle. Elevation of the entire shoulder, as in shrugging the shoulders, is due to the contraction of the trapezius, levator scapulæ, and rhomboideus; depression partly to the weight of the limb and partly to the action of the subclavius and pectoralis minor; movement forward to the serratus and pectoralis; and backward to the trapezius and rhomboid. In rotation of the scapula on the clavicle, the inferior angle of the scapula is drawn forward by the serratus and lower fibres of trapezius, and backward by the levator scapulæ, rhomboid, and lesser pectoral.

Shoulder joint.

The *Shoulder Joint* is a ball-and-socket joint, the ball being the head of the humerus, the socket the glenoid fossa of the scapula. A large capsular ligament, which is pierced by the long tendon of the biceps muscle, and lined by a synovial membrane, encloses the articular ends of the two bones, and is so loose as to permit a range of movement greater than takes place in any other joint in the body. The muscles which cause these movements are inserted into the humerus; the supra-spinatus, infra-spinatus, and teres minor into the great tuberosity; the sub-scapularis into the small tuberosity; the latissimus dorsi and teres major into the bottom of the bicipital groove; the pectoralis major into its anterior border; the coraco-brachialis into the inner aspect, and the deltoid, which forms the fleshy prominence of the shoulder, into the outer aspect of the shaft. Abduction and elevation or extension of the arm outwards at the shoulder joint are due to the supra-spinatus and deltoid; adduction or depression, to the coraco-brachialis, latissimus, and teres major, assisted by the weight of the limb; movement forwards and elevation, to the anterior fibres of the deltoid, pectoralis, and subscapularis; backward movement to the latissimus and teres; rotation outwards to the infra-spinatus and teres minor; rotation inwards to the subscapularis, pectoralis, latissimus, and teres. A combination of abduction, movement forwards, adduction, and movement backwards, produces the movement of circumduction. Certain movements of the upper limb, however, take place not only at the shoulder joint, but between the two bones of the shoulder girdle; for in elevating the arm, whilst the supra-spinatus and deltoid initiate the movement at the shoulder joint, the farther elevation, as in raising the arm above the head, takes place by the trapezius and serratus, which rotate the scapula and draw its inferior angle forward. The free range of movement of the human shoulder is one of its most striking characters, so that the arm can be moved in every direction through space, and its efficiency as an instrument of prehension is thus greatly increased. The movement of abduction, or extension, which elevates the arm in line with the axis of the scapula, is characteristically human, and a distinct articular area is provided on the head of the humerus for this movement.

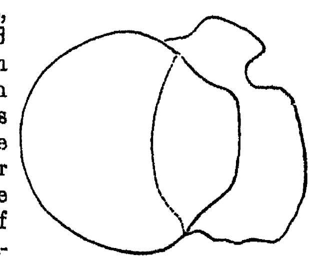


Fig. 22.—Outline sketch of human humerus. The articular area for complete extension lies to the right of the dotted line. (*After Goodsir.*)

Elbow.

The *Elbow Joint* is the articulation between the humerus, radius, and ulna: the great sigmoid cavity of the ulna is adapted to the trochlea of the humerus, and the cup of the radius to the capitellum. The joint is enclosed by a

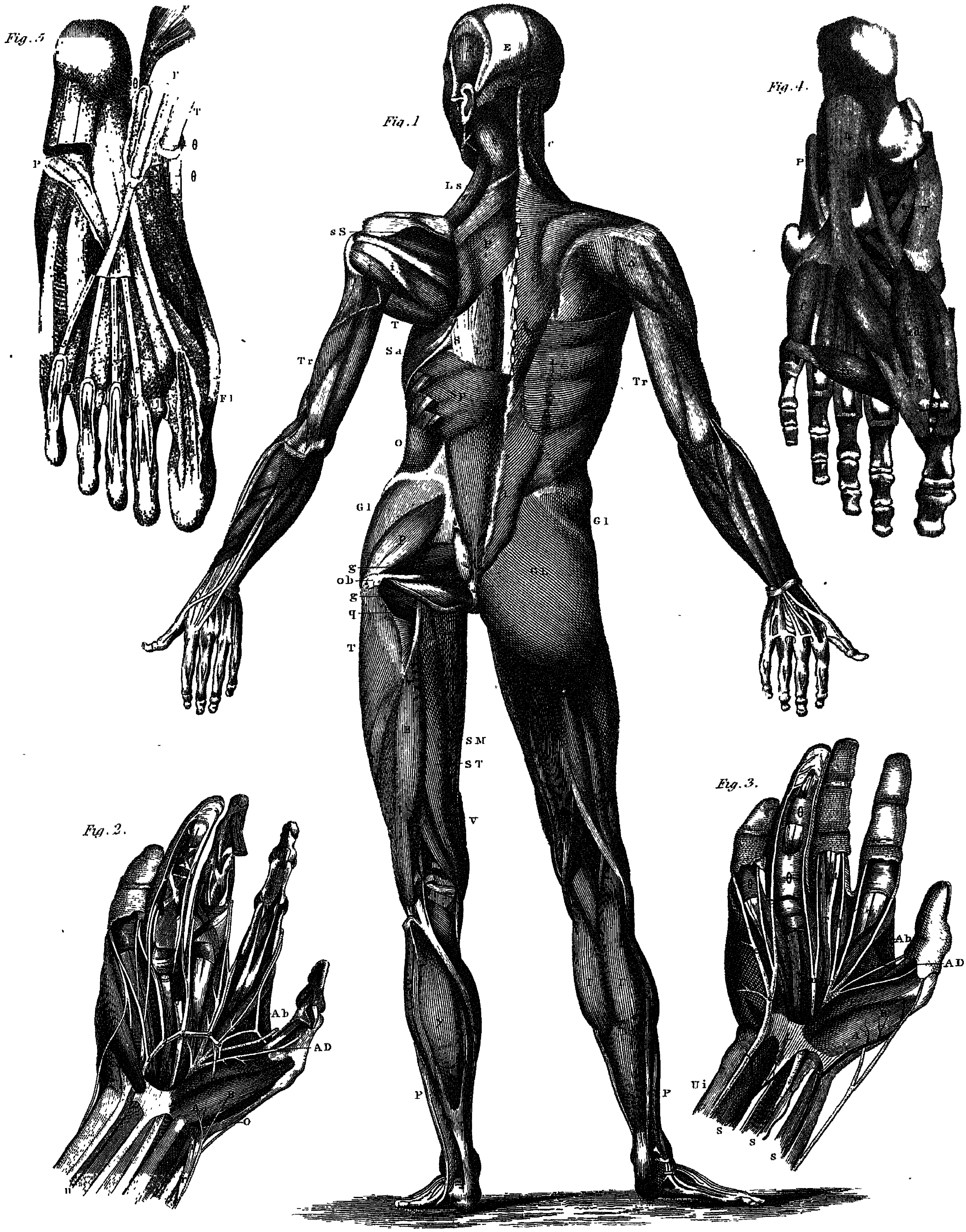


Fig. 5
Fig. 1
Fig. 4
Fig. 2
Fig. 3
E
c
Ls
sS
T
Sa
Tr
Tr
O
Gl
Gl
g
ob
g
q
T
SM
ST
V
P
P
Ab
AD
Ab
AD
Ui
S
S
S
O
Fl

capsular ligament lined by a synovial membrane, which is subdivided into anterior, posterior, internal, and external bands of fibres. Flexion and extension are the two movements of the joint, and the range of movement is limited by the locking at the end of flexion of the coronoid process into the coronoid fossa of the humerus, and at the end of extension of the olecranon process into the olecranoid fossa. The elbow joint is a hinge with screwed surfaces; the path described by the hand and fore-arm is a spiral, so that during flexion they are thrown forwards and inwards. The muscles which cause the movements are inserted into the bones of the fore-arm. The flexors are the brachialis anticus, inserted into the coronoid of the ulna; the biceps, which forms the fleshy mass on the front of the upper arm, into the tuberosity of the radius; the supinator longus into the styloid process of the radius. The only extensor is the triceps-anconeus, which forms the fleshy mass on the back of the upper arm, and is inserted into the olecranon.

Joints of fore-arm.

The *Radio-ulnar Joints* are found between the two bones of the fore-arm. The head of the radius rolls in the lesser sigmoid cavity of the ulna, and is retained in position by a ring-like ligament which surrounds it; the shafts of the two bones are connected together by the interosseous membrane, their lower ends by a capsular ligament and a triangular fibro-cartilage or meniscus. The radius rotates round an axis drawn through the centre of its head and the styloid process of the ulna; rotation of the fore-arm and hand forward is called pronation,—rotation backwards, supination. The supinator and pronator muscles are all inserted into the radius: the supinators are the longus and brevis and the biceps; the pronators are the teres and quadratus. Where delicate manipulation is required the fore-arm is semi-flexed on the upper arm, for the cup-shaped head of the radius is then brought into contact with the capitellum of the humerus, and the rotatory movements of the bone can be performed with greater precision.

Wrist.

The *Wrist* or *Radio-carpal Joint* is formed above by the lower end of the radius and the triangular meniscus, below by the upper articular surfaces of the scaphoid, semi-lunar, and cuneiform bones. An investing ligament, lined by a synovial membrane, and subdivided into anterior, posterior, internal, and external bands of fibres, encloses the joint. It is the oblong form of hinge-joint, and possesses two axes, a long and a short; around the long axis movements occur which bend the hand forwards, or bring it in line with the fore-arm, or bend it backwards; around the short axis the hand may be moved towards the radial or ulnar margins of the fore-arm. The flexors forward are the palmaris longus, inserted into the palmar fascia; the flexor carpi radialis into the metacarpal bone of the index; the flexor carpi ulnaris into the pisiform bone; the extensors and flexors backwards are the longer and shorter radial extensors inserted into the metacarpal bones of the index and middle fingers, and the ulnar extensor into the metacarpal bone of the little finger; the flexors and extensors of the fingers have also a secondary action on the wrist joint. The ulnar flexor and ulnar extensor of the wrist draw the hand to the ulnar side, and the radial flexor and extensor, together with the extensors of the thumb, draw the hand towards the radial border of the fore-arm.

Joints of hand.

The *Carpal* and *Carpo-metacarpal Joints* are constructed thus:—The articular surfaces are retained in contact by certain ligaments passing between the dorsal surfaces of adjacent bones, by others between their palmar surfaces, and by interosseous ligaments between the semi-lunar and cuneiform, semi-lunar and scaphoid, os magnum and unciform, os magnum and trapezoid; lateral ligaments also attach the scaphoid to the trapezium, and the cuneiform to the unciform. Similarly, the trapezoid, os magnum, and unciform are connected to the metacarpal bones of the fingers by dorsal, palmar, and interosseous ligaments, and the metacarpal bones of the fingers have a like mode of union at their carpal ends; further, a transverse ligament extends between the distal ends of the metacarpal bones of the fingers, and checks too great lateral displacement. The range of movement at any one of these carpal joints is very slight, but the multiplicity of joints in this locality contributes to the mobility of the wrist, and makes the junction between the hand and fore-arm less rigid in its nature. The metacarpal bone of the thumb is not jointed to the index, and has a distinct saddle-shaped articulation with the trapezium, invested by a capsular ligament, so that its range of movement is extensive.

Joints of fingers.

The *Metacarpo-phalangeal* and *Inter-phalangeal Joints* are connected by lateral ligaments passing between the bones, and by an arrangement of fibres on their dorsal and palmar surfaces.

In studying the muscles which move the digits, it will be advisable, on account of the freedom and importance of the movements of the thumb, to examine its muscles independently. These muscles either pass from the fore-arm to the thumb, or are grouped together at the outer part of the palm, and form the elevation known as the ball of the thumb; they are inserted either into the metacarpal bone or the phalanges. The thumb is extended and abducted, *i.e.*, drawn away from the index, by three extensor muscles descending from the fore-arm, and inserted one into each of its three bones, and a small muscle, specially named abductor pollicis, inserted into the outer side of the first phalanx: its bones are bent on each other by a long and short flexor muscle; it is drawn back to the index by an adductor muscle; and the entire thumb is thrown across the surface of the palm by the opponens pollicis, which is inserted into the shaft of the metacarpal bone.

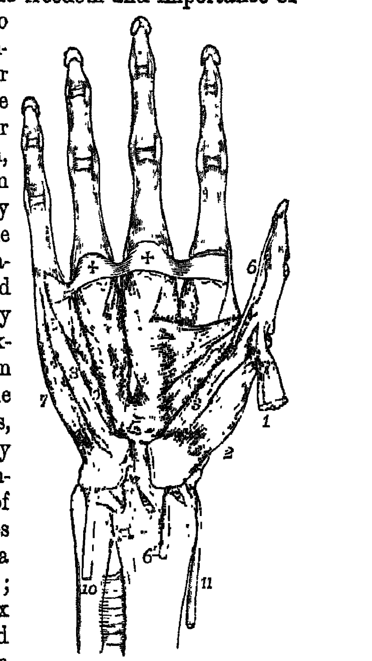


FIG. 23.—Deep muscles of the palm of the hand. 1, abductor pollicis cut short; 2, opponens; 3 and 4, subdivisions of flexor brevis; 5, adductor; 6, 6', tendon of long flexor pollicis; 7, abductor of the little finger; 8, short flexor; 9, opponens; 10, tendon of flexor carpi ulnaris; 11, tendon of long supinator; ++ transverse metacarpal ligament

The four fingers can be either bent, or extended, or drawn asunder, *i.e.*, abducted; or drawn together, *i.e.*, adducted. The ungual phalanges can be bent by the

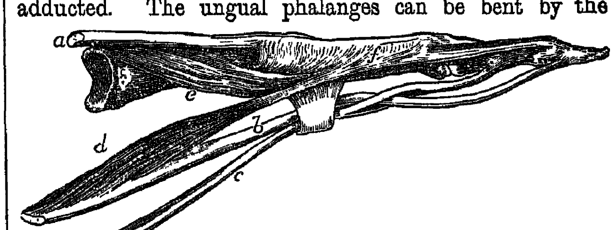


FIG. 24.—Tendons attached to a finger. *a*, the extensor tendon; *b*, deep flexor; *c*, superficial flexor; *d*, a lumbrical muscle; *e*, an interosseous muscle; *f*, tendinous expansion from the lumbrical and interosseous muscles joining the extensor tendon.

action of the deep flexor muscle, the four tendons of which are inserted into them; the second phalanges by the superficial flexor, also inserted by four tendons, one into each phalanx; these muscles descend from the front of the fore-arm into the palm in front of the wrist, where they are

enclosed in a canal by a strong band, the *anterior annular ligament*, and their surfaces are invested by a synovial membrane, which facilitates their movements to and fro beneath that ligament; as they pass downwards in front of the fingers they are enclosed in a strong fibrous sheath lined by a synovial membrane, and the tendon of the superficial flexor is pierced by the deep flexor, so that the latter may reach the third phalanx into which it is inserted. Four rounded muscles, the lumbricales, arise in the palm from the deep flexor tendons, turn round the radial borders of the first phalanges, and are inserted one into the extensor tendon on the dorsum of each finger; these muscles bend the first phalanges on the metacarpal bones, but from their insertion into the extensor tendons they also extend the second and third phalanges on the first; as they are much used in playing stringed instruments, they have been called "fiddlers' muscles." The fingers are extended or straightened by muscles inserted into the back of the second and third phalanges; the extensor muscles descend from the back of the fore-arm,—one, the common extensor, subdivides into four tendons, one for each finger, but in addition the index and little have each a separate extensor muscle, the tendon of which joins that of the common extensor. The index finger possesses more independent movement than the other digits—hence its more frequent use as a "pointer;" the extensor tendons of the little and ring fingers are usually united together, so that these digits are associated in their movements. Abduction and adduction of the fingers are caused by seven small muscles situated in the intervals between the metacarpal bones,—hence called interossei; four of these lie on the back of the hand, three on its palmar surface; they are inserted into the sides of the first phalanges, and either pull the fingers away from a line drawn through the middle finger or approximate them to that line. Too great abduction is checked by the transverse metacarpal ligament. The human hand is a perfect instrument of prehension; not only can the individual fingers be bent into hooks, but the thumb can be thrown across the front of the palm, so that it can be opposed to the several fingers, and objects can therefore be grasped between it and them; but further, this power of opposing the thumb permits objects to be held in the palm of the hand, which may be hollowed into a cup or made to grasp a sphere. The movements of the joints are indicated on the surface of the palm by tegumentary folds,—an oblique fold for the thumb, and two oblique folds for the metacarpo-phalangeal joints of the fingers; the joints of the second and third phalanges are also marked on the surface by folds.

JOINTS AND MUSCLES OF THE LOWER LIMB.

Sacro-iliac joint.

The innominate bones are connected to the spinal column by the sacro-iliac joints and the sacro-sciatic ligaments. The *Sacro-iliac Joint* is between the side of the sacrum and the internal surface of the ilium, the articular surfaces of which bones are covered by cartilage, and connected together by short, strong ligaments. The sacro-sciatic ligaments stretch from the side of the sacrum and coccyx to the spine and tuberosity of the ischium. The two innominate bones are also connected together at the *pubic symphysis*, which is an amphiarthrodial joint. The sacro-iliac joints and pubic symphysis permit only slight movement; that at the former is around an imaginary axis, drawn transversely through the second sacral vertebra, which allows the base of the sacrum to be thrown forward and its apex backward in the stooping position of the body; but too great movement backward of the apex is checked by the sacro-sciatic ligaments. As the weight of the trunk, or of what may be carried in the arms or on the back, is transmitted through the haunch-bones to the lower limbs, the sacro-iliac ligaments require to be of great strength, because the sacrum, and with it the entire trunk, are suspended by them on the two innominate bones.

Hip joint.

The *Hip Joint* is a ball-and-socket joint; the ball is the head of the femur, and the socket the cup-shaped acetabulum in the haunch bone, the depth of the cup being increased by a ligament which is attached around the brim. A large capsular ligament, which is especially strong in front, encloses the articular surfaces. The ligament is lined by a synovial membrane, which also invests the neck of the thigh bone. Within the joint is the round or suspensory ligament attached to the head of the thigh bone and to the sides of the depression at the bottom of the acetabulum. Whilst the hip joint possesses considerable mobility, it has much more stability than the shoulder, owing to the acetabulum being deeper than the glenoid fossa, and the greater strength and tension of the fibres of its capsular ligament. The muscles which move the thigh at the hip joint are situated either behind the joint, where they form the fleshy mass of the buttock, or at the front and the inner side of the thigh. They are inserted either into the femur or fascia lata, and the great and small trochanters serve as their principal surfaces of attachment. The thigh can be bent on the abdomen by the action of the psoas, iliacus, and pectineus, which lie in front of the joint; it can be extended or drawn into line with the trunk by the glutæus-maximus and medius; it can be abducted or drawn away from the opposite thigh by the glutæus maximus, medius, and minimus, which muscles are of large size, and form the fleshy mass of the buttocks. It can be adducted or drawn to touch its fellow, or, if slightly bent, drawn in front of its fellow, by the adductor longus, brevis, and magnus, which muscles are inserted into the linea aspera, and form the fleshy mass on the inner side of the thigh; and by the pectineus and quadratus femoris. It can be rotated outwards by the obturator and gemelli muscles, the glutæus maximus, pyriformis, and quadratus femoris; and rotated inwards by the glutæus medius, minimus, and tensor fasciæ femoris. In standing erect the hip joints are fully extended, and the mechanical arrangements in and around these articulations are such as to enable them to be retained in the extended position with but a small expenditure of muscular power. As the weight of the body in the erect attitude falls behind the joints, the strong anterior fibres of their capsular ligaments are made tense, and the extended position of the joints is preserved. So long as the centre of gravity falls within the basis of support of the body, *i.e.*, the space between the two feet when standing on both legs, the body will not fall. If the body is made to lean forward, then the capsular ligament is no longer tense, and the glutæal muscles are put in action to re-extend the trunk on the thigh, and prevent it from falling forward; if the body is made to lean to one side or the other, the round ligament is made tense, or the strong ilio-tibial band of the fascia lata of the thigh, which stretches from the ilium to the tibia, is put on the stretch, and falling sideways is prevented. When, in standing erect either on one or both feet, the balance of the body is disturbed, then various muscles both of the trunk and lower limb are brought into action to assist in preserving the erect position. In the erect position the weight of the trunk is transmitted through the acetabula to the heads of the thigh-bones, but the position and connections of the round ligament enable it to suspend that portion of the trunk the weight of which is thrown upon it, and to distribute the weight over the head of the femur.

Knee.

The *Knee* is the largest and most complicated joint in the body. It consists of the femur, tibia, and patella. The patella moves up and down the trochlear surface of

the femur, whilst the condyles of the femur roll upon the semilunar cartilages and articular surfaces of the tibia. A powerful investing ligament encloses the articular surfaces. This ligament is subdivided into bands, one on each side of the joint—the internal and external lateral ligaments—a posterior and an anterior. The anterior extends from the patella to the anterior tubercle of the tibia, and serves both as a ligament and as the tendon of insertion of the extensor muscles of the leg. Within the investing ligament two interarticular or crucial ligaments pass from the inter-condyloid fossa to the upper surface of the tibia; and interposed between the tibia and femoral condyles are two menisci, which from their shape are called the semilunar cartilages. The synovial membrane not only lines the investing ligaments, but covers the front of the femur for some distance above the trochlea, and forms folds or pads within the joint itself, which in certain movements are interposed between the articular surfaces of the bones. The movements at this joint are those of flexion and extension. The flexors are the three great muscles on the back of the thigh, called the ham-strings; they all arise from the ischial tuberosity, and are inserted—the biceps into the head of the fibula, the semi-tendinosus and semi-membranosus into the upper end of the tibia. The extensors form the fleshy mass on the front and outer side of the thigh; one muscle, the rectus, arises from the ilium—the others, the vasti, from the shaft of the femur; and they are all inserted by a powerful tendon into the patella, and through the anterior ligament of the knee into the tibia. The patella is indeed a sesamoid bone, developed in the tendon of these muscles (Fig. 18). The knee can be bent so that the calf can touch the back of the thigh, and in this position the patella is drawn down in front of the joint, as in kneeling. The articular surface of the patella is divided into seven areas or facets, and in passing from the bent to the extended position of the joint, these facets come successively into contact with the articular surface of the femur, until, when the leg is fully extended on the thigh, the whole of the patella is raised above the femoral trochlea, except the lowest pair of narrow facets. It is in order to provide a smooth surface for the patella in this position that the synovial membrane of the joint covers the front of the lower end of the femur. At the commencement of flexion a slight rotation inwards of the leg and foot takes place through the action of the sartorius, gracilis, and semi-tendinosus, which are inserted close together into the tibia; whilst the extensor muscles cause, at the completion of extension, a slight rotation outwards of the leg and foot. The movements of flexion and extension are not simply in the antero-posterior plane, but along oblique paths which are determined by the screwed configuration of the femoral condyles. In complete extension of the leg the joint is "screwed home;" and as this position is necessary for the preservation of the erect attitude, the lateral, the posterior, and the anterior crucial ligaments are then all tense, to prevent displacement of the bones. The muscles which rotate the leg and foot inwards initiate the act of flexion by unlocking the joint.

The *Tibio-fibular Joints* are found between the upper and lower ends of the bones, and in addition a strong interosseous membrane fills up the interval between their shafts. The movement between the two bones is almost inappreciable.

Joints of ankle and foot.

The *Ankle Joint* is formed by the convex upper and the lateral surfaces of the astragalus fitting into the concavity formed by the lower end of the tibia and the two malleoli. An investing ligament, lined by synovial membrane, encloses the joint; the lateral portions of this ligament form distinct bands, and are much stronger than the anterior and posterior fibres. A diarthrodial joint also exists between the astragalus and os calcis, between which bones a powerful interosseous ligament passes. Between the astragalus and scaphoid, and the os calcis and cuboid, important diarthrodial joints are found, which are enclosed by ligamentous bands. The remaining tarsal bones are connected together usually by dorsal, plantar, and interosseous ligaments, and a similar mode of union is found between the distal row of tarsal bones and the metatarsals, except between the great toe and ento-cuneiform, where there is no interosseous ligament. The four outer metatarsals are also connected at their proximal ends by distal, plantar, and interosseous ligaments; and further, a transverse metatarsal ligament passes between the distal ends of all the metatarsal bones. The metatarsal bones articulate with the phalanges, and the phalanges with each other, in a similar manner to that described in the corresponding bones of the hand.

At the ankle joint movements of flexion and extension take place. The dorsum of the foot is bent towards the front of the leg by the direct action of the muscles on the front of the leg, more especially the tibialis anticus, inserted into the ento-cuneiform and metatarsal of great toe, and the peroneus tertius, inserted into the metatarsal of little toe; the opposite movement, the so-called extension of the foot, is due to the action of the gastrocnemius and soleus, the great muscles of the calf of the leg, which are inserted by the Tendo Achillis into the posterior prominence of the os calcis or heel. This movement is made at every step in walking or running, and the great size of the calf-muscles is in relation to their use in the act of progression. The foot cannot, however, be drawn so far back as to be brought into direct line with the leg. In standing erect the foot is at right angles to the axis of the leg, the astragalus is locked in between the two malleoli, and the fibres of the lateral ligaments are tense, so as to check movement forwards or backwards, and prevent displacement.

Between the several bones of the tarsus a certain amount of gliding is permitted, more especially between the os calcis and cuboid and the astragalus and scaphoid, so that it is possible to invert or evert the foot, *i.e.*, to raise its inner or outer borders from the ground. The inversion is performed by the tibialis anticus and by the tibialis posticus, which latter is inserted into the scaphoid bone; the eversion by the peroneus longus and brevis muscles, situated on the outer side of the leg, the tendons of which pass behind the outer malleolus,—the brevis to be inserted into the metatarsal bone of the little toe, the longus into the plantar surface of the metatarsal bone of the great toe. The individual toes are bent on the sole by the action of the flexor muscles inserted into the plantar surface of the phalanges, and they are straightened by the extensor muscles inserted into their dorsal surfaces; the toes also can be drawn asunder or abducted, and drawn together or adducted, chiefly by the action of the interossei muscles. The hallux or great toe is the most important digit; a line prolonged backwards through it to the heel forms the proper axis of the foot, and the sole chiefly rests upon the pads of integument situated beneath its metatarso-phalangeal joint and the heel. The hallux is much more restricted in its movements than the thumb: the configuration of its tarso-metatarsal joint and the attachment of the transverse metatarsal ligament prevent the great toe from being thrown across the surface of the sole as the thumb is thrown across the palm in the movement of opposition; an object can, however, be grasped between the hallux and second toe by the action of its adductor muscles, and persons can be trained to write with a pen or pencil held in this position.

The act of walking consists in the movement forwards of the trunk by the alternate advancement of the lower

limbs. Suppose a person to be standing erect, with one leg a little in advance of the other; the body, being inclined slightly forwards, is pushed in advance by the extension of the hindmost limb, so that the weight falls more and more upon the advanced leg, which at the same time is shortened by bending the knee and ankle. The heel of the hindmost limb being then raised by the action of the muscles of the calf, the toes press against the ground so as to push the trunk so far in front of the advanced limb as to be no longer safely supported by it; the hindmost limb is then raised from the ground by muscular action, and allowed to swing forward by its own weight, but guided by the muscles, until the toes touch the ground in front of the opposite limb. A step has now been made, and the limbs are in a corresponding but opposite position from that in which they were when the step commenced: a repetition of the act constitutes another step, and so the alternate action continues. At one moment in each step both feet touch the ground at the same time, *i.e.*, when the hind foot presses against the earth. The act of running consists in a repetition of the movements of walking performed with so much greater rapidity that the feet never touch the ground at the same moment; the heels also are never brought to the ground. The propulsive action is also greatly increased by the extension of the hip and knee joints, so that a succession of small leaps on to alternate feet takes place. In leaping from the standing position the joints of both lower limbs, previously flexed, are suddenly and simultaneously extended, and the body is projected forwards with a rapid impulse.

Development and Homologies of the Voluntary Muscular System.

The voluntary muscles, like the bones and joints with which they are so intimately associated, are developed out of the middle of the three layers—the *meso-blast*—into which the germinal area or *blastoderm* of the young embryo is divided. The muscles of the axial skeleton are capable of subdivision into a group situated outside the endo-skeleton, *i.e.*, between it and the integument—which muscles have recently been called *epi-skeletal*—and a group lying on the ventral surface of the vertebral bodies and within the rib arches, which have been termed the hæmal or *hypo-skeletal* muscles. The epi-skeletal muscles, like the vertebræ themselves, are developed within the *proto-vertebræ*, but it is not known if the hypo-skeletal group have the same origin. In fishes the epi-skeletal muscles preserve their fundamental arrangement with but little modification. They are disposed in transverse segments or *myotomes*, which equal in number the vertebræ. These myotomes are separated from each other by bands of fibrous tissue, the *inter-muscular septa*. In man and the higher vertebrates the simple transversely segmented arrangement is to a large extent lost. Traces are preserved, however, in the interspinales and intertransversales muscles, situated in the intervals between the spines and transverse processes of some of the vertebral segments; in the external intercostals and in the recti abdominis muscles, in the last-named of which tendinous bands subdivide the muscle into several transverse segments. More usually, the intermuscular septa either are not formed or disappear, and adjacent myotomes become blended into a continuous mass of muscle. In some instances the fibres of this muscle run longitudinally, and the entire mass subdivides longitudinally into separate and distinct parallel muscles, as is seen in the subdivision of the great erector spinæ into the sacro-lumbalis, musculus accessorius, cervicalis ascendens, longissimus dorsi, transversalis cervicis, trachelo-mastoid, and spinalis dorsi muscles. In other instances the muscles run obliquely; some on the back of the body pass obliquely from below upwards and outwards, as the splenius and obliquus inferior; others obliquely from below, upwards and inwards, as the complexus, obliquus superior, semi-spinalis, multifidus and rotatores spinæ; others again, as the external and internal oblique muscles of the abdomen, extend obliquely from behind forwards to the ventral mesial line.

Of the hypo-skeletal group of muscles, the internal intercostals display the transverse segmentation. As a rule, however, the muscles of this group extend longitudinally, and form the præ-vertebral group, named anterior recti, longi colli, and psoæ; though the diaphragm, triangulares sterni, transversi abdominis, and levatores ani, which lie in relation to the inner surfaces of the ribs and visceral cavities, are not longitudinal, but are specially modified in arrangement for functional reasons. The plane of demarcation between the hypo- and epi-skeletal groups of muscles, where they form together the walls of the great visceral chambers,—the thorax and abdomen,—is marked off by the position and course of the intercostal series of spinal nerves.

The muscles of the appendicular skeleton are either limited to the limbs (purely appendicular, therefore), or pass from the axial part of the body to the limb (axi-appendicular). The axi-appendicular group are undoubtedly prolongations of the axial system of muscles. They are in the upper limb derived from the epi-skeletal subdivision, and form the trapezius, rhomboid, levator anguli scapulæ, latissimus dorsi, serratus magnus, greater and smaller pectorals, and subclavius muscles of each superior extremity. In the lower limb they are in part derived from the hypo-skeletal subdivision, and form the psoas and pyriformis; and in part, as the glutæus maximus, from the epi-skeletal subdivision. It is not improbable that the purely appendicular muscles are also prolongations of the axial system, and that as the limbs, in their development from their fundamental bud-like lappets, undergo both a transverse and a longitudinal segmentation, so the muscular mass, prolonged into them, differentiates both transversely and longitudinally into a motor apparatus, fitted for the performance of the special functions of each extremity.

Anatomy of the Textures or Tissues.

Introductory.

Before proceeding to the description of the other organic systems of which the human body is built up, it may be well to enter into the consideration of the minute or microscopic structure of its constituent parts. These parts may primarily be divided into fluids and solids. The fluids are the blood, the lymph, the chyle, the secretions of the various glands, and of the serous and synovial membranes. The solids form the framework of the several organic systems, and assume different appearances in different localities. Sometimes they are arranged in compact solid masses, as in cartilage; at others they are elongated into fine threads or fibres, as in muscle, tendon, nerve; at others they are expanded into thin membranes, as in the fasciæ or aponeuroses, the serous, synovial, and mucous membranes; at others they are hollowed out into distinct tubes for the conveyance of fluids, as in the blood-vessels, the lymph and chyle vessels, and the ducts of glands. To the solids of the body, whatever their form may be, the general name of Tissues or Textures is applied. Each organic system may be regarded as in the main composed of a tissue or texture peculiar to and characteristic of itself. Thus, the bones are essentially composed of the osseous tissue, the muscles of the muscular tissue, the nervous system of the nervous tissue, fibrous membranes of the fibrous or connective tissue, &c. But though the essential constituent of each organic system is a tissue peculiar to that system, yet in most localities certain other tissues are mingled with that which is to be regarded as the characteristic texture of the part. In a muscle, for example, not only is the muscular tissue present, but mingled with it are connective tissue, nerve tissue, blood-vessels, and lymph-vessels. A gland also not only consists of its proper tissue, the secreting cells, but of more or less connective tissue, nerves, blood and lymph vessels, and gland ducts. Indeed, there are few localities in which, along with the proper tissue of the part, blood and lymph vessels, nerves and connective tissue, are not found; and to a part built up of two or more tissues the name of an Organ is applied. Thus the muscular system consists of the series of organs which we call the muscles, the glandular system of the several organs called glands, and so on. Each tissue and each organ, into the construction of which that tissue enters as the characteristic texture, possesses not only distinctive structural, but also distinctive functional properties. Thus the muscular tissue is characterised by the property of contractility, and the muscles, of which it forms the essential texture, are organs of motion or locomotion; the osseous tissue is characterised by its

hardness and strength, and the bones, of which it forms the essential texture, are organs of protection and support.

But the study of the textures embraces an inquiry not only into the special, structural, and functional properties of each tissue and organ—into the special part which each plays in the animal economy—but the consideration of their properties as living structures. It would be out of place in this article to enter into a discussion of the meaning of the term LIFE, or LIVING, or to attempt an analysis of the various definitions of the term which have been suggested from time to time by different philosophers, which will naturally find a place in the article PHYSIOLOGY. It will suffice for our present purpose to adopt the old Aristotelian definition, and to speak of Life as the faculties of self-nourishment, self-growth, and self-decay. All the tissues, over and above the special properties which they possess, have the power of growing and of maintaining themselves in full structural perfection and functional activity for a given period of time. After a time they begin to exhibit signs of diminished perfection and activity, they degenerate or decay; ultimately they die, and the entire organism of which they form the constituent parts is resolved by the putrefactive process into more simple forms of matter.

GENERAL CONSIDERATIONS ON CELLS.

Protoplasm. The simplest form of organic matter capable of exhibiting the phenomena of life is called Cyto-blastema or Protoplasm. It possesses a viscous or jelly-like consistency. Under the highest powers of the microscope it seems to be homogeneous, or dimly granulated, like a sheet of ground glass. Not only can it assimilate nutriment and increase in size, but it possesses the power of spontaneous movement and contractility. It enters in a very important manner into the structure of the bodies of the lower animals. The elongated processes, or pseudopodia, to which Dujardin applied the name of sarcode, which the Rhizopoda can project from their surface into the surrounding medium, and again withdraw into their substance, consist of protoplasm, and may be cited as furnishing excellent examples of its motive and contractile power. From the recent researches of Haeckel it would appear that protoplasm is capable of forming, without the superaddition of any other structure, independent organisms, which stand at the lowest grade of organisation, and from their extreme simplicity are named by him Monera. To the group Monera belong the genera Protamœba, Protogenes, and Bathybius. Of these, Bathybius is that which has attracted most attention. It has been regarded as a layer of soft slimy undifferentiated protoplasm covering the bottom of the deep sea, and capable of exhibiting the phenomena of contractility, growth, assimilation of food, and reproduction. Doubts, however, have been expressed regarding the nature of this Bathybius, so that it cannot now be cited as so definite an organism as the freely-swimming Protamœba and Protogenes. Haeckel has referred these simple organisms to a subkingdom of PROTISTÆ, which he considers to lie on the confines of both the animal and vegetable kingdoms. To a mass of protoplasm, whether it forms, as in one of these PROTISTÆ, an independent organism, or is merely a portion of the substance of the body of a higher organism, he has given the general name of a Cytode. Sometimes a cytode is a naked clump of soft protoplasm, without a trace of differentiation either on its surface or in its substance, as in the freely-moving Monera; at others the peripheral part of the cytode hardens, and differentiates into a more or less perfect envelope, as in the genera Protomonas and Protomyxa. So far back as 1861, Lionel Beale had described, under the name of *germinal matter* (*Bioplasm*), minute living particles of vegetable protoplasm, and in 1863 he demonstrated the presence of extremely minute particles of living matter in the blood. More recently Stricker has also called attention, in the bodies of the higher animals, to minute detached clumps of protoplasm which exhibited the phenomena of life. Cytode.

FIG. 25.—Undifferentiated cytode mass of protoplasm.

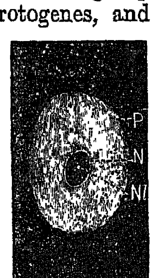


FIG. 26.—A simple form of nucleated cell. *P*, protoplasm cell-substance; *N*, nucleus; *Nl*, nucleolus.

As a rule, however, in both vegetable and animal organisms the specks or clumps of protoplasm assume definite shapes, and show evidence of an internal differentiation. In the midst of a minute clump of this substance a sharply-defined body called a *nucleus* is found, which differs from the surrounding protoplasm in not being contractile; and sometimes a minute speck, or *nucleolus*, exists within the nucleus. When a definite clump of protoplasm contains a nucleus in its interior, whether a nucleolus be present or not, it is called a Nucleated Cell. Cells are definite anatomical and physiological units, and exhibit all the phenomena of life. Some of the lowest organisms consist merely of a single cell, others of two or more cells united together, and these are called uni- or multi-cellular organisms. Cells also enter in the most material manner into the constitution of the textures of all the higher forms of plants and animals. Not unfrequently the peripheral part of the protoplasm of the cell differentiates into a distinct investing envelope, technically named a *cell wall* or *cell membrane*. Cell.

In the earlier periods of investigation into the minute structure of cells it was believed that a cell wall was constantly present, and that each cell was a minute microscopic vesicle or bladder, which in its typical shape was globular or ovoid, but capable of undergoing various modifications both in form and chemical composition. The material enclosed by the cell wall was termed the *cell contents*, and either in the midst of these contents or in contact with the cell wall was the nucleus, which might or might not contain a nucleolus. Schwann believed that the cell wall was the most active constituent of the cell, *i.e.*, possessed the power not only of producing chemical and physical changes in its own substance and in the cell contents, but of separating materials from the surrounding media,—of secreting them, as it were, into the interior of the cell. In this manner he accounted for the formation in some cells of fat, in others of pigment, in others of the characteristic secretion of glands, and so on.

It was then maintained by John Goodsir that the nucleus was the part of a cell which in all probability was concerned in separating and preparing its characteristic cell contents, and in its nutrition. Martin Barry and Goodsir also contended that the reproduction and multiplication of cells were due to self-division of the nucleus, which was thus the source of successive broods of young cells. They gave to the nucleus, therefore, an importance in the economy of the cell greater than had previously been assigned to it.

As the investigations into cell structure became more extended, it was ascertained that a cell wall was by no means always present; that in many of the cells in which it had been supposed to exist it could not satisfactorily be demonstrated, and that in others, more especially in young actively-growing cells, no trace of an investing envelope

could be observed. Hence the importance of the cell wall as an essential component of a cell was still further diminished; and Leydig then defined a cell to be a little mass composed of a soft substance enclosing a central nucleus.

But a most important advance in our conceptions of the essential structure of a cell was made when Brücke pointed out that the contents of cells not unfrequently possessed the property of spontaneous movement and contractility, and when Max Schultze determined that the contractile substance termed sarcode, which forms so large a part of the bodies of the lower animals, was analogous and apparently homologous with the contents of young actively-growing animal and vegetable cells, before a differentiation of these contents into special secretions or other materials had taken place. As the term "protoplasm" had been introduced by Von Mohl to express the contents of the vegetable cell, which undergoes changes in the process of growth, it was adopted by the animal histologist; and Max Schultze suggested that a cell should be defined to be a nucleated mass of protoplasm,—a definition which is adopted in this article. Now, as protoplasm, whether it occurs along with a nucleus in the form of a cell, or in independent clumps or cytodes, exhibits not merely the property of contractility, but the power of growing and maintaining itself, it is regarded as the functionally active constituent of the cell. And thus our conceptions as to the part of the cell in which its functional activity resides have passed through three phases. In the first, the cell wall; in the second, the nucleus; in the third, the protoplasm cell contents, or cell substance, has been regarded as the active constituent, not only as regards its nutrition, but the reproduction of young cells. But though the protoplasm can of itself perform these offices, yet there can be no doubt, as Barry and Goodsir were the first to show, that the nucleus of the cell plays a part not unfrequently in the multiplication of cells by self-division.

Ovum. One of the most characteristic cells is the mammalian ovum. In it a cell wall exists, known as the zona pellucida or vitelline membrane; within this envelope is the granular yelk or cell contents, in the midst of which is imbedded the nucleus or germinal vesicle, which in its turn contains the nucleolus or germinal spot. The granules of the yelk are a special metamorphosis of the protoplasm cell substance.

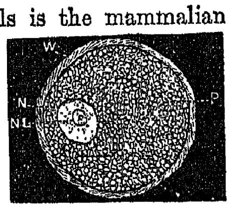


FIG. 27.—Ovum of a sheep. *W*, cell wall or zona pellucida; *P*, protoplasm of yelk; *N*, nucleus, or germinal vesicle; *Nl*, nucleolus, or germinal spot.

Cell genesis. Schwann made the important generalisation that the tissues of the animal body are composed of cells, or of materials derived from cells, "that there is one universal principle of development for the elementary part of organisms, however different, and that this principle is the formation of cells." The ovum is the primordial or fundamental cell, or germ-cell, from which, after being fertilised by the male sperm, the tissues and organs of the animal body are derived. Within the fertilised ovum multiplication of cells takes place with great rapidity. It is as yet an unsettled question how far the original nucleus of the ovum participates in this process of multiplication; but there can be no doubt that the protoplasm cell contents divide, first into two, then four, then eight, then sixteen segments, and so on. Each of these segments of protoplasm contains a nucleus—is, in short, a nucleated cell, and the protoplasm of these cells exhibits the property of contractility. The ovum or germ-cell is therefore the immediate parent of all the new cells which are formed within it, and mediately it is the parent of all the cells which, in the subsequent processes of development and growth, are descended from those produced by the segmentation of the yelk. The process of development of young cells within a parent cell, whether it occurs in the ovum or in a cell derived by descent from the ovum, is called the *endogenous* reproduction of cells. But cells may multiply by a process of *fission*—*i.e.*, a constriction, gradually deepening, may take place in a cell until it is subdivided into two; the nucleus at the same time participating in the constriction and subdivision. A third mode of multiplication of cells is by *budding:* little clumps of protoplasm bud out from the protoplasm of the parent cell, become detached, and assume an independent vitality. If a nucleus differentiates in the interior of such a clump, it becomes a cell; if it remains as a mere clump of protoplasm, it is a cytode.

These various methods of multiplication are all confirmatory of Schwann's generalisation of the descent or derivation of cells from pre-existing cells. But as the nucleated cell, either with or without a cell wall, is not, in the present state of science, regarded as the simplest and most elementary unit capable of exhibiting vital phenomena, and as these phenomena can be displayed by individual clumps of protoplasm, without the presence of a nucleus, some modification of the doctrine, as regards the formation of the tissues from nucleated cells, seems to be necessary. For, although there can be no doubt that all the tissues are mediately derived from the ovum or fundamental cell, and that most of the tissues are derived directly from nucleated cells, yet there is reason to think that a differentiation of a cytode clump of protoplasm into tissue may take place, so that the direct formation of such a tissue would be, not from a nucleated cell, but from the more simple cytode. Hence a more comprehensive generalisation, to which observers have gradually been led from the consideration of numerous facts, has now been arrived at,—that the tissues and organs of the body, whatever may be their form and composition, are formed of protoplasm, or produced by its differentiation; and that the protoplasm itself is derived by descent from the protoplasm substance of the primordial germ-cell. Some, indeed, have contended that protoplasm, cells, and their derivatives can arise by a process of precipitation or aggregation of minute particles or molecules in an organic infusion, and that living matter may be thus spontaneously generated. But the evidence which has been advanced in support of this hypothesis is by no means satisfactory or conclusive, whilst the correctness of the theory of the direct descent of protoplasm from pre-existing living protoplasm is supported by thousands of observations made by the most competent inquirers.

In the process of conversion of protoplasm into the several tissues, there takes place a differentiation of form and structure (*i.e.*, a morphological differentiation), and of composition (*i.e.*, a chemical differentiation), as the result of which a physiological differentiation is occasioned, whereby tissues and organs are adapted to the performance of special functions. Hence arise the several forms of tissue which occur in the human body and in the higher animals. Many of the tissues consist exclusively of cells which present in different parts of the body characteristic modifications in external configuration, in composition, and in properties, as may be seen in the fatty tissue, pigmentary tissue, and epithelium. Other tissues, again, consist partly of cells, and partly of an intermediate material which separates the constituent cells from each other. Here also the cells present various modifications; and the intermediate material, termed the *matrix* or *intercellular substance*, varies in structure, in composition, and in properties in the different textures, as is seen in the connective, cartilaginous, osseous, and muscular tissues.

It is not an easy matter to devise a classification of the tissues, based on their structural characters, which shall be in all respects logically perfect; but a convenient basis of arrangement for descriptive purposes may be found by dividing them into those which consist—1st, of cells suspended in fluids; 2d, of cells placed on free surfaces; 3d, of cells imbedded in solid tissues.

1st Group.—Cells Suspended in Fluids.

The fluids of the body which have cells or other minute solid particles suspended in them are the blood, the lymph, and the chyle. Sometimes cells are found floating in the secretions of glands.

Blood.

THE BLOOD.—The blood is the well-known red fluid which circulates throughout the blood-vascular system. As its composition and general properties will be described in the article PHYSIOLOGY, the solid particles only, which are suspended in the liquor sanguinis, will be considered here. If a drop of human blood be examined under the microscope, crowds of minute bodies, the blood corpuscles, or blood globules, may be seen in it. These present two different appearances, and are distinguished by the names of red and white blood corpuscles.

Red corpuscles.

The red corpuscles, which are by far the more numerous, are minute circular discs, slightly concave on both surfaces. Their average diameter is about $\frac{1}{3500}$th of an inch, and their thickness about $\frac{1}{4}$th of that measurement; hence they are not spheres, as the old name blood globules would imply. They are non-nucleated. Single corpuscles have a faint fawn-coloured hue, but collectively they give to the blood its characteristic red colour. This colour is due to the presence in the corpuscles of the substance termed *hæmoglobin*. It has been estimated by Vierordt and Welcker that 5,000,000 red corpuscles are present in every cubic millimetre of healthy human blood. The red corpuscles in the blood of all mammals, except the tribe of camels, are circular bi-concave discs; but in these exceptional mammals they have an elliptical outline. In all mammals the red corpuscles are non-nucleated, though appearances of nucleation have been seen in exceptional individual cases; for Rolleston saw a nucleated appearance in a small proportion of the dried red blood corpuscles of a two-toed sloth; and Turner observed in a proportion of the red blood discs of a Hoffmann's sloth an appearance of a central nucleus.

In all birds, reptiles, and amphibia the red corpuscles are oval or elliptical, and in each corpuscle an oval or elliptical nucleus is situated. In all fishes they are nucleated and also elliptical in form, except in some of the Cyclostomata, which possess circular discs. In the elliptical nucleated corpuscles the surfaces are not bi-concave, but have central projections, which correspond in position to the nucleus (2, 4, 5, Fig. 28). The red corpuscles vary materially in size in different vertebrata, and these variations have been specially studied by Gulliver. He has found them to vary in mammals from an average diameter of $\frac{1}{2745}$th of an inch in the elephant, and $\frac{1}{2769}$th in *Orycteropus capensis*, to $\frac{1}{12325}$th in *Tragulus javanicus*, and he concludes that the smallest blood discs occur in the small species of an order or family, the largest in the large species. In birds they are larger than in mammals, and vary in length from an average of $\frac{1}{1455}$ inch in *Casuarius javanicus* to $\frac{1}{2418}$th in *Linaria minor*. In reptiles they are still larger, and vary in length from an average of $\frac{1}{1178}$th in *Anguis fragilis* to $\frac{1}{1555}$th in *Lacerta viridis*. In amphibia the largest corpuscles, according to Gulliver, are about $\frac{1}{400}$ inch in length in *Proteus* and *Siren*, though Riddell states that in *Amphiuma tridactylum* they are $\frac{1}{3}$d larger; whilst the smallest, as in the common frog, average in length $\frac{1}{1108}$ inch. In cartilaginous fish the corpuscles are larger than in osseous. In *Lamna cornubica* Gulliver found their long diameter to be $\frac{1}{923}$ inch; while in the Salmonidæ, which have the largest blood discs among osseous fish, the long diameter in the salmon and common trout is only about $\frac{1}{1500}$ inch.

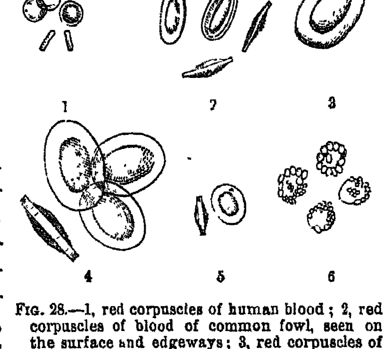


FIG. 28.—1, red corpuscles of human blood; 2, red corpuscles of blood of common fowl, seen on the surface and edgeways; 3, red corpuscles of frog; 4, of *Squalus squatina*; 5, of *Lophius piscatorius*; 6, corpuscles of the blood of a scorpion.

White corpuscles.

The white or colourless corpuscles are comparatively few in number in the healthy human blood. Welcker has estimated the normal relative number as one white to 335 red; in pregnant and menstruating women the proportion is increased to about 1 to 280. In some forms of disease the proportion is so very materially increased that they appear to be almost as numerous as the red. They are rounded in form, finely granulated or mulberry-like in appearance, and nucleated—the nucleus becoming more distinct after the addition of acetic acid; moreover, they are larger than the red corpuscles, their average diameter being from $\frac{1}{2500}$th to $\frac{1}{3000}$th of an inch. Corpuscles of a similar form are found in the blood of all vertebrata. They do not vary so much in size in different animals as do the red corpuscles. In *Triton*, according to Gulliver, their average diameter is $\frac{1}{2000}$th, whilst in *Herpestes griseus* they are not more than $\frac{1}{3872}$ inch. The white blood corpuscles are minute nucleated clumps of protoplasm; they are therefore minute cells. It is very doubtful if they possess a cell wall, the evidence being against rather than in favour of its presence.

The red blood corpuscles in all vertebrata, except the mammalia, are nucleated clumps of protoplasm; they are therefore minute cells. In mammals, owing to the absence of a nucleus, they do not accord with the definition of a cell adopted in this article, and they are not therefore morphologically identical with the red corpuscles in other vertebrates. What their precise homology may be is somewhat difficult to say, owing to the obscurity which prevails as to their exact origin. If they are merely clumps of specially modified protoplasm, budded off from the white corpuscles, then they are cytodes. If, as some have supposed, they are the nuclei of the white corpuscles, specially modified in composition, then they are free nuclei. If, again, they are the white corpuscles, the cell substance of which has undergone a special differentiation, and the nucleus has disappeared, then they are potentially cells, though no nucleus is visible. Whatever may be their exact homology, there can be no doubt that the non-nucleated mammalian red corpuscle, and that part of the nucleated red corpuscle which lies outside the nucleus, are functionally identical with each other; the protoplasm having undergone a special chemical differentiation into hæmoglobin, a proximate principle characterised by containing iron as its essential constituent. The action of water, spirit, acids, alkalies, various gases, heat, cold, and electrical currents, on the red corpuscles has been studied by several observers, and the conclusion has been reached that the corpuscles consist of a "stroma," with which the colouring matter is blended, but from which it may be separated without the stroma affording any evidence of the presence of an investing envelope or membrane. When blood is drawn from the vessels the red corpuscles, in about half a minute, run together into piles, like *rouleaux* of coins

(Fig. 29), which arrange themselves into irregular meshes. In inflammatory diseases, and in the blood of pregnant women, the piles of corpuscles form more readily, and at the same time sink rapidly below the surface of the fluid,

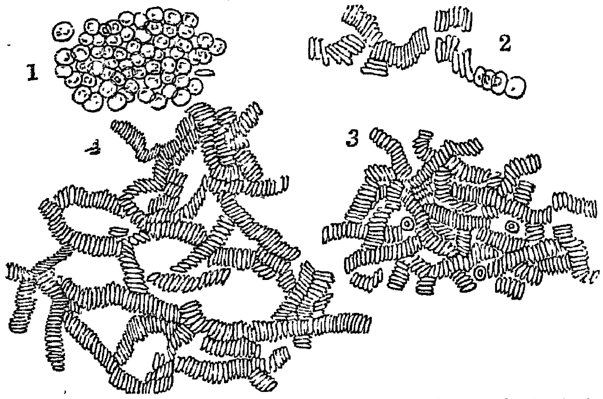


FIG. 29.—1, red corpuscles of healthy human blood; 2, red corpuscles beginning to form *rouleaux*; 3, mesh-like arrangement in healthy blood; 4, mesh-like arrangement in buffy blood, where the meshes are larger than in healthy blood.

so as to cause the "buffy coat" seen in the blood coagulum. In the healthy blood of horses a buffy coat is formed as a natural condition of the coagulation.

One of the most curious properties possessed by the living white blood corpuscle is that of protruding delicate processes from its circumference, which processes may change their shape, or be again withdrawn into the substance of the corpuscle, which then resumes its former circular outline. These processes resemble the sarcode prolongations which *Amœba* and other Rhizopods can project from various parts of their circumference; and as a white blood corpuscle, like an *Amœba*, can by the movements of the processes change its position, the term "amœboid movements" has been applied to the phenomena in question. Like an *Amœba*, also, a white corpuscle can by these movements include within its substance minute particles of solid matter which it may come in contact with in its path. Thirty years ago W. Addison stated that the white blood corpuscles could pass through the walls of the blood-vessels into the surrounding tissue, where they formed mucus corpuscles, and, under certain pathological conditions, the corpuscles of pus or inflammatory lymph. The passage of white blood corpuscles through the wall of the capillaries was seen in 1846 by A. Waller; and though for many years his observations were ignored, yet the more recent inquiries of Cohnheim and others into the subject have anew directed attention to them. It is now generally admitted that the migration of these corpuscles from the blood through the wall of the capillaries into the tissues does take place, and that they may then "wander" to and fro, owing to the mobility of their contractile protoplasm. These migrated corpuscles are also believed to play an important part in many physiological and pathological processes.

But the blood contains, in addition to the red and white corpuscles, still more minute particles, which are, however, inconstant in number. Minute globules have been described by Beale and Max Schultze, which are probably detached fragments of protoplasm budded off from the white corpuscles; and Zimmermann has described, as elementary corpuscles, minute particles, which are apparently derived from broken-up red corpuscles.

In the very young embryo the blood corpuscles, like the capillary blood-vessels themselves, are formed by special differentiation of certain of the cells of the embryo, and these young corpuscles seem to have the power of multiplying by fission. At first they are colourless, but afterwards assume a red colour. Even in mammals the earliest red blood corpuscles are nucleated and larger than the future red discs, but as development goes on, non-nucleated red corpuscles appear, and as their number increases, both absolutely and relatively with the progress of the fœtus, in course of time all the nucleated red corpuscles have disappeared, and are replaced by the non-nucleated discs. In adults the red corpuscles are believed to be derived from the white corpuscles, though the exact process of metamorphosis has not been satisfactorily ascertained. It is also believed that red corpuscles may be new-formed in the spleen, and Neumann has recently stated that the red marrow of the bones may serve as a centre of origin for the red blood corpuscles. In the fœtus the liver apparently serves as a centre of origin for the white corpuscles, but its blood corpuscle forming function ceases at the time of birth. Throughout extra-uterine life the spleen and the lymphatic glands are without doubt organs of formation of the colourless corpuscles,—those produced in the lymphatic glands, under the name of lymph corpuscles, being mingled with the blood-stream where the fluid lymph flows into the venous system. When mixed with the blood, the lymph corpuscles become the white blood corpuscles.

Corpuscles are also found in the blood of the invertebrata. They are as a rule colourless, but R. Wagner pointed out that in the Cephalopods they are coloured. They are sometimes round, at others oval or fusiform, and in worms and insects have even branched processes. They are always nucleated.

THE LYMPH AND CHYLE.—The lymph is the fluid found Lymph.
in a subdivision of the vascular system named the lymph vascular system. It is transparent and colourless, and contains numerous corpuscles floating in it, which correspond, in appearance, structure, and the possession of the property of amœboid movements, to the white corpuscles of the blood. The lymph corpuscles are formed in the glands situated in the course of the lymph vessels, and are carried away from the glands by the stream of lymph which flows through them.

The chyle is a milky fluid found during the period of Chyle.
digestion in the delicate lacteal vessels which pass from the walls of the intestine. The lacteals join the lymphatics at the back of the abdomen to form the thoracic duct in which the lymph and chyle become mingled together. The chyle contains corpuscles similar to the lymph corpuscles, which are apparently derived from the lymph glands in the mesentery, through which the chyle flows on its way to the thoracic duct. The fluid of the lymph, the chyle, and the blood, in which the corpuscles are suspended, is sometimes described as a fluid intercellular substance. Corpuscles possessing the type of structure of the lymph corpuscles, are named lymphoid cells or *leucocytes*.

Cells are also met with floating free in the secretions formed in the interior of some of the glands. They are more particularly found in the secretion of mucus from the mucous glands, and of saliva from the salivary glands. They are round, colourless, nucleated corpuscles, not unlike the white corpuscles of the blood, and have been detached from their original position in the gland follicles.

2d Group.—Cells placed on Free Surfaces.

By the term free surface is meant a surface which is not blended with or attached to adjacent structures, but is free or separable from them without dissection. Every free surface is covered by one or more layers of cells. Sometimes these cells are named an Epithelium, at others an Endothelium. By the term Epithelium is meant the cells situated on free surfaces which are exposed either directly or indirectly to the air. By the term Endothelium is meant the cells situated on free surfaces which are not exposed either directly or indirectly to the air.

Epithelium.

Mucous Membranes.

EPITHELIUM.—The free surfaces covered by an epithelium are the skin and the membranes, named, from the character of their secretion, mucous membranes. The Mucous Membranes line internal passages and canals, and are continuous at certain orifices with the skin,—*e.g.*, the mucous membrane of the alimentary canal opens on the surface at the mouth and anus; the respiratory mucous membrane opens on the surface at the nostrils, and is continuous in the pharynx with the alimentary mucous membrane—it is also prolonged through the Eustachian tube into the tympanum, and is continuous through the nasal duct with the conjunctiva; the genito-urinary mucous membrane opens on the surface at the orifice of the urethra and vagina. Mucous membranes also line the ducts of the various glands which open on the surface either of the skin or the several mucous membranes. The epithelial cells are as a rule arranged in layers or strata, and the shape of the cells is by no means uniform in the different layers. The cells of the deeper strata are usually smaller, softer, more rounded, and more recently formed than those of the superficial strata, though sometimes, as in the bladder, conjunctiva, and some other mucous surfaces, they may be irregular in form and size, or even elongated into short columns. The cells next the free surface have a tendency to be shed, and their place is then taken by the cells of the deeper layers, which become modified in form as they approach the surface. The form of the cells of the superficial layer varies in different localities, which has led to a division of epithelium into groups bearing appropriate names. Epithelium is distinguished further by being devoid of blood-vessels, *i.e.*, it is non-vascular; and also, with some exceptions, devoid of nerves, *i.e.*, non-sensitive.

The epithelial cells, whether arranged in one or several strata, rest upon a subjacent tissue, which, from its relation to the cells, may be called *sub-epithelial*. The sub-epithelial tissue is a delicate modification of the fibrous form of connective tissue, to be subsequently described, and in it the nerves and the blood and lymph vessels of the skin and mucous membranes ramify; hence it is sometimes described as a fibro-vascular tissue or *corium*. It was for a long time believed that between the deeper surface of the epithelium and the corium a homogeneous continuous membrane, named by Bowman a basement membrane, intervened. Bowman, however, himself admitted that in some of the localities where this membrane was theoretically supposed to exist it could not satisfactorily be demonstrated; and the general opinion of anatomists now is, that a distinct separable membrane does not intervene between the epithelium and the fibro-vascular corium, but that the cells of the former rest directly upon the surface of the latter. The corium is also the seat of the numerous glands, with the blood and lymph vessels and the nerves belonging to them, found in connection with both the skin and the mucous membranes; and the epithelial lining of the glands is continuous at their orifices with the epithelial investment of the corium. The surface both of the skin and mucous membranes is usually more or less undulated—sometimes it is thrown into strong folds or rugæ, at others it is elevated into minute, frequently conical, processes, named in some localities papillæ, in others villi; but in all these cases the epithelium is prolonged as a continuous covering over the undulating free surface. The free surface of all mucous membranes is kept moist by the secretion or mucus which lubricates it.

Tessellated, *pavement*, *scaly*, or *squamous* epithelium is situated on the free surface of the mucous lining of the mouth, pharynx, œsophagus, vestibular entrance to the nose, ocular conjunctiva, and entrance to the urethra and vagina. It forms, under the special name of the horny layer of the cuticle or epidermis, the superficial investment of the skin. Its cells are nucleated flattened scales, varying in diameter from $\frac{1}{500}$th to $\frac{1}{1000}$th inch. Those in the same layer, being in contact by their edges, form a tessellated, pavement-like arrangement, whilst the cells in adjacent layers have their flattened surfaces in contact with each other. Sometimes the cells have jagged, serrated edges, or fluted surfaces, and usually they contain scattered granular particles. In the formation of this epithelium a morphological differentiation of the protoplasm of the rounded cells of the deeper strata into flattened scales, and at the same time a chemical differentiation of their soft contents into a horny material, have occurred.

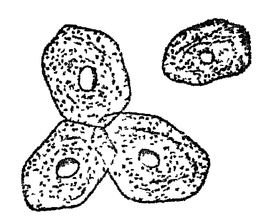


FIG. 30.—Scaly epithelium from the mucous membrane of the mouth.

Columnar or *cylindrical* epithelium is situated on the free surface of the mucous lining of the alimentary canal from the œsophageal orifice of the stomach to the anus, it is prolonged into the ducts of various glands which open on the alimentary mucous membrane; it covers the mucous lining of the urethra and the mucous membrane of the gall bladder. Its cells are elongated, cylindrical columns, about $\frac{1}{500}$th inch long, placed side by side like a row of palisades, and with their long axes perpendicular to the surface on which the cells rest. Sometimes the cells are uniformly cylindrical; at other times they are compressed at the sides; at others they vary in circumference,—the broader end, lying next the surface, being rounded or polygonal; the deeper extremity being narrower and more pointed. The nuclei are distinct, and the cell contents are finely granular. Usually this epithelium forms only a single layer of cells. The columnar cells which cover the intestinal villi have a clear space at their broad free ends, which is often streaked with fine parallel lines. Intermingled with the cells of the columnar epithelium of the alimentary canal are small goblet-shaped cells.

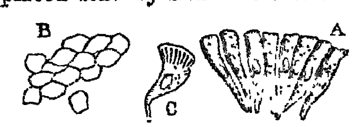


FIG. 31.—Columnar epithelium. A, side view of a group of cells; B, larger free end of a group of cells; C, a striated columnar cell from intestinal villus.

Ciliated epithelium is situated on the free surface of the nasal mucous membrane, which extends into the air-sinuses within the cranial bones, into the nasal duct and lachrymal sac, into the Eustachian tube and tympanum; on the free surface of the mucous membrane of the windpipe as far as the terminal branches of the bronchial tubes; on the mucous surface of the uterus and Fallopian tubes; on the mucous lining of the commencement of the vas deferens, and on the lining membrane of the ventricles of the brain and central canal of the spinal cord. It generally consists of columnar cells, which have at their free ends extremely slender, soft, pellucid, hair-like processes, or *cilia*. These cilia are specially differentiated at the free ends of the epithelium cells from which they project. Beale states that the soft bioplasm (protoplasm) of the body of the cell is prolonged along the axis of each cilium, whilst the periphery possesses the firmer consistence of formed or differentiated material. During life these processes move rapidly to and fro in the fluid which moistens the surface of the membrane on which this form of epithelium is situated. In the human body the cilia are not more than from $\frac{1}{2500}$th to $\frac{1}{5000}$th inch in length; but in various marine invertebrata they are both longer and stronger. Sometimes, as in the lining membrane of the cerebral ventricles and central canal of the spinal cord, the cells carrying the cilia

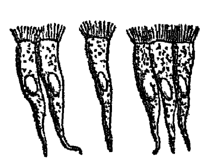


FIG. 32.—Ciliated epithelium cells.

are either spheroidal or cylindrical; but as the cavities lined by these cells are shut off from the air, the cells ought rather to be referred to the endothelial than the epithelial series of structures. Cilia occasion currents in the fluid in which they move, and play an important part in the economy of many animals; in some of the invertebrata they serve as organs of locomotion, in others they propel currents over respiratory surfaces, and in others aid in bringing food within the animal's reach.

Spheroidal or *glandular* epithelium is situated on the free surface of the follicles or ultimate secreting apparatus of glands, and the commencement of gland ducts. The cells are often spheroidal in form, though not unfrequently they are polyhedral. Their contents are specially differentiated into the secretion of the particular gland in which they are situated.

Secreting glands.

The epithelial cells of a Secreting Gland rest upon a sub-epithelial tissue. Not unfrequently this tissue has the appearance of a membrane; it represents, indeed, the basement membrane of Bowman, and is called *membrana propria*. Deeper than this apparent membrane is a delicate connective tissue in which the blood and lymph vessels and the nerves of the gland ramify. The anatomical structures necessary for secretion are cells, blood-vessels, and nerves. The blood-vessels convey the blood from which the secretion has to be derived; the cells, as Goodsir showed by a variety of proofs, are the active agents in separating the secretion from the blood; the nerves regulate the size of the blood-vessels, and therefore the amount of blood which circulates through the gland, and perhaps also exercise some direct influence on the activity of the cells. The connective tissue and the *membrana propria* are merely supporting structures for the cells, vessels, and nerves. All secreting glands have the same general type of structure, though they differ from each other, as will be pointed out when the individual glands are described, in the degree of complexity in which their constituent parts are arranged.

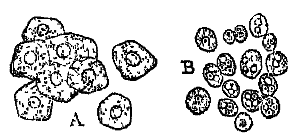


FIG. 33.—A, polyhedral gland cells from the liver; B, spheroidal gland cells from the saliva.

Transitional epithelium is the name applied to epithelial cells, situated on some free surfaces, which possess transitional forms either between the columnar and tessellated epithelia, or the columnar and spheroidal. The epithelium of the mucous lining of the bladder is transitional between the columnar and scaly varieties; and in many glands the continuity of the epithelial layer from the spheroidal epithelium of the gland follicles to the columnar epithelium of the ducts is preserved by the interposition of intermediate transitional forms of cells.

The epithelial surfaces of the upper part of the mucous lining of the nose and of the back of the tongue are specially modified in connection with the senses of smell and taste localised in those regions, as will afterwards be considered when their anatomy is described.

Endothelium

ENDOTHELIUM.—The free surfaces covered by an endothelium are the serous membranes, the inner surface of the walls of the lymph and blood vessels and of the heart, the synovial membranes of the joints and of synovial bursæ, the free surface of the osseous and membranous labyrinth of the internal ear, and the free surface of the ventricular cavities of the brain and central canal of the spinal cord. The tubes, canals, and cavities lined by an endothelium are shut off from all communication with the external atmosphere. The cells of the endothelium are arranged so as to give perfect smoothness to the surface which they cover. In the blood and lymph vessels this smoothness of surface is in order to facilitate the flow of the blood and lymph in the course of the circulation. The serous and synovial membranes are found covering the surfaces of parts which move on each other, and the smoothness of their respective surfaces, by permitting freedom of movement, diminishes the friction.

Serous membranes.

Each Serous Membrane consists of a portion which invests the viscus or organ, named the visceral layer, and a portion which lines the walls of the cavity in which the organ is situated, named the parietal layer. Between these two layers is the so-called serous cavity, the wall of which is formed by the smooth surfaces of both the parietal and the visceral layers. The serous membranes are as follows:—The two pleuræ situated in the cavity of the chest, one investing each lung, and lining the interior of that part of the thoracic cavity in which the lung is situated; the pericardium, which invests the heart, and lines the bag in which the heart is contained; the peritoneum, which invests the abdominal viscera, and lines the abdominal cavity; and the arachnoid membrane, which invests the brain and spinal cord, and is regarded by many as lining the dura mater, which encloses these important organs. The smooth free surfaces of the serous membranes are moistened by a limpid fluid, or serum, which facilitates their movement on each other, just as the free smooth surfaces of the synovial membranes are lubricated by the viscid synovia which they secrete.

Endothelial cells form usually only a single layer, and are, as a rule, flattened scale-like cells, arranged after the manner of a tessellated epithelium. Endothelium, like epithelium, is non-vascular, and, so far as is known, non-nervous.

The endothelial cells rest upon a sub-endothelial tissue, consisting of a delicate modification of the fibrous form of connective tissue. Here, as in the surfaces covered by epithelium, a basement membrane was at one time supposed to intervene between the cells and the connective tissue; but it is now believed that the cells are in direct contact, by their deeper surface, with the connective tissue itself. In the serous membranes and in the coats of the larger blood-vessels elastic fibres are present in considerable numbers in the sub-endothelial tissue, which serves as the framework of support for the blood and lymph vessels and the nerves of the part. In the serous membranes the lymph-vessels are very abundant in the sub-epithelial tissue, where they form a layer parallel to the free surface of the membrane, from which short vessels pass vertically to open by minute orifices into the serous cavity. The serous membranes are attached by the sub-endothelial connective tissue to the organs which they invest.

The endothelium of the Serous Membranes consists of irregular and squamous cells, the edges of which may be smooth or slightly serrated. The cells are closely adapted to each other by their edges, so as to form a continuous smooth layer, which forms the free surface of the serous membrane. Scattered irregularly over this surface are the minute orifices, or *stomata*, which open into lymphatic vessels. The cells which surround the stomata differ in form and appearance from the ordinary endothelium; they are smaller, and are polyhedral, their contents are granular, and the nucleus is more distinct.

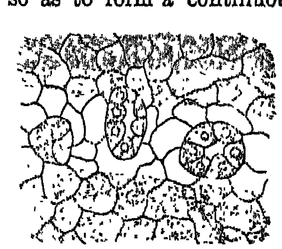


FIG. 34.—Endothelial cells from the peritoneal serous membrane. Three stomata may be seen surrounded by polyhedral nucleated cells; the one to the left is closed. The light band marks the position of a vertical lymphatic vessel. (*After Klein.*)

The endothelium lining the Lymphatic Vessels consists of flattened cells, which, instead of having an irregular shape, are elongated spindles, slightly sinuous in outline. The endothelium of the lymphatics is continuous with that of the serous membranes through the stomata, so that the cavities of the serous membranes are now regarded as great lymph-sacs.

The endothelial lining of the Blood Vessels corresponds in general characters with that of the lymphatics. In the small blood capillaries the cells are fusiform; in those of larger size, more irregular: in the veins they are broader, more irregular, and less distinctly fusiform than in the arteries. The endothelial covering of the endocardial lining of the heart consists of a layer of flattened cells with irregular outlines. The endothelial lining of the blood-vascular system is continuous with that of the lymph-vascular system, where the thoracic duct and other large lymph-vessels open into the great veins, and thus a continuity of surface is established between the serous membranes and the lining membrane of the blood-vascular system through the lymphatics.

The endothelium of the Synovial Membranes is formed of roundish, or polygonal, or tessellated cells, arranged after the manner of a stratified epithelium. Not unfrequently processes of the sub-endothelial vascular connective tissue covered by the endothelium project into the cavities of joints and synovial bursæ. They have been called synovial fringes, and contribute to the formation of the synovia which lubricates the surfaces of a synovial membrane.

The endothelium of the Cerebral Ventricles and Central Canal of the spinal cord is, as already stated, formed of spheroidal or cylindrical cells, possessing cilia on the free surface. The endothelial lining of the osseous labyrinth consists of flattened scales, whilst the membranous labyrinth possesses a layer of polygonal cells.

3d Group.—Cells imbedded in Solid Tissues.

The cells which are imbedded in the solid tissues are either grouped together in considerable masses, or, as not unfrequently happens, are more or less separated by an intermediate matrix or intercellular substance. The matrix substance varies in its character in different tissues, and sometimes is so abundant as to obscure the cells. The textures which are constructed on this plan are of great importance, and constitute by far the larger proportion of the tissues not only of the human body, but of the bodies of animals generally. Sometimes these tissues are elongated into delicate threads or fibres, at other times they are expanded into thin membranes, at others they form solid masses of considerable thickness.

Connective tissue.

CONNECTIVE TISSUE.—By the term connective tissue is meant a group of tissues which, though the members of the group differ in various respects from each other, both in naked eye and microscopic characters, yet agree in the property of binding or connecting together other tissues or parts of the body, and in serving as a supporting framework for more delicate tissues. This group of tissues is the most extensively diffused of all the textures, for there is no organ in the body which does not contain one or other of its forms. The following varieties, based on modifications in their appearance and structure, may be recognised.

a. Neuroglia. This name, which means nerve glue, has been applied by Virchow to the delicate tissue in the central organs of the nervous system, and of the retina, which supports the nerve cells, nerve fibres, and blood-vessels of those parts. Microscopically it consists of small round or ovoid corpuscles, imbedded in a soft undifferentiated protoplasm. A form of tumour, named Glioma, is sometimes produced by the excessive growth in the brain or retina of this variety of connective tissue.

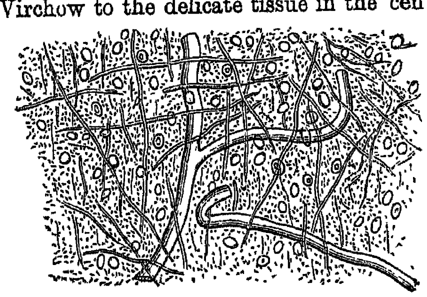


FIG. 35.—Section of the white matter of the cerebrum The neuroglia, nerve fibres, and capillary blood-vessels are represented.

b. Retiform connective tissue constitutes the stroma or supporting framework of the lymphatic and other glands which possess the adenoid type of tissue. It also forms the middle subdivision of the enamel organ of the teeth. It consists of stellate branching cells, the branches of which blend with each other, and form a delicate anastomosing network or reticulum. In the lymph glands, the colourless lymph corpuscles are set in the meshes of this network. In the solitary and Peyer's glands of the alimentary canal, in the tonsils, the back of the tongue, the posterior wall of the nasal part of the pharynx, the palpebral conjunctiva, the thymus gland, the pulp and Malpighian bodies of the spleen, colourless lymph-like corpuscles are also included in the meshes of a reticulum. The name *adenoid* or *lymphoid* tissue is sometimes employed in describing this type of structure, and in some forms of disease the tissue increases in certain localities so largely in quantity as to form well-defined lymphoid tumours.

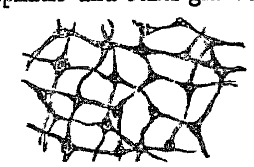


FIG. 36.—Retiform connective tissue from a lymphatic gland.

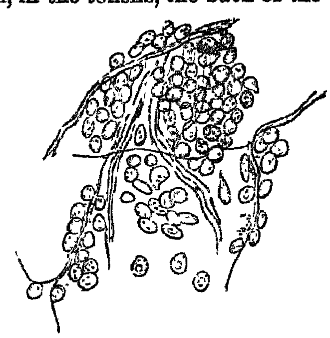


FIG. 37.—Lymphoid cells, included in a reticular mesh of connective tissue from a lymphoid tumour of the mediastinum.

c. Gelatinous or *mucous* connective tissue (*Schleimgewebe*), forms the connective tissue of the embryo, the vitreous humour of the eye-ball, and the jelly of Wharton, which invests the blood-vessels of the umbilical cord. It is soft and jelly-like in consistency. Microscopically it consists of rounded, or spindle-like, or stellate cells, imbedded in a soft gelatinous intercellular substance. Sometimes the intercellular substance is in part differentiated into short delicate fibres. Under some pathological conditions, this form of tissue increases largely in quantity in some parts of the body, and forms a kind of tumour named Myxoma.

FIG. 38.—Gelatinous connective tissue. The fusiform and stellate cells, and the partial differentiation into fibres of the intercellular substance, are shown.

d. Fibrous connective tissue presents four modifications in appearance. It may be soft and delicate, with the fibres short and but faintly marked, as in the sub-epithelial tissue of the skin and mucous membranes. It may be loose, flocculent, and filamentous, and may contain small spaces or areolæ (when it is called *areolar tissue*), which is well seen in the subcutaneous tissue of the adult, and in the omenta. It may be expanded in the form of a *fibrous membrane*, as in the fasciæ or aponeuroses, and the threads or fibres, strong and well marked, sometimes run parallel, sometimes cross each other at various angles. It may be collected into rounded or flattened bands, as in tendons and ligaments, where it forms the *tendinous* and *ligamentous* tissues. Here also the threads or fibres may be distinctly recognised and seen to run in parallel bundles, so as to

connect together the two structures between which the tendon or ligament passes.

In the fibrous form of connective tissue, both cells and intercellular substance, the latter of which is differentiated into fibres, may be recognised. The cells are, as a rule, either elongated, or fusiform, or caudate, or stellate branched cells, and are familiarly known as the *connective tissue corpuscles*. In these cells the nucleus is round or oval, and usually well marked. It is surrounded by granular protoplasm, but it is very doubtful if the protoplasm is invested by a cell wall. Not unfrequently, more especially where the cells are stellate, the delicate branched protoplasm processes of adjacent cells appear to blend at their extremities with each other, and form an anastomosing network. In tendons the cells are arranged in linear rows, which lie parallel to the long axis of the tendon itself. In adults these cells are flattened, but in younger tendons they are more polygonal in form. There seems reason to think, indeed, as Thin has shown, that the bundles of connective tissue are invested by a layer of flattened cells. The wide diffusion of the connective tissue throughout the body, and the great importance of its cellular elements, have been especially dwelt on by Virchow as sources of origin of the new cell forms which arise in various pathological processes.

The *intercellular substance* consists of fibres, which are not uniform in shape, and are divided into the two groups of white and yellow fibres.

White fibrous tissue.

The *white fibres* of connective tissue constitute the most common form, and make up the great bulk of most ligaments, tendons, and fibrous membranes. They consist of excessively delicate filaments, varying from $\frac{1}{25000}$th to $\frac{1}{50000}$th inch in thickness, which are united together in bundles or fasciculi of variable size. The bundles, as well as the filaments of which they are composed, have a wavy course, and the filaments in each bundle lie almost parallel to each other. The bundles also in some cases are parallel, though in others they cross at various angles. Not only the filaments in each bundle, but the bundles themselves, are cemented together; the firmness of the adhesion varies in the different modifications of the fibrous connective tissue, being much more decided in the tendons, ligaments, and fasciæ, than in the lax areolar tissue.

FIG. 39.—Fasciculi of white fibres of connective tissue.

Yellow fibrous tissue.

The *yellow fibres* of connective tissue, named elastic fibres, from their elasticity, make up the mass of the ligamentum nuchæ, the ligamenta sub-flava, and the yellow elastic coat of the arteries. They are also found, mingled with the white fibres, in the fibrous membranes, the skin, mucous and serous membranes, the areolar tissue, in tendons, and some ligaments. In the ligamenta sub-flava and nuchæ the yellow fibres are arranged in bundles, the individual fibres of which are comparatively broad, with a distinct dark outline. They branch, and their branches readily break across, and the broken end then curls upon itself. Their diameter is about $\frac{1}{4000}$th inch. In the coats of the arteries the elastic fibres form an anastomosing network. When mingled with the white fibres they are much finer, and sometimes do not exceed $\frac{1}{25000}$th inch in diameter. They possess, however, a distinct and definite outline; they branch and occasionally anastomose; and the individual fibres, possessing a ring-like, spiral, or twisted course, are wound around the bundles of the white fibres. The white fibres yield gelatine on boiling, but the elastic fibres do not. The white fibres swell up and become so transparent under the action of acetic acid as to be no longer recognisable. The yellow fibres, again, are not affected by that reagent. Quekett pointed out that the elastic fibres of the ligamentum nuchæ of the giraffe were marked by transverse striæ, and M. Watson has seen a similar appearance in the elastic pericardiac ligament of the elephant. These transverse striæ are apparently cracks in the fibre; and, as Beale has shown, are not unfrequently seen in the elastic fibres in beef and mutton which have passed through the alimentary canal.

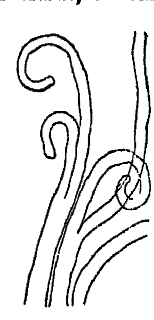


FIG. 40.—Fasciculus of fibres of yellow elastic tissue from ligamentum nuchæ.

Bearing on the mode of nutrition of the tendons, and other fibrous forms of connective tissues, the existence of plasma, or juice, canals has been described, along which, not blood, but the liquor sanguinis is supposed to flow. Virchow conceived that the connective tissue corpuscles formed an anastomosing network for this purpose. Brücke believed that delicate channels or lacunæ existed between the bundles of connective tissue, whilst Recklinghausen maintained that serous canaliculi were situated in the homogeneous substance which connects the fibrous fasciculi and lamellæ of the connective tissue with each other. These lacunæ or canaliculi are, in all probability, the rootlets of origin of the lymphatic system of vessels. There can indeed be no doubt, as the recent injections of Ludwig and Schweigger-Seidel have shown, that tendons and fasciæ are well provided with lymph vessels, for they have injected in them a minute network, consisting in part of polygonal meshes, and in part of vessels running longitudinally and parallel to the connective tissue bundles, and the walls of these vessels were formed of endothelial cells. Recklinghausen and others have recently described corpuscles in the connective tissue which resemble in size and appearance the white corpuscles of the blood and lymph. These corpuscles are believed to move about in the juice canals already referred to, and it is possible that they may have migrated into the tissue through the walls of its nutrient blood-vessels.

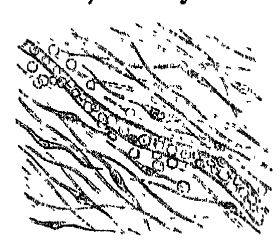


FIG. 41.—Connective tissue of the omentum of the fœtus, showing the characteristic fusiform corpuscles. A capillary blood-vessel crosses the figure, and near it are several blood corpuscles which have probably migrated from the vessel.

The vascularity of the connective tissue varies in different localities. The periosteum and perichondrium are very vascular; but their numerous vessels are concerned in the nutrition not merely of these fibrous membranes, but of the bone and cartilage which they invest. The sheath of connective tissue which invests a tendon is more vascular than the substance of the tendon itself. As a rule, it may be stated that the fibrous connective tissues are not highly vascular, and that the nutritive changes which take place in them after their growth is completed are not very active.

Development of connective tissue.

The mode of development of the connective tissue has been much discussed by anatomists, and various views have been advanced as to the changes which lead to its production. It is now, however, generally admitted that it arises from the embryonic cells by a special morphological and chemical differentiation of their protoplasm, but the degree to which this differentiation may proceed varies with the particular form of the texture. In the neuroglia the tissue is apparently a simple nucleated protoplasm. In the retiform connective tissue the cells have assumed a stellate shape, and their branches anastomose. In the gelatinous and fibrous forms an intercellular matrix is extensively produced, and exhibits a differentiation into fibres. In these last-named forms, which are the most characteristic varieties of the tissue, the cells of the embryo change their form,

and assume a fusiform, caudate, or stellate shape; and, subsequently a delicate fibrillated structure appears between them, which assumes the characters of the bundles of white fibrous tissue, and by separating the cells from each other forms the fibrous intercellular matrix. It has been much disputed whether these white fibres take their rise immediately from the peripheral portion of the cells by a direct differentiation of their protoplasm, or whether this protoplasm is not in the first instance converted into a homogeneous matrix in which the fibrous differentiation then occurs. There can be no doubt that the fibres are formed by a metamorphosis of the protoplasm of the cells; whether the metamorphosis takes place directly, or through the intermediate stage of a homogeneous matrix, is a secondary question, and in all probability both modes of conversion take place at different times and in different localities. As the differentiation into fibres progresses, the tissue becomes firmer and tougher, and the proportion of the cellular to the fibrous element diminishes. Hence, say in a young tendon, the rows of connective tissue cells are not only closer together, but are much more readily seen than in an adult tendon, in which the increased production of fibres obscures the cellular element.

The mode of origin of the yellow elastic fibres has also been much discussed. At one time it was believed that they were derived from nuclei, and on this supposition they were named nuclear fibres. But from more recent observations there is reason to believe that they are produced, like the white fibres, by a special differentiation of the protoplasm of the embryonic cells, or of a homogeneous matrix derived from that protoplasm. In such localities as the ligamentum nuchæ, where the fibres are both large and numerous, the whole of the cell protoplasm appears to become converted into elastic tissue. In tendons, and those parts where these fibres are slender and scanty, and coil round the bundles of white fibrous tissue, they apparently arise from a differentiation of the protoplasm on the surface only of the formative embryonic cells.

Fatty tissue.

Adipose Tissue.—The adipose or fatty tissue varies in its amount in different individuals. It is especially found in the marrow of the bones; as a layer beneath the skin, differing in thickness in different individuals; and collected in the cavity of the abdomen in the folds of peritoneum, known as the mesentery and omenta, in which, and indeed in the other localities where it occurs, it is intimately associated with the connective tissue. It consists of cells, which vary in size from $\frac{1}{300}$th to $\frac{1}{800}$th inch, usually ovoid or spherical in form, though when collected into masses they may be laterally compressed. These cells are sometimes isolated, though most usually arranged in rows or clusters to form lobules of fat. The number of cells in a given lobule varies with the size of the lobule. The distinctive contents of these cells is a minute drop of oil, which, when examined by transmitted light, presents a bright appearance; but when seen by reflected light, looks, as Monro *primus* described it long ago, like a cluster of pearls. Each fat cell possesses a distinct wall, as can be readily demonstrated by digesting these cells in ether, when the oil is dissolved out and the membranous wall remains. The nucleus of the fat cell is more difficult to demonstrate, and when seen is found attached to the inner surface of the cell wall. In the fat of old persons, and in specimens of this tissue which have been removed from the body for a length of time, a stellate group of acicular crystals is not unfrequently to be seen in the interior of the cell, which consists either of margarin or margaric acid, one of the constituents of human fat. The lobules of fat cells are included between bundles of the areolar variety of connective tissue, which form their supporting framework. But in addition, they are more or less perfectly surrounded by a network of capillary vessels, which not only serves to convey to them blood for their nutrition, but aids in retaining them in position.

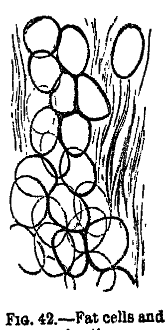


Fig. 42.—Fat cells and areolar tissue.

The close anatomical relation between the adipose and the connective tissue points to a genetic relationship between them. It has now been ascertained that the first stage in the formation of a fat cell consists in the appearance of extremely minute drops of oil in the protoplasm of the connective tissue corpuscles of the part; as these run together larger drops are produced, a cell wall at the same time differentiates from the peripheral part of the protoplasm, and as the cell becomes distended with oil, by the conversion into fat of its substance, it swells out into a spherical or ovoid cell. Klein has recently shown that the fatty tissue of the omentum and mesentery is formed by the production of oil drops within the branched cells, which form the reticular tissue that supports the lymphoid cells found so abundantly between these folds of peritoneum.

Pigment.

Pigmentary Tissue.—In some parts of the body a yellow, brown, or black pigment is found in the interior of cells, which gives to the tissue and organ a characteristic colour. In the coloured races of mankind, and in certain parts of the body of the white races, pigment is produced in the cells of the cuticle or epidermis, more especially in the cells of the deeper strata or rete Malpighi. In the connective tissue corpuscles, also, more especially in the dermis of fish, amphibia, and reptiles, pigment is found in considerable abundance. The choroid coat of the eyeball owes its dark brown or black colour to the presence of pigment in the interior of the cells. The pigment cells of the choroid are usually polyhedrons, 5 or 6-sided, and are arranged to form a mosaic pattern. In the centre is a nucleus, and the cell substance is occupied by numbers of minute brown granules. In the connective tissue on the outer surface of the choroid, the pigment is contained in stellate cells. In the skin of fishes and amphibia, the stellate pigment cells branch and subdivide so as to form highly complex patterns, and the cells are crowded with brown or yellow granules. The production of pigment, either in the interior of epidermal cells, in the polyhedral cells of the choroid, or in the stellate connective tissue corpuscles, is owing to a special metamorphosis or differentiation of the protoplasm substance of these cells.

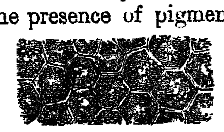


Fig. 43.—Group of 6-sided choroidal pigment cells.

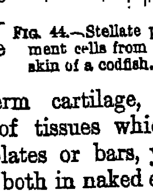


Fig. 44.—Stellate pigment cells from the skin of a codfish.

Cartilage.

Cartilaginous Tissue.—By the term cartilage, or cartilaginous tissue, is meant a group of tissues which, though usually found in the form of plates or bars, yet differ in various aspects from each other, both in naked eye and microscopic characters. They agree, however, in forming solid textures, opaque when seen in mass, but, in thin slices, translucent, pearly, or bluish white, firm in consistence, but easily cut with a knife, endowed with considerable elasticity, and yielding chondrine on boiling. Cartilage is of greater importance in the fœtus, and in the immature condition of the body than in the adult, for in early life the bones are in a great measure formed of it. As development and growth proceed, a considerable proportion of the cartilage becomes converted into bone, and is called, therefore, *temporary* cartilage, whilst the remaining portion continues as cartilage throughout life, and is

termed *permanent*. The following varieties of cartilage, based on modifications in structure and appearance, may be recognised

Cellular cartilage.	Cells with matrix substance.	
	Matrix homogeneous. (Hyaline cartilage.)	Matrix fibrous. (Fibro-cartilage.)
		White fibro-cartilage. / Yellow fibro-cartilage.

The *Cellular* or *Parenchymatous Cartilage* does not exist in the adult human body. It occurs, however, in the human embryo, in the embryos of all the vertebrata, and in the larval stage of development of the tunicata, as the slender rod named chorda dorsalis or notochord. In all the higher vertebrata the chorda dorsalis disappears as development advances, but in the lower vertebrates it persists throughout life as a more or less perfect structure. In the lamprey and myxine it forms a continuous rod in the vertebral region. In fish generally, but more especially in the cartilaginous group, it forms a jelly-like mass, occupying the concavities between the bodies of the vertebræ. The cells lie in contact with each other. They are comparatively large in size, are sometimes rounded, but more usually compressed laterally. The nucleus is often very distinct, though at other times more difficult to detect, and the cell wall is well marked. Sometimes a little intercellular substance is found. By some anatomists the chorda dorsalis is regarded as a variety of connective tissue, and not of cartilage

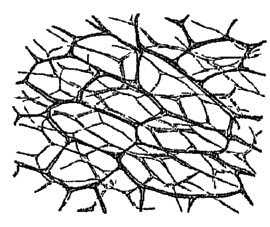


FIG. 45.—Cells of the chorda dorsalis of the lamprey.

The cartilaginous framework of the ear of some small mammals—as the mouse, the bat, and the rat—is formed of cellular cartilage, the cells of which are smaller in size than those of the chorda dorsalis, irregularly polygonal, and closely packed together so as to form a solid tissue.

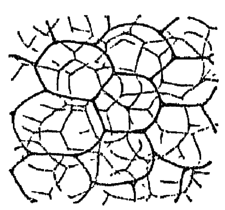


FIG. 46.—Cells of the cartilaginous framework of the ear of the mouse.

The *Hyaline Cartilage* consists of cells imbedded in a pellucid or hyaline matrix, which, under some conditions, however, may assume a dimly granulated appearance. The xiphoid and costal cartilages, the encrusting cartilages at the articular ends of the bones, the cartilages of the nose, those of the windpipe, except the epiglottis and cornicula laryngis, belong to this variety, as also the temporary cartilages. In hyaline cartilage the cells are ovoid or polygonal, or even fusiform, and sometimes flattened, the flattened form of cell being found next the surface of the cartilage. They lie singly, or in groups of two, or three, or four; sometimes they are arranged in linear series, at other times they are irregularly grouped together. The cell contents are dimly granular, with a well-defined nucleus containing a nucleolus. Not unfrequently two or more nuclei are present in a cell; and in old cartilage the contents are often coarsely granular, or even infiltrated with drops of oil. Heidenhain has shown that powerful induction shocks cause contraction of the protoplasm of the cells towards the central nucleus. The cells lie in cavities in the matrix substance, and the part of the matrix which forms the immediate wall of the hollow is named the capsule of the cell. Two or more cells may sometimes lie in the same hollow.

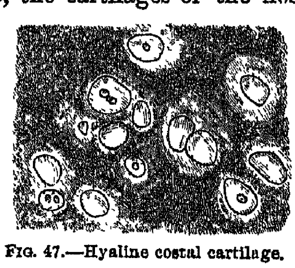


FIG. 47.—Hyaline costal cartilage.

The *matrix* of hyaline cartilage is usually homogeneous. In some animals the matrix appears to have a concentric arrangement around the cells; and Rollett has stated that by the use of dilute sulphuric acid or chromic acid the matrix may be made to split up into concentric layers. Sometimes the matrix appears granulated, a change which is very apt to occur in sections of cartilage which have been removed for some time from the body. In the costal cartilages of old persons the matrix becomes fibrous; and it is by no means uncommon to find in advanced age these bars of cartilage converted into bone.

In the articular or encrusting cartilages the arrangement of the cells is quite distinctive. If a vertical section be made through a plate of this cartilage, the cells next the bone are seen to be arranged in parallel rows perpendicular to the surface of the bone on which the cartilage rests; the cells are smaller than those of the costal cartilage, oblong in form, and the adjacent rows are separated by intermediate hyaline matrix. Near the free surface of the cartilage the cells are flattened, placed parallel to the plane of the surface, and so closely packed together that the proportion of matrix is much reduced. In the intermediate parts of the cartilage the cells lie irregularly in the matrix, and are rounded in form. It was from the study of the changes which take place in articular cartilage in disease that Goodsir was enabled to establish the production of new cells by the multiplication of the normal pre-existing cells of the cartilage,—an observation which formed the starting-point of the modern doctrine of cellular pathology.

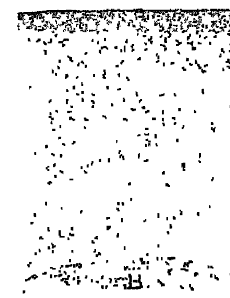


FIG. 48.—Vertical section through an encrusting cartilage. *B*, the bone on which the cartilage rests.

Fibro-cartilages are divided into white and yellow. *White* fibro-cartilage may form the connecting medium between the articular surfaces of an amphiarthrodial joint, as in the intervertebral discs; or it may form plates in the interior of joints, as in the semilunar cartilages of the knee and other menisci in diarthrodial joints; or it may extend around the margin of the socket of a joint, as in the cotyloid ligament of the hip; or it may invest the surfaces of bones over which tendons have to play, as where the tendons of the peronei muscles play in the groove on the back of the external malleolus. In the intervertebral discs, which give the best illustrations of the structure of white fibro-cartilage, the cells are ovoid in form and distinctly nucleated. Sometimes two or three are grouped together, but not unfrequently they occur singly. They are separated from each other by short fibres. In these discs the fibrous matrix is always stronger and more distinct in the peripheral than in the central part. The other forms of white fibro-cartilage are transitional between the true cartilage and connective tissue, *i.e.*, the cells possess the characters of cartilage cells, whilst the fibrous matrix approximates to the matrix of the connective tissue.


FIG. 49.—White fibro-cartilage of an intervertebral disc.

The *yellow elastic* fibro-cartilages are the epiglottis, the cornicula laryngis, the cartilaginous framework of the auricle of the human ear, and the ears of mammalia generally, and the cartilaginous wall of the Eustachian tube. The cells are rounded or ovoid, distinctly nucleated, and usually arranged singly or in pairs. The matrix is distinctly fibrous; the fibres, which form a close intersecting net-

work, branch and sometimes anastomose. They resist the action of acetic acid like the yellow fibres of connective tissue; and Donders has described a continuity between them and the elastic fibres of the connective tissue, which forms the investing perichondrium of this form of cartilage. The yellow fibro-cartilage has no tendency to ossify.

The bars and plates of cartilage,—except the encrusting hyaline cartilages, and the interarticular, marginal, and investing white fibro-cartilages,—are surrounded by a fibrous m mbrane or *perichondrium*. In the adult human body ca tilage is not penetrated by blood-vessels, but is nourished by the vessels which ramify in its investing perichondrium. In the fœtus, however, and in the large masses of cartilage which are found in the skeletons of the cetacea and of the cartilaginous fishes, the cartilage is permeated by canals in which blood-vessels ramify. In the encrusting cartilages, the cartilage is nourished by the blood-vessels of the synovial membrane of the joint, which, in the case of the articular cartilage, form a vascular ring around its margin; and, both in it and in the forms of white fibro-cartilage that do not possess a perichondrium, by the vessels of the bone, to which these cartilages are as a rule attached. In the movable joints, after the child has begun to use its limbs, the synovial membrane is not continued over the free surface of the articular cartilage, but stops at its margin along the line of the vascular ring. In the fœtus, however, it has been stated that both blood-vessels and synovial membrane are prolonged over the free surface of the articular cartilage.

Development of cartilage.

In the development of hyaline cartilage the contents of the embryonic cells of the part, where the cartilage is to be produced, become clear, and a cell wall differentiates around the exterior of the cell. The nuclei in the cells divide and subdivide, so that a multiplication of the cells by endogenous reproduction takes place. Hyaline matrix substance then appears between the cells, and is concentrically arranged around them; it is believed to be formed by a special conversion of successive layers of the cell protoplasm into a substance which yields chondrine on boiling. The fibro-cartilages, both white and yellow, but especially the latter, yield but little chondrine on boiling, for the fibrous matrix of the white fibro-cartilage is a gelatine-yielding substance, like the white fibres of connective tissue, whilst the fibres of the yellow fibro-cartilage partake of the nature of elastic tissue. The fibro-cartilages, therefore, form a group which links together the connective and cartilaginous tissues.

Bone.

OSSEOUS TISSUE.—The osseous tissue, or bone, is that which constitutes the hard framework of the skeleton. Each bone consists of a hard, more or less dense, tough, and but slightly elastic material. The elasticity of the bones is more marked in young than in adult and aged persons. From differences in their external configuration, bones are divided into long or cylindrical, *e.g.*, femur; short, *e.g.*, carpal or tarsal bones; flat or plate-like, *e.g.*, scapula; irregular bones, *e.g.*, vertebræ. These variations in shape do not, however, involve differences either in composition or minute structure. Bone consists chemically of an earthy and an animal substance intimately blended together. The earthy matter forms about two-thirds of it, and consists chiefly of phosphate of lime, which, from its abundance in bone, is frequently called "bone earth." Carbonate of lime and a small proportion of soda and magnesia salts are also present. The hardness of bone is due to the presence of the earthy matter. The animal matter forms the remaining third, and yields gelatine on boiling; it imparts elasticity and toughness to the bone, and binds together the particles of earthy matter.

Bone presents two different structural characters to the naked eye. The outer part of a bone is its hardest part, and forms a dense external shell, technically called the *compact tissue*. The interior of a bone is much less firm, and is made up of thin delicate plates or bars, or trabecles, which intersect each other at various angles, and form a lattice-like arrangement, technically called the *spongy* or *cancellated tissue*. The plates and bars of the spongy tissue are continuous with the inner surface of the compact tissue. In the long bones the interior of the shaft is hollowed into a canal, named the *medullary canal*, the walls of which are formed by the compact tissue, and the cancellated tissue is found only at the articular ends of these bones; the thickness of the compact tissue in a long bone is always greater at the centre of the shaft than at or near the articular ends.

If the outer surface of the compact tissue of a long bone and the wall of the medullary canal be examined with a pocket lens, they will be seen to be riddled by multitudes of minute orifices, which are the mouths of minute tubular passages or canals that traverse the compact tissue. These passages are named *Haversian canals*, and their arrangement may be studied by making thin sections through the compact tissue, and submitting these to microscopic examination, when they will be seen to pass longitudinally or very obliquely through its substance, so as to terminate by rounded orifices either on its outer surface, or on the inner surface, which forms the wall of the medullary canal. These canals are connected together at intervals by short transverse or oblique canals. Owing to these communications the dense osseous tissue is permeated by an anastomosing network of canals, which, as they contain blood-vessels, may be named vascular canals. These canals are circular in section, and vary in diameter from about $\frac{1}{200}$th to $\frac{1}{1000}$th inch. They not unfrequently are dilated at the inner end, where they open into the spaces of the cancellated tissue. The compact tissue of all bones possesses a system of canals similar to those found in the long bones, but when bone occurs in the form of very thin plates the canals may be absent. In addition to the Haversian canals, irregular spaces, named *Haversian spaces* by Tomes and De Morgan, may also be seen in sections through the compact tissue. They are met with not only in young but in adult bones, and are regarded as produced by absorption of the bone in those particular localities. In thin sections through bone, more especially when the Haversian canals are transversely divided, the dense tissue or matrix of the bone which surrounds the canals is seen to be arranged in concentric rings, as if it were built up of a series of *lamellæ* superimposed on each other. These lamellæ do not at all times form complete circles, and the number which surround a canal may vary from two or three to half a dozen; they are sometimes called the Haversian lamellæ. Other lamellæ lie in relation to the periosteal surface of the bone, and are called peripheral lamellæ; whilst others again are, as it were, intercalated between adjacent Haversian systems of lamellæ, and are named intermediate or interstitial. It has been pointed out by Sharpey that a bone lamella, after the earthy matter has been dissolved out by the action of an acid, is made up of multitudes of fine transparent fibres, which intersect each other and form a network. But he has further shown that the lamellæ are perforated by fibres, or bundles of fibres, which pass through them either perpendicularly or obliquely, so as to bolt adjacent lamellæ together. With a little care, the *perforating fibres* of Sharpey may be drawn out of the holes or sockets in which they are lodged.

When thin sections through a macerated and dried bone are examined under the higher powers of the microscope, the lamellated matrix is seen to exhibit a very peculiar appearance, which is characteristic of the osseous tissue. Between the surfaces of adjacent lamellæ irregularly

elongated spaces, called *lacunæ*, are to be seen in considerable numbers; these lacunæ, like the lamellæ between which they are situated, have a concentric arrangement around the Haversian canals. The lacunæ, the lamellæ, and the Haversian canal which they surround, are sometimes named a Haversian system. From the ends and sides of any one of these lacunæ very minute branching canals, termed *canaliculi*, proceed, which penetrate the lamellæ and anastomose with the canaliculi proceeding from adjacent lacunæ, whilst the canaliculi, springing from the sides of those lacunæ which lie nearest to the Haversian canal, open on the wall of the canal itself. The lacunæ average in length $\frac{1}{1800}$th inch, and their transverse diameter is about $\frac{1}{3600}$th inch; the canaliculi vary from $\frac{1}{12000}$th to $\frac{1}{20000}$th inch in diameter. When examined in a dried bone by transmitted light, the lacunæ look like solid, black bodies, and the canaliculi seem to be processes branching off from them, hence they were erroneously called by the earlier observers bone-corpuscles. But if a little turpentine be added to the section, the fluid displaces the air which the lacunæ and canaliculi contain in the dried bone, renders the part more transparent, and affords a satisfactory demonstration that they are, in a macerated and dry bone, not solid bodies, but a minute system of spaces and anastomosing little canals; and that all those which lie in the same Haversian system not only freely communicate with each other, but, either directly or indirectly, with the Haversian canal which they surround.

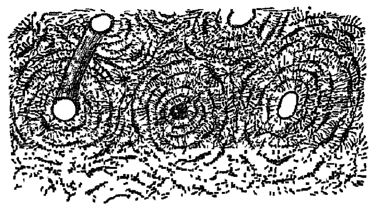


FIG. 50.—Transverse section through the compact tissue of the shaft of a long bone. The Haversian canals, lamellæ, lacunæ, and canaliculi are shown.

But a macerated and dried bone, such as one sees in museums and in articulated skeletons, and the structure of which has just been described, is a bone which has been deprived of several soft tissues by the process of putrefaction, which tissues are of the utmost importance in the economy of the bone in the living animal. A living bone is a complex organ, and a macerated bone is only the skeleton of a living bone. It is essential, therefore, in studying the structure of bone, that the attention should not be limited to the appearances presented by the macerated bone, but that the arrangement and structure of its soft tissues should be considered. The soft tissues of a bone are the periosteum and its prolongations, the marrow, the minute masses of nucleated protoplasm which occupy the lacunæ of the bone, the blood and lymph vessels, and the nerves.

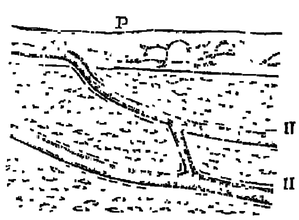


FIG. 51. — Longitudinal section through the compact tissue of a long bone, to show the passage of blood-vessels from the periosteum P, into the Haversian canals H H.

The *Periosteum* is a strong fibrous membrane which invests all the exterior of a bone, except where the encrusting cartilage is continuous with its articular end. It is subdivided into two layers: *a*, a firm external fibrous layer, consisting of bundles of connective tissue, which decussate with each other in various directions, and amidst which a network of small blood-vessels is freely distributed prior to their passage into the Haversian canals; *b*, a softer internal layer, which is especially well marked in young growing bones. This soft layer partly consists of very delicate connective tissue, in which rounded or oval cells are found, which give off slender processes at various points of their periphery, and partly of larger granular cells, which lie next the bone itself. Processes of the soft inner layer are prolonged into the Haversian canals, in which, as Goodsir pointed out, a layer of cellular substance lies between the wall of the canal and its contained blood-vessel, so that these canals are not, as in macerated bones, empty passages, but are filled up by the blood-vessels and the cellular layer.

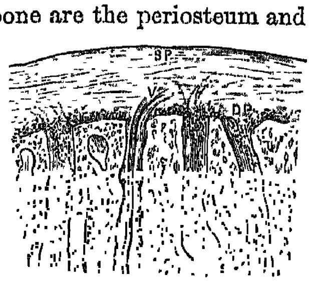


FIG. 52.—Section through the periosteum and compact tissue of a young bone. S P, superficial fibrous layer of periosteum; D P, deeper cellular layer prolonged into H H, the wide Haversian canals; V, a vessel of the periosteum entering a canal.

The *Marrow* occupies the medullary canal of a long bone and the spaces in the cancellated tissue of bones generally. It occurs in two forms, red and yellow marrow. Red marrow is found in the bones of the fœtus generally, and in the cancelli of the plate-like, short, and irregular bones at a more advanced period. It consists principally of large many-nucleated masses of protoplasm, the *myeloid* cells of Kölliker and Robin, lying in a very delicate areolar tissue, and supplied by a network of capillary blood-vessels. It contains little or no fat. Yellow marrow, again, is composed of fat cells lying in a delicate areolar tissue with accompanying blood-vessels. The areolar tissue, which supports the marrow cells, lines the medullary canal and cancelli, and is named the medullary membrane, or the *endosteum*.

In the fresh bone the lacunæ are not empty spaces as in the macerated bone. They are filled up by nucleated clumps of protoplasm, and are therefore, as Goodsir was the first to show, the seats of little masses of nucleated cells, which cells are the true *bone-corpuscles*. The protoplasm of these cells is apparently prolonged into the canaliculi. Hence the hard part of the osseous texture has within it a system of nucleated cells, some of which occupy the lacunæ and canaliculi, while others form a lining to the Haversian canals.

The blood-vessels of a bone are abundant. It receives its arteries partly from the small arteries which ramify in the periosteum, the fine branches of which enter the Haversian canals, and form within them an anastomosing network of capillaries; partly through a special artery which enters the nutrient canal in the bone, to be distributed chiefly to the marrow; partly through small arteries which enter openings in the compact tissue near the articular extremities. The veins of bones are also abundant. In the cancellated tissue they are large, and leave the interior of the bone partly through foramina situated near the articular ends, and partly by a vein which accompanies the artery that traverses the nutrient canal. In the plate-like bones of the skull the veins lie in distinct channels in the diploë, and in the bodies of the vertebræ the veins pass out through large holes in the posterior surface. Bones possess lymph-vessels, but their exact mode of arrangement has not yet been ascertained. Fine nerves have been traced into bones accompanying the arteries which enter the nutrient and Haversian canals.

It is clear, therefore, that a bone, hard and dense though its texture seems to be, is yet hollowed out by spaces, passages, and canals which, under the several names of medullary canal, cancellated spaces, nutrient canal, Haversian canals, Haversian spaces, lacunæ, and canaliculi, are occupied by blood-vessels or other soft tissues. By the penetration of blood-vessels into the bone, blood is conveyed not only to the medulla, but into the very substance even of the compact tissue; and there can be no doubt that the nucleated masses of protoplasm which occupy the lacunæ and canaliculi, and line the Haversian canals, are, as Goodsir long ago pointed out, centres concerned in the nutrition of the matrix substance of the bone in their immediate neighbourhood. These cells,

together with the periosteum, the medulla, and their blood-vessels, are active agents in the development, growth, and nutrition of the osseous tissue.

Development of bone.

In the description of the development of the skeleton, it was stated that the bones are formed by ossification in cartilage and fibrous membrane, so that bones are produced by secondary changes in a pre-existing material. The mode of production of the osseous tissue in the cartilaginous and fibrous tissues will now be considered, and it should be clearly understood at the outset that, in normal ossification, bone is not formed by a mere calcification of the matrix of the pre-existing tissue, and a conversion of the cartilage or connective tissue corpuscles into bone corpuscles; but, as the researches of Sharpey, Bruch, H. Müller, Lovén, and Gegenbaur have made known, is due to a development of new corpuscles, which Gegenbaur has named *osteo-blasts*, accompanied by an abundant formation of blood-vessels.

When the process of ossification in temporary cartilage begins, a change takes place in the arrangement of its cells at the centre, or point, or nucleus of ossification. The cells, instead of preserving their irregularly scattered arrangement in the matrix, are now collected into longitudinal parallel rows, not unlike what was described in a previous section, in the deeper cells of encrusting cartilage. In each row the cells lie with their long axes transverse, and apparently multiply by a process of fission. The cells at the end of the rows which lie nearest the centre of ossific change swell out and become more rounded. Calcification of the matrix substance, which separates not only the parallel rows of cells, but also the cells in the same row, from each other, then takes place, which calcification includes also the capsules of the cartilage cells. A general opacity of the cartilage is the result of this calcification, and the further progress of ossification is rendered obscure. It is necessary, therefore, to dissolve out by an acid the calcareous matter, in order to follow the steps of the process.

Spaces or canals now form in the ossifying cartilage, into which blood-vessels, continuous with the vessels of the perichondrium, are prolonged. These spaces are lined by concentric layers of small rounded cells, not unlike lymphoid cells in size and appearance, and form the *medullary spaces* of fœtal cartilage, whilst the cells and blood-vessels form the *medulla*. Respecting the source of origin of the cells of this medulla, there have been difficulties in arriving at a correct conclusion. Some have believed them to be descended from the cartilage cells, though no demonstration of their derivation from this source has ever been obtained. Henke conceived that they might be blood corpuscles migrated from the blood-vessels within the spaces. But the recent observations of Stieda seem satisfactorily to show that the layers of medulla cells are continuous with similar layers beneath the perichondrium, which layers are prolonged along with the blood-vessels into the medullary spaces as they form in the ossifying cartilage. But, whatever be their derivation, there can be no doubt that these cells undergo certain modifications which are of the utmost importance in the further stages of the ossific process. A few become elongated into fusiform or stellate corpuscles, like those of connective tissue; others have oil drops forming in their interior, and become the cells of yellow marrow; others become the corpuscles of red marrow; others, again, which form the osteo-blasts, properly so-called, are the direct agents in the production of the osseous tissue itself.

The formation of the medullary spaces in cartilage is owing to an absorption of the calcified cartilaginous tissue. Kölliker points out that the absorption is effected through the agency of colossal, many-nucleated cells (*myeloplaxes*), which he believes to be derived from the osteo-blastic cells of the medulla already described, so that a destruction of the calcified cartilage precedes the formation of the proper osseous tissue. As the absorption of the cartilage goes on, an irregular series of medullary spaces communicating more or less freely with each other is produced. But along with the destructive changes in the cartilage the production of the new osseous tissue takes place. Certain of the cells of the medulla are arranged in layers around the walls of the medullary spaces, and undergo an important change both in composition and shape. They become granular, their protoplasm hardens from the periphery towards the nucleated centre of the cell, so as to give origin to the dense matrix substance of a bone lamella; but the nucleus, and the protoplasm immediately investing it, do not harden,—they form the soft contents of the lacunæ and canaliculi. A second layer of osteo-blastic medulla cells then passes through a similar metamorphosis, and a second lamella is formed. By a repetition of this process around the walls of the several medullary spaces, the lamellæ of the bone are produced. Hence it would appear that the dense solid matrix of the osseous tissue is produced by a special hardening of the protoplasm of the osteo-blastic cells in the medullary spaces, and as layer after layer of these cells is ossified successive lamellæ are produced. The persistence, however, of the nucleus of each osteo-blast, and of a small portion of its investing protoplasm, preserves within the hard matrix a certain amount of soft material, which being destroyed when a bone is macerated, leaves the lacunary and canalicular system already described. The formation of successive lamellæ diminishes the size of the medullary spaces, which then form the Haversian canals. The vascular and cellular contents of these canals are therefore the remains of the contents of the medullary spaces of the fœtal cartilage, and are continuous with the deeper layer of the periosteum.

Fig. 53.—Section through a fœtal bone to illustrate its development. B, B, the dense osseous tissue, in which the lacunæ, with their soft nucleated contents, may be seen. M, M, the medullary tissue in the medullary spaces. OB, OB, layer of osteo-blastic cells of the medulla, next the osseous tissue, some of which in places are obviously becoming included in it. V, V, transversely divided blood-vessels, surrounded by medulla cells, situated in medullary spaces, which are assuming the form of Haversian canals.

So long as any cartilage remains in a fœtal or young bone the process of replacement of the cartilaginous tissue by the proper osseous tissue goes on, until none of the cartilage is left, except the thin layer of encrusting cartilage at each articular extremity. Bones grow in length by an ossification in cartilage; and a provision for their longitudinal increase is furnished up to, and even beyond the age of puberty, by the plate of cartilage which separates the epiphysis from the shaft of a bone. The ossification of this plate of cartilage marks the period when growth ceases in the long axis of the bone. But bones also grow in thickness, and this addition to their girth takes place by an ossification of material situated at their circumference. It has already been pointed out that a bone is invested by a fibrous membrane, the periosteum, which fulfils for it the same purpose as does the perichondrium for the cartilage. On the deeper surface of the periosteum, *i.e.*, next the bone itself, are osteo-blastic cells, similar to those which lie in the medullary spaces of the fœtal cartilage. These cells pass through a similar series

of changes, and produce successive layers of new bone at the periphery. The importance of the periosteum as a centre of origin of new bone has, indeed, long been recognised by both surgeons and pathologists. The parts of this membrane in which the special bone-producing power resides is the deep layer of osteo-blastic cells, whilst the blood-vessels furnish the pabulum for their nutrition. If strips of periosteum be removed, along with the cells of the deeper osteo-blastic layer, from a bone, and transplanted to other parts of the living body, bone will continue to be produced by their agency.

The intra-membranous ossification of bone was first recognised by Nesbitt, and has been worked out in most of its details by Sharpey, Kölliker, and Gegenbaur. The tabular bones of the skull offer the best illustration of this mode of ossification. Sharpey has pointed out that a network of minute spicula of bone forms in the membrane, and extends in radiating lines from the centre of ossification towards the circumference of the bone. The ossifying tissue consists of fibres, of multitudes of granular corpuscles or osteo-blasts, and of blood-vessels. The osteo-blasts invest the fibres, but as the investing osteo-blastic cells calcify, from the periphery towards the nucleus, they assume a stellate configuration, and pass through a series of changes similar to those described in the intra-cartilaginous mode of ossification. The fibres, which are in the first instance soft, also calcify, and contribute to the formation of the bone. Here, however, as in the intra-cartilaginous ossification, the active agents in the ossific process are the osteoblastic cells. The lamellated structure is due to ossification of successive layers of these cells, and the formation of the lacunæ and canaliculi is owing to the persistence of their nuclei with a small proportion of unossified investing protoplasm. The increase in thickness of a membrane bone, like that of a cartilage bone, takes place through ossification in a deep periosteal layer of osteo-blasts. Hence it follows that, though the tissue which precedes the appearance of bone in the skeleton is not uniformly the same, in some cases being membrane, in others cartilage, there is an identity in the ossific process in the two forms of pre-existing tissue, in both of which the osteo-blastic cells are the active agents in ossification. The chemical differentiation which takes place in the protoplasm of the osteo-blasts during bone-formation is not merely a calcification, but a coincident production of a gelatine-yielding substance, within which the minute calcareous particles are deposited.

Stress has been laid by some anatomists, in discussing the homologies of the several bones of the skeleton, on the differences met with in the place of their formation. Thus, it has been supposed that a bone originally developed in cartilage cannot be homologous with one originally developed in membrane, and that a fundamental morphological distinction should be drawn between cartilage bones and membrane bones. But when it is considered that, though the place of formation may vary, the method of formation is the same in all localities, it does not appear that so much importance should be attached to the distinction between cartilage and membrane bones as it has sometimes received. Moreover, the differences between these two varieties of bones are, during the growth of the bone, still further diminished, for in both cases increase in thickness takes place in the same kind of pre-existing tissue, and in the same way, viz., by ossification of the deep periosteal layer of osteo-blasts.

In the description of the development of bone in the fœtus and young person, the formation of medullary spaces was referred to. But the production of spaces in bone is by no means limited to its early stages of growth. The medullary canal in a long bone can scarcely be said to exist in the bones of an infant's limbs. The hollowing out of the shaft of a long bone into a large canal, and the enlargement of the spaces of the cancellated tissue, goes on not only up to the period of adult life, but even to advanced years; so that in an old person the relative size of this canal is greater than in the prime of life. The Haversian spaces also, as Tomes and De Morgan pointed out, are produced by the absorption of the lamellæ of the osseous tissue surrounding the Haversian canals, and the production of these spaces is constantly going on during the life of the bone. The air-sinuses in the cranial bones are also formed by the absorption of the diploë, and consequent separation of the two tables of the skull. Bones, therefore, are organs which are continually undergoing change. During growth additions are being made to their length and thickness, and additional lamellæ are being formed in the walls of the Haversian canals. At the same time a hollowing out of spaces in their interior is going on, so that an increase in weight commensurate with their growth does not take place. The interstitial absorptive changes, whether occurring during growth or after growth is completed, are due, as Kölliker has shown, to the action of many-nucleated colossal cells which line the walls of the spaces where absorption is going on, which cells he has named *osteo-klasts*. The development and configuration of a bone is therefore, as has been well expressed by Kölliker, the product of the formation of osseous tissue by the agency of the osteo-blasts, and of its absorption or destruction by the action of the osteo-klasts.

From the fact that osseous tissue may be produced either in the cartilaginous or in the fibrous tissues, and that all three contribute to the formation of the skeleton, it is evident that these tissues are closely allied. To express this alliance they have all been grouped together under the common term connective substances.

Muscle

Muscular Tissue.—The muscular tissue is that which is actively concerned either in the movement of parts of the body on each other, or in the movement of the entire body from place to place; it is the active agent, therefore, both in motion and locomotion. It forms a large proportion of the general mass of the body, is the essential constituent of the muscles or flesh, and enters into the formation of the walls of the hollow viscera. It consists structurally of threads or fibres, some of which are distinguished by being marked with transverse stripes or striæ, others have no such markings. Hence it is customary to divide the fibres of the muscular tissue into transversely striped fibres and non-striped fibres. As a rule, the striped fibres are collected together to form those muscles which are under the influence of the will, so that both the muscles and the fibres of which they are composed are called voluntary. One important exception to this rule is, however, met with, for the muscular fibres of the heart, though transversely striped, are involuntary; the will exercises no control over the action of the heart. The non-striped fibres, and the muscles into the construction of which they enter, are in no instance, however, subject to the influence of the will; so that, without exception, they may be named involuntary.

The *Non-striped* or *Involuntary* fibre, sometimes called pale or smooth muscular fibre, enters into the formation of the walls of the hollow viscera—*e.g.*, stomach, intestines, bladder, uterus—of the walls of the air-tubes, gland-ducts, blood and lymph vessels, of the skin, and various mucous membranes. The fibres are usually collected into bundles or fasciculi, which are not aggregated together into such compact red masses as in the voluntary muscles, but are of a paler red colour, and are set farther apart, and often cross and interlace with each other in the walls of the tubes and hollow viscera, in which this form

of muscle is found. The fasciculi are separated from each other by a delicate, areolar connective tissue, or *perimysium*. The size of the fasciculi varies in different localities; in the hollow viscera they are so large that their arrangement can be observed with the naked eye; but in the skin, the walls of gland-ducts, &c., they can only be seen with the aid of the microscope. If a fasciculus be carefully torn up with needles it can be resolved into its constituent fibres, and the number of the fibres varies with the size of the fasciculus. The non-striped fibres are pale and almost colourless, with soft, ill-defined outlines, from $\frac{1}{3500}$th to $\frac{1}{7000}$th inch in diameter; they are rounded in form or laterally compressed, and are so easily flattened by artificial pressure, that they have erroneously been regarded as flat or ribbon-shaped fibres. When digested for a few hours in dilute nitric or hydrochloric acid, and sometimes even without any reagent, the fibres may be resolved into elongated fusiform cells—the *contractile fibro-cells* of Kölliker—which vary in length from $\frac{1}{300}$th to $\frac{1}{600}$th inch, and which taper off usually into attenuated ends. In the middle of each cell is a characteristically elongated, rod-shaped nucleus, and sometimes the substance of the cell is finely granular, or even faintly longitudinally striped. No cell wall or sarcolemma can be distinguished. In some localities, as was pointed out by Lister in the minute arteries in the web of the frog's foot, isolated contractile fibro-cells are wound spirally around the wall of the vessel.

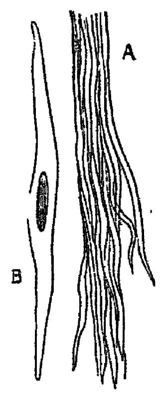


FIG. 54.—A, a fasciculus of non-striped muscular fibre; B, an isolated muscular fibre cell, more highly magnified.

The *Transversely Striped* fibre is the characteristic tissue of the voluntary muscular system, and is found wherever energetic movements are to be performed. In these muscles the fibres are collected together in fasciculi, which bundles usually lie parallel to each other, and extend from the tendon of origin to the tendon of insertion. Each muscle is invested by a membranous sheath formed of connective tissue, the *perimysium externum*, which sheath gives off processes that dip into the substance of the muscle, so as to form delicate partitions between the fasciculi, and from these partitions still more slender prolongations of connective tissue, named *perimysium internum*, pass between the fibres. The number and size of the fasciculi vary with the size and texture of the muscle; in some, as the deltoid and glutæus maximus, the fasciculi are large and coarse; whilst in others, as the gracilis and omo-hyoid, they are much finer. The number of fibres in a fasciculus varies with its length and thickness, and the fibres which are adjacent to each other in a fasciculus lie parallel. The striped fibres are cylindrical or laterally compressed; they usually taper off at their extremities, and apparently do not, even in muscles with long fasciculi, exceed $1\frac{1}{2}$ inch in length. The transverse diameter of the striped fibres varies, in different localities in the human body, from $\frac{1}{400}$th to $\frac{1}{2400}$th inch, according to the measurements of Kölliker. Much wider differences in diameter are found in the animal series, in insects the fibres being of extreme minuteness, whilst in cold-blooded animals they are much larger than in man and mammals.

If a fibre be carefully separated from a fasciculus, and examined microscopically by transmitted light, transverse stripes may be readily seen to extend across it from side to side. These transverse striæ are not mere surface marks, but, as Bowman pointed out, pass through its entire thickness, and lie parallel to each other. The striation is due to the structure of the fibre, which consists of dark and light bands or discs, alternately dark and light. The discs differ in optical properties, for, as Brücke's observations show, the light discs refract light singly—are isotropic; whilst the dark discs refract light doubly, and consist of an anisotropic substance. Busk and Huxley described in 1853 a dark line passing across the light disc, so as to subdivide it into two halves; and this appearance has also been figured by Sharpey, Krause, and others. It is believed to be due to the presence of a strongly refracting stripe in the middle of the feebly refracting disc. More recently Hensen has directed attention to a slender, feebly refracting stripe passing transversely across the strongly refracting disc, so as to subdivide it also into two halves. In addition to the transverse striæ, the fibres not unfrequently show markings which extend longitudinally, but these are irregular in position, do not correspond to the whole length of the fibre, or necessarily pass through its entire thickness.

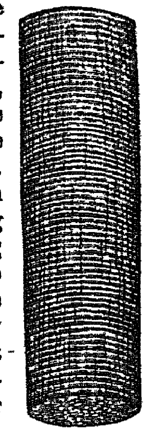


FIG. 55.—A transversely striped muscular fibre.

The transverse and longitudinal markings indicate that a muscular fibre has a disposition to split up transversely or longitudinally into smaller particles. The transverse subdivision of the fibre is promoted by digesting a piece of muscle for some hours in dilute hydrochloric acid. If the fibres be then examined, gaps or fissures will be seen to extend transversely into the substance of the fibre; and, if the digestion has been sufficiently prolonged, the fissures have extended completely across the fibre, and have subdivided it into a multitude of plate or disc-shaped bodies—the *muscular-fibre discs*. These discs are the strongly and feebly refracting discs already described, and the transverse diameter of each disc corresponds to that of the fibre from which it has been derived. The longitudinal marks in the fibre are best seen by digesting a piece of muscle in strong spirit of wine, or in a solution of chromic acid. If a fibre so treated be teased out with needles, and the thin covering glass be smartly tapped, the fibre will split up longitudinally into multitudes of minute, elongated threads—the *muscular-fibre fibrillæ*. A fibrilla may be regarded as equalling in length the fibre of which it formed a part, and like the fibre is transversely striped; but its breadth is not definite, and depends upon the minuteness with which the fibre has been split up in the longitudinal direction. If in the same fibre the processes of transverse and longitudinal splitting were to go on simultaneously, then the fibre would be resolved into an immense multitude of rectangular particles—the *sarcous elements* of Bowman. If these particles be regarded as the ultimate subdivisions of the fibre, then the discs may be conceived to be built up of a number of these particles, possessing similar optical properties, arranged side by side, so as to occupy the entire diameter of the fibre in any transverse plane: whilst the fibrillæ are built up of the particles arranged end to end, so as to correspond to the entire length of the fibre; but in this longitudinal arrangement, particles with different optical properties, the one singly refracting, the other doubly refracting, alternate with each other with the utmost regularity.

Another view of the structure of muscular fibre has just been advanced by E. A. Schäfer. He describes the dark, or, as seen in a living fibre, the "dim discs," as traversed by multitudes of excessively fine, dark, rod-shaped particles parallel in their direction to the fibre itself, which extend into the contiguous bright discs, near the middle of which each *muscle rod* ends in a knob-like extremity, and the series of knobs form a line of minute dark dots, passing transversely across each bright disc. The muscle rods are

imbedded in a "ground substance," that forms the alternating dim and bright discs, which substance he believes to be anisotropous, whilst the muscle rods are isotropous. He regards the ground substance as the true contractile part of the fibre.

Each transversely striped fibre is invested by a homogeneous membrane, the *sarcolemma* or *myolemma*, which is so transparent as to allow the characteristic transverse striæ to be distinctly seen through it. The sarcolemma is so closely incorporated with the periphery of the fibre, that its isolation and demonstration as a distinct membrane are attended with some difficulty, but when water is added to a living fibre it is absorbed, and elevates the sarcolemma from the sarcous contractile particles. If acetic acid be added to a muscular fibre the transverse striæ become less distinct, and a number of oval bodies come into view. These are especially to be seen next the periphery of the fibre in relation to the inner surface of the sarcolemma, though some apparently lie deeper in the substance of the fibre. These bodies have long been known as the nuclei of the striped fibre. More recent investigations have, however, shown that each nucleus lies in a little finely-dotted protoplasm, which often extends in a fusiform manner beyond the ends of the nucleus. These nuclei, with their investing protoplasm, have the anatomical characters of nucleated cells, and are called the muscle *corpuscles*.

Some peculiar modifications of the striped muscular fibre are met with in certain localities. As a rule, this form of fibre does not branch; but in the muscles of the tongue and lip, and other muscles of the face, these fibres usually branch prior to their insertion, and the branches taper off to finely attenuated ends. In the heart also the fibres branch; and the branches of adjacent fibres anastomose, so that the muscular wall of this organ consists of a compact network of fibres. The individual fibres are smaller than those of the voluntary muscles, the transverse striation is much less distinct, and it is doubtful if an investing sarcolemma be present.

Some difficulty has been experienced in determining the exact mode of connection of the fibres of the belly of a muscle with those of its terminal tendons. By some it has been supposed that the fibres of the one are directly continued into those of the other; whilst Weismann has described the muscular fibre as terminating in a sharply-defined, rounded, or pointed extremity, to which the fibres of the tendons are closely apposed.

Both the striped and non-striped forms of muscle are well provided with blood-vessels, which ramify in the substance of the muscle lying in the areolar connective tissue that separates the fasciculi and fibres from each other. The capillaries form an elongated network, the principal strands of which lie parallel to the muscular fibres, but never penetrate the sarcolemma. Hence, though the belly of a muscle is a highly vascular organ, its individual fibres are extra-vascular. The vascularity of the fleshy belly is much greater than that of the terminal tendons of attachment, and the nutritive changes are much more active in it than in them.

Development of muscle.

The contractile fibro-cells of the non-striped muscular fibre are formed by the gradual elongation of the rounded cells of the middle germinal layer of the embryo into spindle-shaped cells, the oval nuclei at the same time becoming elongated, so as to assume a rod-shaped form. Usually the spindle cells which lie in the same linear series become cemented together into the smooth fibres of this form of muscle.

The mode of development of the striped fibre is more difficult to follow out, and various statements have been made as to the successive stages of its formation. Schwann believed that a fibre was built up of the embryonic cells of the part, which arranged themselves in linear series, coalescing with each other at their surfaces of contact; that the contents of the cells then became transversely striated, and that the cell walls formed the sarcolemma. Savory and Lockhart Clarke maintained that a formation of blastema took place around free nuclei, and that this blastema gradually assumed the striated character. Remak, Kölliker, Wilson Fox, and Frey have, however, by studying the earliest stages of development in the very young embryo, established the fact that the striped fibres are developed from the cells of the embryo, though not in the manner described by Schwann. The process, briefly stated, is as follows: The embryonic cells elongate, the nucleus may remain single, but more usually it divides and subdivides, so that many nuclei appear in the interior of the elongated cell. The nuclei lie in linear series, and may either be separated from each other, or two or more may be in contact, and they may lie either near the periphery of the elongated cell, or in its axis. With this multiplication of the nuclei, the cell increases in length and assumes the form of a fibre. The cell protoplasm, both in the single and many-nucleated fibres, then differentiates into the sarcous particles of the transverse striæ, and as this progresses the fibre assumes its characteristic striped appearance. The whole amount of the protoplasm does not, however, assume the transversely striped appearance, for a small quantity remains around each nucleus and forms with it a muscle corpuscle. The differentiation of the protoplasm occasions an anatomical and chemico-physical change in the fibre, and confers on it the property of energetic contractility. W. Engelmann has endeavoured to show that the opaque anisotropic discs of the fibre are those in which the power of contractility resides, and that the clear isotropic discs possess only elastic properties. The mode of development of the sarcolemma is still somewhat obscure. By some it is regarded as the wall of the embryonic cell, which has become metamorphosed into a muscular fibre; by others it is regarded as a special differentiation of the protoplasm at the periphery of the fibre taking place at the time when the transverse striæ are being formed; whilst by others it is considered to be a special modification of connective tissue formed around the fibre. In the development of the muscular fibres of the heart, the cells of the embryo heart branch and anastomose, and the nuclei multiply. By the transverse striation of the protoplasm of these cells the branched muscular fibres of the heart are produced.

In the growth of a muscle the individual fibres increase in size, so that they are bigger in the adult than at the time of birth. The observations of Budge, Weismann, and Beale show that new fibres may also form in a muscle. Weismann believes that this increase may be due to a longitudinal splitting of a pre-existing fibre; but Beale maintains that the new fibres are produced in the muscle in the same manner as the original fibres of the part.

Nervous System.

The Nervous System consists of a number of organs which are named respectively Nerve Centres, Nerves, and Peripheral End-organs. The largest and most important Nerve Centres are the brain and spinal cord, which together constitute the cerebro-spinal nervous axis, and are lodged in the cranial cavity and spinal canal. But, in addition, numerous small bodies, usually oval in form, technically called ganglia, are situated in the axial part of the body, and form smaller nerve centres. The Nerves are white cords which traverse the different regions of the body, both axial and appendicular, for a greater or less distance, for the purpose of connecting together the other sub-divisions of the nervous system. The Peripheral End-organs are

minute structures connected with the peripheral extremities of the nerves. These end-organs are situated in the skin and other organs of sense, in the glands, blood-vessels, and muscles. The nerves establish communications and conduct nervous impulses, either between different nerve centres, or between nerve centres and peripheral end-organs, so as to associate together in their action parts of the nervous system often widely separated from each other. Nerves, therefore, are internuncial structures. When a nerve connects two nerve centres together it is intercentral. When a nerve connects a nerve centre with a peripheral end-organ, and conducts impulses from the centre to the end-organ, it is a centro-peripheral or centrifugal nerve. When a nerve connects a peripheral end-organ with a centre, and conducts impulses from the end-organ to the centre, it is a periphero-central or centripetal nerve. Owing to the different directions in which impulses are conducted by nerves, the varying nature of their end-organs, and the functional differentiation of the nerve centres, or portions of the nerve centres in which their central extremities terminate, nerves vary so in their functions, that a classification of the nerves, based upon their functional properties, has been proposed. Of the centro-peripheral nerves, those which end in the muscles are motor nerves; those which end in the muscular coat of the blood-vessels are vaso-motor nerves; whilst some physiologists have named nerves which they believe to terminate in connection with the secreting cells of a gland, secretory nerves; and others, which they believe to terminate in the tissues and to be concerned in the regulation of their nutrition, trophic nerves. It should be stated, however, that it is not yet absolutely determined that the secreting cells of glands and the cell elements of the tissues have special nerves terminating in connection with them for the purpose of exercising a direct influence over secretion and nutrition. Should these special nerves be non-existent, then the secretory and nutritive functions would be influenced solely by the vaso-motor nerves, which regulate the size of the blood-vessels and the amount of blood which flows through a part in a given time. Of the periphero-central nerves, those which arise in the end-organs in the skin, terminate in a nerve centre, and excite in it the sense of touch, are nerves of common sensation; those which arise in the end-organs in the eye, ear, nose, and tongue, and excite in their appropriate nerve centres the sensations of sight, sound, smell, and taste, are nerves of special sense; whilst nerves which conduct impulses from peripheral end-organs to a nerve centre, and, instead of exciting in the latter a sensation, have the impulses reflected to motor nerves, are reflex or excito-motory nerves.

The nerve centres, nerves, and peripheral end-organs are arranged in two groups or systems—a Cerebro-spinal and a Sympathetic. The Cerebro-spinal nervous system consists of the brain and spinal cord, the nerves which arise from or terminate in these large centres, the small ganglia connected with these nerves, and the end-organs at their peripheral terminations. The Sympathetic nervous system consists of the sympathetic ganglia, with their nerves and end-organs.

NERVOUS TISSUE.—The several parts of the nervous system are not uniform in colour, some being white, others grey. The nerves, at least those of the cerebro-spinal system, are invariably white, and white masses, variable in size, are met with in the brain and spinal cord; they constitute the white matter of the nervous system. In the nerve centres, both of the cerebro-spinal and sympathetic systems, grey matter is found, sometimes in considerable quantities. This grey colour is so characteristic, that it may be regarded as marking the position of a nerve centre.

The nervous system possesses a characteristic form of tissue—the nervous tissue—which in part consists of fibres (Nerve Fibres), and in part of cells (Nerve Cells). The nerve cells are found in the grey matter—that is, in the nerve centres—and sometimes also in the peripheral end-organs. The nerve fibres constitute the nerves, enter into the nerve centres, and pass into the peripheral end-organs; they form the white matter. But in addition to the characteristic nervous tissue, the nervous system also contains a considerable quantity of connective tissue, numerous blood-vessels, and some lymph vessels.

Nerve Fibres.—Nerve fibres are of two kinds: *a*, the white, medullated, or dark-bordered fibres, which are the characteristic fibres of the cerebro-spinal nervous system, though they do also sparingly occur in the sympathetic system; *b*, the pale, non-medullated, or gelatinous nerve fibres, which are the characteristic fibres of the sympathetic nervous system.

Medullated Nerve Fibres.—To examine the structure of these fibres, a portion of a cerebro-spinal nerve may be selected. In the first place, it will be seen to be invested by a sheath of connective tissue, the *perineurium*, which gives off processes that pass into the nerve, and subdivide it into fasciculi or funiculi. Each fasciculus is in its turn composed of nerve fibres, which are separated from each other by bundles of delicate connective tissue, prolonged from the perineurium, in which the nutrient blood-vessels of the nerve ramify. The size of a nerve is in relation to the number and size of its fasciculi, and the size of a fasciculus is in relation to the number of its fibres. The fibres and the fasciculi lie parallel to each other in the same nerve; but as nerves branch at intervals, the more external of the fasciculi diverge from the main stem to form the branches. In the white matter of the brain and spinal cord the nerve fibres are not arranged in such definite fasciculi as in a distributory nerve, and the connective tissue between the fibres is the soft, delicate form called neuroglia.

A medullated nerve fibre is an elongated cylinder, which, when examined in the body of a living animal, or immediately after removal from the living body, consists apparently of a soft, homogeneous, or glassy-looking substance enclosed within a limiting membrane. When examined some time after death, or after the addition of reagents, such as water, spirit, ether, collodion, acetic acid, &c., it loses its homogeneous aspect, and the following structures can be distinguished in it: A (Fig. 56), a delicate transparent investing membrane,—the so-called tubular or *primitive membrane*, or neurilemma; C, a delicate thread, extending along the axis of the fibre,—the *axial cylinder* or central band of Remak; B, a substance which lies between the primitive membrane and the axial cylinder,—the white substance of Schwann, or the *medullary sheath*. Within the external outline of the fibre, formed by the investing membrane, is a second line, not quite parallel to the first. and the presence of these two lines gives to the fibre a characteristic double-contoured appearance. The investing membrane is a perfectly pellucid, homogeneous structure, with nuclei arranged at intervals in it. It is

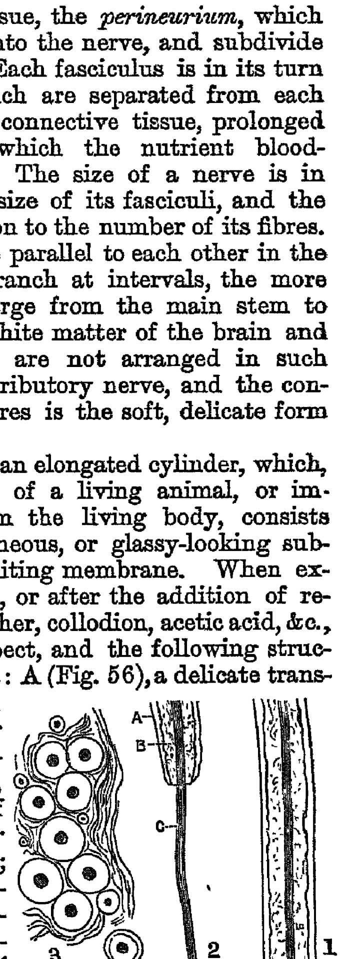


FIG. 56.—1. Medullated nerve fibres, showing the double contour. 2. A similar fibre in which A is the primitive membrane, B the medullary sheath, C the axial cylinder, protruding beyond the broken end of the fibre. 3. Transverse section through the medullated fibres of a nerve, showing the axial cylinder in each fibre. Between the fibres is the interfibrous connective tissue.

believed to be absent from the nerve fibres in the brain and spinal cord, as well as at the peripheral terminations of many nerves. The medullary sheath is a fatty and albuminous substance, which refracts the light strongly. Not unfrequently it collects into little ball-like masses, and sometimes causes irregular bulgings on the fibre, and produces a knotted, varicose appearance; at other times it becomes granular, and makes the fibre opaque. By gentle pressure it can be squeezed out of the broken end of a fibre. The axial cylinder is a pale, grey, cylindriform band, usually about one-third or one-fourth the diameter of the fibre, which possesses more tenacity than the medullary sheath, and not unfrequently, as in Fig. 56, 2, projects for some distance beyond the broken end of a fibre. Max Schultze showed that it is not homogeneous, but exhibits a very delicate longitudinal fibrillation, and at the ends of the nerves these primitive fibrillæ may separate from each other.

Although from its great delicacy the axial cylinder cannot be seen in the living fibre of a cerebro-spinal nerve, yet there are many reasons for regarding it as a structure existing in the living nerve, and not the product of a *post mortem* change. It is the part of a fibre which first appears in the course of development, the medullary sheath and primitive membrane being secondary investing structures, superadded as development proceeds. It forms not unfrequently the only constituent of a nerve fibre at its central and peripheral terminations, and is therefore the part of the fibre which is anatomically continuous with the nerve cell, or with the peripheral end-organ. As it is the sole constituent of many nerve fibres at their terminations, and of all nerve fibres in the earlier stage of development, and as it forms the medium of connection between them and the structures in which they terminate, it is obviously of primary importance, both anatomically and physiologically, and is believed to be the part of the fibre directly concerned in the conduction of impulses; whilst the investing structures serve the purpose of insulating materials. Lister and Turner pointed out, in 1859, that essential differences in chemical composition existed between the axial cylinder and the medullary sheath; the former being unaffected by chromic acid, though the latter is rendered opaque and brown, and concentrically striated under its influence; while, on the other hand, the axial cylinder is stained red by an ammoniacal solution of carmine with great facility, although the medullary sheath is unaffected by it. They further showed that these differences in the mode of action of chromic acid and carmine might advantageously be employed in the demonstration of the structure of nerve fibres. Ranke has subsequently stated that the axial cylinder possesses an acid, and the medullary sheath an alkaline reaction.

Medullated nerve fibres vary materially in diameter in different parts of the nervous system. In the brain, for instance, they are sometimes as fine as the $\frac{1}{12000}$th inch; whilst, in the distributory nerves, fibres of $\frac{1}{1500}$th of an inch in diameter may be seen; though it should be stated that, even in the nerves of distribution, fibres of great minuteness are often placed in the same bundle with those of the largest size. Nerve fibres do not branch in their course, but only at their central or peripheral terminations, and much more frequently at the latter than the former.

Non-medullated Nerve Fibres.—These fibres, which are characterised by the absence of a medullary sheath, are chiefly found in the sympathetic nervous system, but they occur also in the cerebro-spinal system. The fibres of the olfactory nerve are non-medullated, so also are the peripheral terminations of the cerebro-spinal nerves, and indeed all nerve fibres in the first stage of their development. In *Petromyzon* it has been stated that all the nerve fibres are distinguished by the absence of a medullary sheath.

This form of nerve fibre consists of pale grey, translucent, flattened bands, the $\frac{1}{6000}$th to $\frac{1}{3000}$th inch in diameter. They usually appear as if homogeneous or faintly granular; but Schultze showed that, when carefully examined, they present a delicate fibrillated appearance, like that seen in the axial cylinder of a medullated nerve; so that, like that cylinder, they are supposed to be composed of multitudes of extremely delicate primitive fibrillæ imbedded in a finely granulated material. Sometimes these fibres consist solely of this fibrillated material, at other times they are invested by a sheath similar to the primitive membrane of a medullated fibre. Nuclei are also found both in the substance of the fibre and in relation with the primitive membrane. The presence of multitudes of fibres in the sympathetic nervous system, formed either entirely, or almost entirely, of a material precisely similar in structure to the axial cylinder of a medullated fibre, and by which the proper function of the fibre can alone, therefore, be exercised, is, of course, an additional argument to those previously advanced, in favour of the existence of the axial cylinder as a normal constituent of the fibre, and of its functional importance.

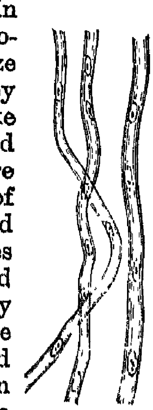


Fig. 57. — Non-medullated nerve fibres from the sympathetic system.

Nerve Cells.—Nerve cells constitute an important division of the nervous tissue. They are the characteristic structures in the nerve centres, are susceptible to impressions, or nervous impulses, and are the texture in which the molecular changes occur that produce or disengage the special form of energy named nerve energy, the evolution of which is the distinctive mark of a nerve centre. The central extremities of the nerve fibres lie in relation to, and are often directly continous with, the nerve cells. It was at one time thought that nerve cells were globular in form; but it is now generally understood that, though the body of the cell is not unfrequently globular, two or more processes or poles project from it, and are continuous with its substance. Nerve cells are distinctly nucleated; the nuclei are usually large, and contain one, and often two nucleoli. The cell substance is granular, and not unfrequently brown or yellow pigment is collected around the nucleus. A cell wall is sometimes apparently present, though at others it cannot be demonstrated. The nerve cells in the grey matter of the brain and spinal cord are imbedded in the neuroglia. In the smaller nerve centres, as the sympathetic ganglia and the ganglia on the posterior roots of the spinal nerves, the nerve cells are surrounded by a capsule of connective tissue. Fräntzel, Kölliker, and others, have described this capsule as lined by an endothelium formed of flattened cells; and it should be stated that Ranvier has described a similar endothelium in relation to the connective tissue investment of the cerebro-spinal nerves. It is not improbable that these endothelial cells form the walls of delicate capillary rootlets of the lymphatic vascular system.

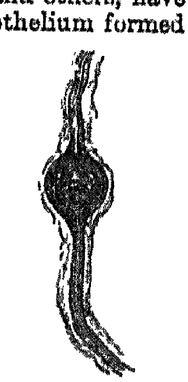


Fig. 58. — Bipolar nerve cell, with two nerve fibres continuous with it, from the spinal ganglion of a skate.

Nerve cells from which two poles or processes proceed are called bipolar. Characteristic specimens of these cells, as was first pointed out by Robin and R. Wagner, may be recognised without difficulty in the ganglia on the posterior roots of the spinal nerves of fishes, and it is probable that similar cells exist in the corresponding centres in other vertebrates. These cells usually possess a globular body, though sometimes it may be elongated; and from opposite points

of the surface of the body a strong process is given off, which is directly continued into a nerve fibre. The axial cylinder of the fibre is continuous with the cell substance, and Schultze has shown that both exhibit a delicate fibrillated structure. The medullary sheath and the primitive membrane are also usually continued from the fibre over the nerve cell. Hence these bipolar cells seem to be, as Schultze expressed it, nucleated enlargements of the axial cylinder.

A remarkable modification of the bipolar nerve cell, carefully studied and described by Lionel Beale, is found in the sympathetic ganglia of the frog. The cells are pear-shaped, and from the narrow end of the pear two nerve fibres arise, one of which, called the straight fibre, forms, as it were, the stalk of the pear; whilst the other, or spiral fibre, winds spirally round the straight fibre, and then passes away from the cell in the opposite direction. Both fibres are nucleated, and at their origin consist, apparently, of axial cylinder substance only; but in their course they may acquire both a medullary sheath and a primitive membrane. The straight fibre passes into the interior of the cell substance, and Arnold and Courvoisier believe that they have traced it into the nucleus; but the spiral fibre apparently arises nearer the periphery of the cell. The pyriform cells are invested by a distinct capsule of connective tissue. The nerve fibres of these pyriform cells, although they both arise close together from one end of the cell, represent its poles. Should one of the poles, either in this, or in the bipolar form of nerve cell described in the preceding paragraph, be from any cause removed or not developed, then the cell would be unipolar; and if both poles were absent it would be apolar.

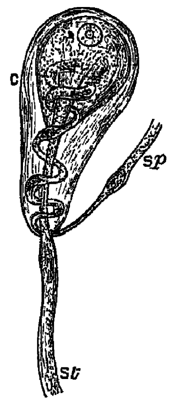


FIG. 59.—Pyriform nerve cell. *St*, straight nerve fibre; *Sp*, spiral nerve fibre; C, capsule of connective tissue around nerve cell. (*After Beale.*)

In other localities, as in the sympathetic ganglia of man and many other vertebrates, and in the several subdivisions of the cerebro-spinal nervous axis, the nerve cells have more than two poles or processes projecting from them. Cells of this kind are called multipolar, and in many localities they present characteristic forms. In the grey matter of the spinal cord, more especially in its anterior horn, they give rise to numerous processes, and have a stellate or radiate form. In the grey matter on the surface of the convolutions of the cerebrum they are pyramidal in shape. The apex is directed to the surface of the convolution, the base towards the white matter. The processes arise from the base, apex, and sides of the pyramid. In the grey matter on the surface of the cerebellum the body of the cell is almost globular. From that aspect of the cell which is directed towards the white matter a slender central process arises; from the opposite or peripheral aspect of the cell two strong, many-branched processes extend for a considerable distance. In the human sympathetic ganglia, again, the stellate form of cell prevails, and the existence of a capsule of connective tissue around the individual cells can be recognised. The processes which arise from a multipolar nerve cell, as a rule, divide and subdivide as they pass away from the body of the cell, until at last they give rise to branches of extreme tenuity. These branching processes apparently consist exclusively of cell protoplasm, and have been called *protoplasm processes.* Gerlach has described the protoplasm processes of the multi-polar nerve cells of the brain and spinal cord as forming an excessively minute network, from which minute medullated nerve fibres arise; and F. Boll conceives that a similar arrangement occurs in the cells of the cerebellum. One, at least, of the processes of a multipolar nerve cell does not branch, but becomes directly continuous with a nerve fibre, and has been named the *axial-cylinder process.* This process was first recognised by Deiters in the cells of the spinal cord; but Hadlich and Koschennikoff have since described the central process of the cells of the cerebellum as continuous with a medullated nerve fibre; and the latter observer has pointed out, that from the base of a pyramidal nerve cell in a cerebral convolution a process may be traced directly into a nerve fibre. Hence it would appear that the multipolar nerve cells may have two modes of union with nerve fibres—one directly through the passage of the non-branched axial-cylinder process into a fibre, the other through the origin of fibres from the minute network in which the branched protoplasm processes terminate. The branched processes of adjacent nerve cells may also blend with each other, so as to form an anastomosing cell network, though these anastomoses are, in all probability, not so frequent as was at one time supposed. Schultze has pointed out that not only the protoplasm substance of the body of a multipolar nerve cell, but both the non-branched and branched processes, possess a fibrillated structure similar to that described by him in the axial cylinder of the nerve fibres.

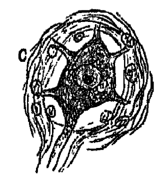


FIG. 60.—Multipolar cell from human sympathetic ganglion. C, capsule of connective tissue.

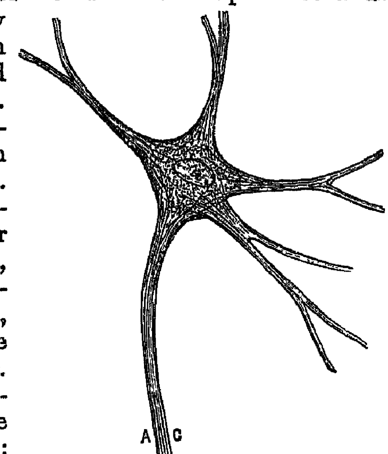


FIG. 61.—Multipolar cell from the grey matter of anterior cornu in the spinal cord. A C, non-branched axial-cylinder process directly continuous with a nerve fibre.

Peripheral End-Organs or *End Bodies.*—Nerve fibres at their peripheral extremities terminate in connection with peculiar structures, named *end-bodies, terminal bodies,* or *peripheral end-organs,* which are situated in the several organs of the body. The motor nerves end in the voluntary and involuntary muscles; the vaso-motor nerves end in the muscular coat of the blood-vessels; the sensory nerves end in the skin, mucous membranes, and organs of special sense; and it has been stated that secretory nerves terminate in connection with the ultimate cell elements of the secreting glands. These end-organs possess certain structural peculiarities, which are by no means uniform in the different parts, so that the end-body connected with the peripheral termination of a nerve is distinctive of the organ in which it is situated. It will be a matter of convenience to defer the consideration of the peripheral end-bodies in the skin, organs of special sense, coats of the blood-vessels, and the several glands, until these parts are described. In this place the mode of termination of the motor nerves in the voluntary and involuntary muscles, of the sensory nerves in the mucous membranes, and of the ending of the nerves in the remarkable bodies named Pacinian corpuscles, will alone be examined.

After a nerve has entered a voluntary muscle it ramifies in the connective tissue, which lies between the fasciculi, and at the same time divides and subdivides into smaller branches. These branches interlace with each other and form plexuses, from which slender nervous twigs, often consisting of only a single medullated nerve fibre, proceed, which ramify in the connective tissue, separating the individual muscular fibres from each other. The single

nerve fibres in their turn branch, accompanied by a splitting of the axial cylinder, and these branches usually lose the medullated character. The mode of termination of these very delicate branches has been a subject of much dispute. Beale described them as forming a minute network, situated on the exterior of the sarcolemma, but in contact with it, and the fibres of this nervous network were distinctly nucleated. Other observers have, however, described peculiar bodies, called motorial end-plates, at the extremity of these nerves. These end-plates consist of a clump of richly nucleated protoplasm, somewhat oval or perhaps irregular in form, into which the axial cylinder of the nerve fibre penetrates. The exact position of these end-plates in relation to the muscular fibres is difficult to determine. Krause holds that they lie outside the sarcolemma, but adherent to it; whilst Kühne, Margo, and Rouget maintain that the end-plate lies within the sarcolemma, and that the nerve fibre has to pierce that membrane before it can enter the end-plate. After the axial cylinder has entered the end-plate it subdivides into very minute branches. Each muscular fibre has apparently only a single end-plate, and consequently only a single axial cylinder in connection with it.

In the non-striped muscles the nerves are distributed in the connective tissue which separates the fasciculi from each other. Here they form plexuses, which in some localities, as in the myenteric plexus of Auerbach in the muscular coat of the intestines, have collections of nerve cells, forming microscopic ganglia lying in them. From these plexuses fibres arise which subdivide into delicate non-medullated fibres possessing nuclei. These delicate fibres form still finer plexuses, which in their turn give origin to minute fibres, which pass between the muscular fibre cells to form a still more minute intra-muscular network. Frankenhäuser maintains that the delicate nerve fibrils which arise from this terminal network penetrate the muscular fibre cells, enter the nucleus, and terminate in the nucleolus; but Arnold considers that, after having entered the nucleus, the fibril again gives off a filament, which passes out of the cell to join the intra-muscular plexus; the ending of the nerve, therefore, within the nucleus is only apparent, and is rather to be regarded as the nodal point of a fine intra-nuclear plexus.

The termination of the sensory nerves in the mucous membranes has been especially studied in the conjunctiva, the mucous membrane of the soft palate, and the glans of the penis and clitoris. In these parts Krause discovered oval or globular end-bodies, which consisted of a soft, homogeneous substance invested by a nucleated capsule of connective tissue. A nerve fibre pierces the capsule and terminates in the interior of the end-body, which forms a bulbous enlargement at the end of the nerve, and is called the end-bulb. After the nerve has entered the end-bulb, it may consist only of the axial cylinder and terminate in a pointed extremity, or it may twist upon itself and form a coil within the end-bulb. When the structure of the skin is described, it will be seen that the ending of the nerves in the cutaneous papillæ bears a general resemblance to their termination in the end-bulbs of a mucous membrane.

But in certain of the mucous membranes delicate nerves have been traced into the layer of epithelium, situated on the free surface of the membrane. Petermöller described nerve fibres continuous with the nerves of the cornea passing into the layer of conjunctival epithelium on the front of the cornea. Klein recognised an intra-epithelial nervous network in the same locality. Chrschtschonovitsch traced non-medullated nerve fibres proceeding from a sub-epithelial network into the deeper epithelial layers of the vaginal mucous membrane, and similar nerve fibres have been seen by Elin to end in the epithelial investment of the mucous membrane of the mouth.

Pacinian corpuscles.

Connected with the sensory nerves in some localities are the remarkable bodies named the Corpuscles of Pacini, which were the first terminal organs discovered in connection with the peripheral distribution of the nerves. These corpuscles have been found attached to the nerves which pass to the skin of the fingers and toes, to the nerves which supply the skin of the neck and arm, to the intercostal nerves, to the nerves of the joints, to the nerves of the periosteum, to the nerves of the genital organs, and to the mesenteric nerves. In cats they are often extremely abundant both in the mesentery and omenta. A Pacinian

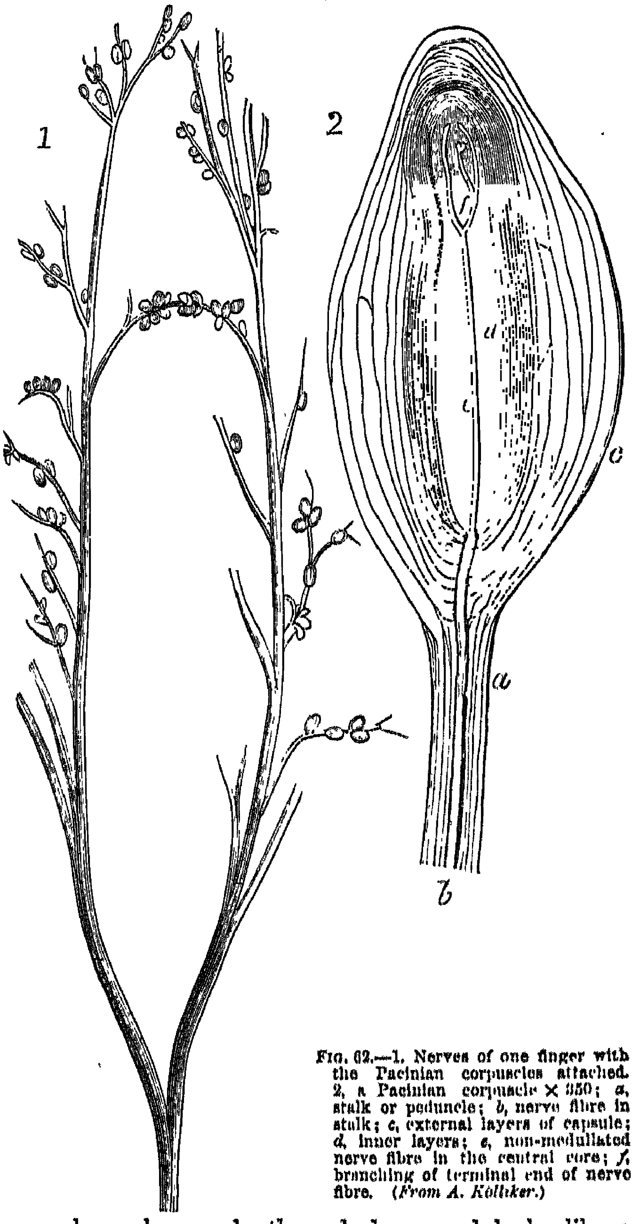


FIG. 62.—1. Nerves of one finger with the Pacinian corpuscles attached. 2, a Pacinian corpuscle × 350; *a*, stalk or peduncle; *b*, nerve fibre in stalk; *c*, external layers of capsule; *d*, inner layers; *e*, non-medullated nerve fibre in the central core; *f*, branching of terminal end of nerve fibre. (*From A. Kölliker.*)

corpuscle can be seen by the naked eye, and looks like a minute grain from $\frac{1}{10}$th to $\frac{1}{20}$th inch long. It is elliptical in form, and may either be sessile or attached to the nerve stem by a slender stalk. Examined microscopically, it is seen to consist of numerous layers of connective tissue concentrically arranged, which form its capsule, and surround a central core. Numerous connective tissue corpuscles may be seen in the concentric layers, and Hoyer has recently shown that an endothelial-like appearance exists on the inner surface of the corpuscle. Entering one pole of the corpuscle is a nerve fibre which extends along the axial core for a considerable distance, and usually termi-

nates in a slight bulbous enlargement. The nerve fibre parts with its perineurial sheath after it enters the Pacinian corpuscle; and as it lies in the core it loses its medullary substance, so that its terminal part consists only of the axial cylinder. Sometimes the nerve fibre divides into two branches within the corpuscle. Capillary blood-vessels are distributed to the concentric layers of the Pacinian corpuscle.

Development of nerve tissue.

The mode of origin of the nervous tissue in the course of development of the embryo is still involved in some obscurity. It is, however, believed that the nerve cells are derived from the embryo cells, which multiply, and the young cells then grow and assume characteristically granular and finely fibrillated contents. Processes or poles then appear at the periphery of the cells, which, according to the observations of Beale, connect adjacent cells together. As the growth of the part goes on, the cells are more widely separated from each other, and the anastomosing processes in consequence become considerably elongated, and form the axial cylinder of the nerve fibre. In the course of time the medullary sheath and the primitive membrane may form around this axial cylinder so as to insulate it. The exact mode of formation of the medullary sheath is not properly understood; but it is believed that the primitive membrane, and the perineurial connective tissue, are derived from those surrounding embryonic cells which differentiate into connective tissue. Of the two originally contiguous cells from which the nerve fibre is, as it were, spun out, one, as Hensen conceived, may form a cell in a nerve centre, the other may differentiate into a peripheral end-organ. In the tail of the tadpole the formation and growth of nerve fibres have been studied by Kölliker and others, and it has been seen that the terminal part of a fibre may have fusiform or tri-radiate cells connected with it, the processes of which cells gradually differentiate into nerve fibres. The young cerebro-spinal nerve fibres are distinctly nucleated, and correspond in appearance and structural characters to the non-medullated nerve fibres of the adult. If in a young or adult person a nerve be cut across, its conducting power is destroyed; but after a time it reunites, and its function is restored. The part of the nerve which lies between the place of section and its peripheral extremity, undergoes, as Waller pointed out, degenerative changes. To how great an extent the degeneration affects the various constituents of each fibre, it is difficult to determine; for whilst some experiments would seem to show that only the medullary sheath broke up into granular particles and was absorbed, in others both it and the axial cylinder disappeared. In process of time, however, these parts may be reproduced, and the nerve then recovers its functional activity.

Descriptive Anatomy of the Cerebro-spinal Nervous System.

In this section the anatomy of the Brain and Spinal Cord, and of the numerous distributory Nerves which arise from them, will be described. The brain and spinal cord are the largest and most important of all the nerve centres. They occupy the cranial cavity and spinal canal, and are continuous with each other through the foramen magnum in the occipital bone. As the arrangement of the structures which compose the brain and spinal cord is extremely complex, and as the names applied to the several parts are numerous and often very arbitrary, it may be well, before commencing a detailed description, to make a few general observations on their mode of development.

Development of the Cerebro-Spinal Nervous Axis.—The brain and spinal cord are developed in the cranio-spinal groove of the embryo, and appear originally as a thin band extending along the whole length of this groove. About the time when the walls of the groove meet posteriorly to complete the cranio-spinal cavity, the margins of this band become elevated, bend backwards, and meet, so that the originally simple band becomes converted into a cylindriform *cerebro-spinal tube.* In the walls of this tube the nervous structures of the brain and spinal cord are formed, whilst the axis of the tube forms a central canal. In the part which becomes the Spinal Cord the central canal persists as the *central canal* of the spinal cord, and around it a layer of ciliated cylindrical endothelium is developed. Outside this layer a mass of grey matter containing nerve cells is formed, which is subsequently divided into two lateral *crescent-shaped masses.* Outside the grey matter white matter is produced, which ultimately becomes arranged in the form of *longitudinal columns* of nerve fibres. With the formation and growth of these columns and of the internal grey matter, a longitudinal mesial fissure appears on the anterior and another on the posterior surface of the cord, which gradually increase in depth until the cord is almost completely divided into two lateral halves. At the bottom of the *anterior median fissure* the nerve fibres of the *anterior commissure* are developed, and at the bottom of the *posterior median fissure* those of the *posterior commissure.* These commissures unite the two halves of the cord together.

Development of cerebro-spinal system.

The upper or cerebral end of the cerebro-spinal tube becomes the Encephalon, or Brain. At first the cerebral part of the tube is uniform in appearance with the spinal part, but it soon expands into three vesicular dilatations — the *primary cerebral vesicles.* These vesicles, named (from before backwards) anterior, middle, and posterior, are separated from each other by constrictions, and as the development progresses the vesicles bend on each other and on the upper end of the spinal cord. As each vesicle is an expansion of the cerebro-spinal tube, it is necessarily hollow, and the space in its interior is continuous with the central canal of the spinal cord. In the walls of the vesicles the nervous structures are produced, which form the several subdivisions of the encephalon.

The *posterior cerebral vesicle* bends first forwards from the upper end of the spinal cord, and then backwards; the part which bends forward becomes the *medulla oblongata;* that which bends backward the *cerebellum,* whilst the *pons* is developed at the angle where these two parts are continuous with each other; the central hollow forms the *central canal* of the medulla oblongata and the dilated space called the *fourth ventricle.* In the medulla oblongata shallow anterior and posterior median furrows then appear continuous with those in the cord, and each lateral half differentiates into grey matter and into a longitudinal arrangement of nerve fibres continuous with the corresponding structures in the cord. A large proportion of these fibres are continued upwards through the pons as its longitudinal fibres. The cerebellum consists at first of a central lobe, and in the lower vertebrates its development does not proceed beyond this stage; but in mammals, including man, a lateral lobe or hemisphere is superadded on each side, and with the growth of these lateral lobes numerous transverse fibres, which connect the two hemispheres together, are developed in the pons. The cerebellum is also connected below with the medulla oblongata by the pair of restiform bodies, or *inferior peduncles,* and above with the corpora quadrigemina by the pair of *superior peduncles.*

The *middle cerebral vesicle* bends forwards from the posterior vesicle. In its roof the *optic lobes* are formed; in its floor the *crura cerebri;* whilst the central hollow becomes the *aqueduct of Sylvius.* At first the optic lobes form a single structure, but about the sixth month of embryo life a median furrow divides this structure into two lateral halves (the *corpora bigemina*), and in the lower vertebrates the development does not proceed beyond this stage; but in the seventh month of embryo life of the human fœtus each lateral half is subdivided into two by a transverse fissure, so that four bodies (the *corpora quadrigemina*) are produced. The crura cerebri form the two cerebral peduncles, which, diverging from each other, pass upwards to the hemisphere of the cerebrum. They consist almost entirely of nerve fibres continuous with the longitudinal fibres of the pons, a few of which go to the corpora quadrigemina, but the greater number ascend to the cerebrum.

The *anterior cerebral vesicle* bends downwards from the middle vesicle. The posterior part of this vesicle forms at first a simple hollow sac, but subsequently divides into the two *optic thalami,* one on each side of the central hollow, which hollow becomes the *third ventricle.* This ventricle is prolonged downwards into a funnel-shaped process, the *infundibulum,* which is connected with the *pituitary body,* or *hypophysis cerebri,* lodged in the pituitary fossa in the sphenoid bone, whilst posteriorly it is continuous with the aqueduct of Sylvius. In its upper and posterior wall the *pineal body,* or *epiphysis cerebri,* is developed, and from this body two white *peduncles* run forwards on the sides of the optic thalami. Immediately below these peduncles the transverse fibres of the *posterior commissure* are developed, which pass between the two optic thalami. The anterior wall of this ventricle is closed in by the *lamina cinerea* or *lamina terminalis,* and behind it are formed the transverse nerve fibres of the *anterior commissure,* and the vertical fibres of the *anterior pillars* of the *fornix.* These fornix fibres pass to the base of the brain, and form the *corpora albicantia,* prior to entering the optic thalami. The posterior part of the anterior vesicle gives off from each side a flask-shaped prolongation, the

primary optic vesicle. The stem of the prolongation, at first hollow, becomes solid, and forms the *optic nerve and tract,* whilst the expanded distal end forms the nervous elements of the *retina.*

The antero-lateral part of the anterior cerebral vesicle is prolonged forward as two hollow processes, the *hemisphere vesicles,* which become the *cerebral hemispheres,* and are separated from each other by a *median longitudinal fissure;* whilst the hollow in the interior of each forms the *lateral ventricle.* In the floor of each hemisphere vesicle is developed a large grey mass, striated with bundles of nerve fibres, the *corpus striatum,* which lies immediately in front and to the outer side of the optic thalamus; a curved band, the *tænia semicircularis,* is formed along the junction of the thalamus with the corpus striatum, and at the inner and anterior end of this band, immediately behind the anterior pillars of the fornix, the two lateral ventricles become continuous with each other and with the third ventricle through the *foramen of Monro.* The roof and side walls of each hemisphere vesicle form a grey expansion or *mantle,* which is at first smooth, but subsequently becomes divided into *lobes* and *convolutions,* separated from each other by fissures. A deep gap or fissure now appears on the inner wall of each hemisphere vesicle, and is bounded above by a longitudinal band of fibres, which, continuous anteriorly with the anterior pillar of the fornix, joins its fellow in the middle line to form the *body* of the *fornix,* and then again diverging from its fellow passes backwards, downwards, and forwards as the *posterior pillar* of the *fornix* or the *tænia hippocampi.* A transverse arrangement of fibres then forms in each hemisphere vesicle, above the plane of the fornix, which, reaching the mesial plane, joins its fellow, connects the two hemispheres together, and forms the *corpus callosum.* In the hinder part this *corpus* rests upon the upper surface of the fornix, but more anteriorly it lies some distance above the fornix, and then bends down in front of it. Hence there is enclosed between the fornix and the antero-inferior part of the corpus callosum two thin layers of grey matter, one belonging to the inner surface of each hemisphere vesicle, and called the *septum lucidum.* Between these two layers is a narrow space, the *fifth ventricle,* which, unlike the other ventricles, is not derived from the cerebro-spinal tube, but is merely a portion of the longitudinal median fissure shut in by the development of the corpus callosum and fornix. Each hemisphere vesicle also gives off from its anterior part a hollow process, which expands in front into a bulbous dilatation, named the *olfactory bulb,* from which the nerves of smell arise, whilst the stalk of the bulb solidifies and forms the *olfactory peduncle.*

Owing to the great development of the mantle of the hemisphere vesicles in the human brain, and the size and complexity of the convolutions, these parts of the hemispheres grow forward so as to overlap the olfactory bulbs and peduncles, and backward, so as to conceal not only the corpora striata and optic thalami, but also the corpora quadrigemina, crura cerebri, cerebellum, pons, and medulla oblongata, so that when the human brain is looked at from above, none of these structures can be seen. It is only when the brain is turned over and its base exposed that the medulla, pons, cerebellum, and crura are visible; and before the corpora quadrigemina, optic thalami, and corpora striata can be exposed, portions of the hemisphere substance must be removed. The great growth of the hemisphere vesicle leads also to a great expansion of the central hollow or *lateral ventricle,* which is prolonged forwards, backwards, and downwards as the *anterior, posterior,* and *descending cornua.* In the descending cornu is a projection, the *hippocamus major,* along which the tænia hippocampi of the fornix runs; in the posterior cornu is a smaller eminence, the *hippocampus minor;* and at the junction of these two cornua is a third elevation, the *eminentia collateralis.*

Immediately investing the spinal cord and encephalon a vascular membrane, the *pia mater,* is developed, processes from which dip into the fissures between the two halves of the cord and between the cerebral convolutions. A broad band, the *velum interpositum,* which possesses two marginal fringes, the *choroid plexuses,* is admitted into the lateral ventricle through the gap or fissure in the inner wall of each hemisphere vesicle. This fissure is bounded above by the arch-shaped fornix, with its tænia hippocampi. When the two hemispheres are *in situ,* and the two halves of the fornix are joined together to form the *body* of that structure, the fissure, with its contained velum interpositum, passes across the mesial plane from one hemisphere to the other, having the fornix and tæniæ for its roof, and the optic thalami and corpora quadrigemina for its floor; it is known as the *great transverse fissure of the cerebrum.*

Membranes of Brain and Spinal Cord.—These nerve centres are invested by three membranes or meninges, which lie between them and the bones that form the walls of the cranial cavity and spinal canal. The membranes are named dura mater, arachnoid mater, and pia mater.

Dura mater.—The most external membrane, named *dura* from its firmness, consists of a cranial and a spinal subdivision. The cranial part is in contact with the inner table of the cranial bones, and is adherent along the lines of the sutures and to the margins of the foramina, which transmit the nerves, more especially to the foramen magnum. It forms, therefore, for these bones an internal periosteum, and the meningeal arteries which ramify in it are the nutrient arteries of the inner table. As the growth of bone is more active in infancy and youth than in the adult, the adhesion between the dura mater and the cranial bones is greater in early life than at maturity. From the inner surface of the dura mater strong bands pass into the cranial cavity, and form partitions between certain of the subdivisions of the brain. A vertical longitudinal mesial band, named, from its sickle shape, *falx cerebri,* dips between the two hemispheres of the cerebrum. A smaller sickle-shaped vertical mesial band, the *falx cerebelli,* attached to the internal occipital crest, passes between the two hemispheres of the cerebellum. A large band arches forward in the horizontal plane of the cavity, from the transverse groove in the occipital bone to the clinoid processes of the sphenoid, and is attached laterally to the upper border of the petrous part of each temporal bone. It separates the cerebrum from the cerebellum, and, as it forms a tent-like covering for the latter, is named *tentorium cerebelli.* Along certain lines the cranial dura mater splits into two layers, to form tubular passages for the transmission of venous blood. These passages are named the *venous blood sinuses* of the dura mater, and they are lodged in the grooves on the inner surface of the skull referred to in the description of the cranial bones. Opening into these sinuses are

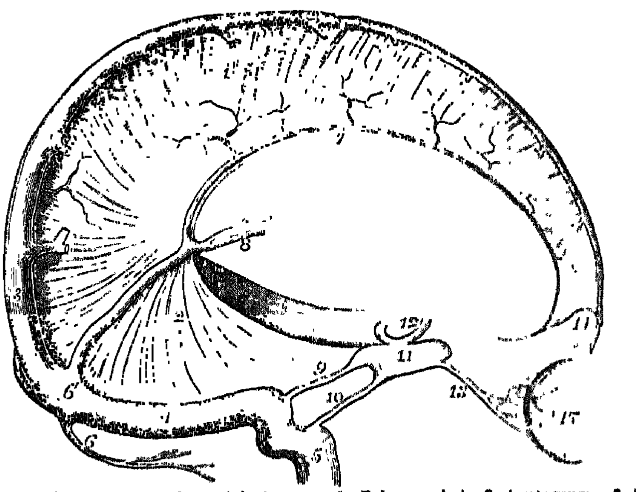


Fig. 68.—Dura mater and cranial sinuses. 1, Falx cerebri; 2, tentorium; 3, 3, superior longitudinal sinus; 4, lateral sinus; 5, internal jugular vein; 6, occipital sinus; 6′, torcular Herophili; 7, inferior longitudinal sinus; 8, veins of Galen; 9 and 10, superior and inferior petrosal sinus; 11, cavernous sinus; 12, circular sinus, which connects the two cavernous sinuses together; 13, ophthalmic vein, from 15, the eyeball; 14, crista galli of ethmoid bone.

numerous veins, which convey from the brain the blood that has been circulating through it; and two of these sinuses, called *cavernous,* which lie at the sides of the body of the sphenoid bone, receive the ophthalmic veins from the eyeballs situated in the orbital cavities. These blood sinuses pass usually from before backwards: a *superior longitudinal* along the upper border of the falx cerebri as far as the internal occipital protuberance; an *inferior longitudinal* along its lower border as far as the tentorium, where it joins the *straight sinus,* which passes back as far as the same protuberance. One or two small *occipital sinuses,* which lie in the falx cerebelli, also pass to join the straight and longitudinal sinuses opposite this protuberance; several currents of blood meet, therefore, at this spot, and as Herophilus supposed that a sort of whirlpool was formed in the blood, the name *torcular Herophili* has been used to express the meeting of these sinuses. From the torcular the blood is drained away by two large

sinuses, named *lateral*, which curve forwards and downwards to the jugular foramina to terminate in the internal jugular veins. In its course each lateral sinus receives two *petrosal* sinuses, which pass from the cavernous sinus backwards along the upper and lower borders of the petrous part of the temporal bone.

The spinal part of the dura mater hangs loosely in the spinal canal. It does not form a periosteum for the vertebræ, but is separated from their bony rings by loose fat and a plexus of veins. It gives off no bands from its inner surface, and it does not split into two layers for the lodgment of venous blood sinuses. The spinal dura mater forms a tubular envelope for the spinal cord and the origins of the spinal nerves. It extends from the foramen magnum, where it is continuous with the cranial dura mater, to the lower end of the sacral canal, ends below in a funnel-shaped prolongation, and is pierced laterally by the roots of the several spinal nerves in their passage outwards to the intervertebral foramina.

Both the cranial and the spinal parts of the dura mater consist of a tough, fibrous membrane; somewhat flocculent externally, but smooth, glistening, and free on its inner surface. The inner surface has the appearance of a serous membrane, and when examined microscopically is seen to consist of a layer of squamous endothelial cells, similar to those drawn in fig. 34. Hence the dura mater is sometimes called a fibro-serous membrane. The dura mater is well provided with lymph vessels, which in all probability open by stomata on the free inner surface. Between the dura mater and the subjacent arachnoid membrane is a fine space containing a minute quantity of limpid serum, which moistens the smooth inner surface of the dura and the corresponding smooth outer surface of the arachnoid. It is regarded as equivalent to the cavity of a serous membrane, and is named the *arachnoid cavity*, or, more appropriately, the *sub-dural space*.

Arachnoid membrane. *Arachnoid mater.*—The arachnoid is a membrane of great delicacy and transparency, which loosely envelopes both the brain and spinal cord. It is separated from these organs by the pia mater; but between it and the latter membrane is a distinct space, called *sub-arachnoid*. The sub-arachnoid space is more distinctly marked beneath the spinal than beneath the cerebral parts of the membrane, which forms a looser investment for the cord than for the brain. At the base of the brain, and opposite the fissures between the convolutions of the cerebrum, the interval between the arachnoid and the pia mater can, however, always be seen, for the arachnoid does not, like the pia mater, clothe the sides of the fissures, but passes directly across between the summits of adjacent convolutions. The sub-arachnoid space is subdivided into numerous freely-communicating loculi by bundles of delicate areolar tissue, which bundles are invested, as Key and Retzius have shown, by a layer of squamous endothelium. The space contains a limpid cerebro-spinal fluid, which varies in quantity from 2 drachms to 2 ounces. The fluid is alkaline, of sp. gr. 1·005, contains a little albumen, and a substance which, as Turner pointed out, reduces blue oxide of copper to the state of yellow sub-oxide. The arachnoid membrane is made up of delicate connective tissue. The free surface next the sub-dural space is smooth, like a serous membrane, and covered by a layer of squamous endothelium. This layer is reflected on to the roots of the spinal and cranial nerves, and, when they pierce the dura mater, it becomes continuous with the endothelial lining of that membrane. As the arrangement and structure so closely correspond with what is seen in the serous membranes, many anatomists regard the arachnoid as the visceral layer of a serous membrane, and the endothelial lining of the dura mater as the parietal layer, whilst the sub-dural space is the intermediate cavity.

Pacchionian bodies. When the skull cap is removed, clusters of granular bodies are usually to be seen imbedded in the dura mater on each side of the superior longitudinal sinus, these are named the *Pacchionian bodies*. When traced through the dura mater they are found to spring from the visceral or proper cerebral arachnoid. The observations of Luschka and Cleland have proved that villous processes invariably grow from the free surface of that membrane, and that when these villi greatly increase in size they form the bodies in question. Sometimes the Pacchionian bodies greatly hypertrophy, occasion absorption of the bones of the cranial vault, and depressions on the upper surface of the brain.

Pia mater. *Pia mater.*—This membrane closely invests the whole outer surface of the brain. It dips into the fissures between the convolutions, and a wide prolongation, named *velum interpositum*, lies in the interior of the cerebrum. With a little care it can be stripped off the brain without causing injury to its substance. The pia mater invests the spinal cord, and is more intimately attached to it than to the brain, for not only does it send prolongations into the anterior and posterior fissures of the cord, but slender bands pass repeatedly from its inner surface into the columns of the cord. Hence it cannot be stripped off the cord without causing injury to its substance. The pia mater is prolonged on to the roots both of the cranial and spinal nerves, and on to the filum terminale. This membrane consists of a delicate connective tissue, in which the arteries of the brain and spinal cord ramify and subdivide into small branches before they penetrate the nervous substance, and in which the veins conveying the blood from the nerve centres lie before they open into the blood sinuses of the cranial dura mater and the extra-dural venous plexus of the spinal canal. The arteries which pass from the pia mater into the brain and spinal cord are invested by a loose sheath, which has been described as forming the wall of a peri-vascular lymphatic vessel; but Key and Retzius have shown that the space between the blood-vessel and the sheath opens into the sub-arachnoid space, and contains cerebro-spinal fluid. A network of lymph vessels ramifies freely in the pia mater. It is also well provided with nerves, which arise from the posterior roots of the spinal nerves, from some of the cranial nerves, and from the carotid and vertebral plexuses of the sympathetic. The epi-cerebral and epi-spinal spaces described by His as existing between this membrane and the brain and spinal cord are in all probability artificial productions.

Ligamentum denticulatum. In the spinal canal a slender fibrous band projects from the pia mater covering the side of the cord, and, pushing the arachnoid membrane in front of it, is attached by about twenty-two pairs of denticulated processes to the inner surface of the dura mater. It is named *ligamentun denticulatum*, and its teeth alternate with the successive pairs of spinal nerves.

Spinal cord. SPINAL CORD.—The MEDULLA SPINALIS, or SPINAL CORD, occupies the spinal canal, and extends from the foramen magnum to opposite the body of the first lumbar vertebra. In the early fœtus it equals in length the canal itself; but as the spinal column grows at a greater proportional rate than the cord, the latter, when growth has ceased, is several inches shorter than the column. The cord is continuous above with the medulla oblongata, whilst it tapers off below into a slender thread, the *filum terminale*, which lies in the axis of the sacral canal, and is attached below to the back of the coccyx, or to the fibrous membrane which closes in below the sacral canal. The length of the cord is from 15 to 18 inches. It approaches a cylinder in shape, but is flattened on its anterior and posterior surfaces, and presents two enlargements which have a greater girth than the rest of the cord. The upper,

called the *cervical* or *brachial enlargement*, extends from opposite the third cervical to the first dorsal vertebra, and from it arise the nerves which supply the upper limbs; the lower, called the *crural* or *lumbar enlargement*, is opposite the last dorsal vertebra, and supplies with nerves the lower limbs. The cord is almost completely divided into right and left lateral halves by two fissures, named respectively *anterior* and *posterior median fissures*, which do not quite reach the centre of the cord, for at the bottom of the anterior fissure are the transverse fibres of the *anterior white commissure*, and at the bottom of the posterior fissure the fibres of the *posterior grey commissure*. By these commissures the two halves of the cord are united together. The fibres of the posterior commissure surround a canal, called the *central canal*, which extends along the whole length of the cord, and even passes into the upper end of the filum terminale. This canal is lined by a ciliated columnar endothelium, and expands superiorly into the cavity of the fourth ventricle. Each lateral half of the cord is subdivided into three columns by two depressions, which mark the points of emergence of the roots of the spinal nerves. The anterior nerve roots pass through the *antero-lateral depression* or fissure, and between it and the antero-median fissure is the *anterior column* of the cord. The posterior nerve roots pass through the *postero-lateral fissure*, and between it and the postero-median fissure is the *posterior column*, whilst between the anterior and posterior nerve roots lies the *lateral column*. In the cervical region, the part of the posterior column which lies next the postero-median fissure is marked off by a fissure into a small internal or *postero-median* column. The subdivision of each lateral half of the cord into the columns, and the arrangement of its nervous tissues, are well seen in transverse sections through its substance. The cord is composed of white and grey matter. The white matter is external, and forms the columns of the cord. The grey matter is surrounded by the white, and has in each lateral half of the cord a crescentic shape. The horns of the crescent are directed towards the fissures of emergence of the nerve roots; the anterior horn is rounded; the posterior long and narrow. The proportion of grey matter to the white varies in different parts of the cord. At the commencement of the filum terminale there is scarcely any white matter; but the white matter increases in amount from below upwards, so that its absolute quantity is greatest in the cervical part of the cord. The grey crescents are thicker in the upper and lower enlargements than in the intermediate part.

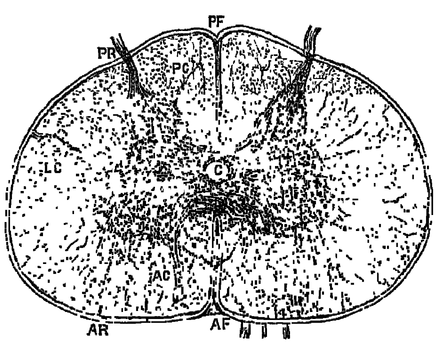


FIG. 64.—Transverse section through the spinal cord. AF, antero-median, and PF, postero-median fissures; PC, posterior, LC, lateral, and AC, anterior columns; AR, anterior, and PR, posterior nerve roots; C, central canal of cord, with its columnar endothelial lining. The pia mater is shown investing the cord, sending processes into the anterior and posterior fissures, as well as delicate prolongations into the columns. The crescentic arrangement of the grey matter is shown by the darker shaded portion.

The cord contains both nerve fibres and nerve cells. The external, columnar, white part of the cord consists of nerve fibres, with a supporting reticular framework of connective tissue and blood-vessels derived from the pia mater. Well-formed stellate connective tissue corpuscles lie in this supporting framework. The nerve fibres of the various columns extend longitudinally, and lie parallel to each other, so that in transverse sections through the columns the fibres are transversely divided. The individual fibres vary much in diameter, but in all the axial cylinder and medullary sheath can be distinctly seen. Wherever the nerve roots enter into the cord, the fibres of these roots pass transversely or obliquely in their course inwards to the grey matter. Horizontal fibres are also found in the white anterior commissure, and a similar appearance can be seen in the posterior commissure. Horizontal fibres have also been traced from the lateral columns into the adjacent part of the grey matter.

The grey crescentic portion of the cord contains connective tissue, blood-vessels, nerve fibres, and nerve cells. The nerve fibres in the grey matter are numerous; and whilst some possess a medullary sheath, others consist only of the axial cylinder; they divide and subdivide, and, as Gerlach has shown, form a narrow-meshed network of extremely minute fibres. The nerve cells are multipolar, and are chiefly collected in the anterior and posterior horns of each crescent. The cells of the anterior cornu are large, distinct, and stellate, and form a well-defined group of nerve cells. Those of the posterior cornu are smaller in size, more elongated in shape, but with stellate branched processes. They are not so distinct as in the anterior horn, owing to the connective tissue with its corpuscles being so abundant. This tissue is best marked at the tip of the posterior horn, where it forms the *substantia gelatinosa* of Rolando. Lockhart Clarke has described an *intermedio-lateral* group of nerve cells situated at the outer side of the grey matter, about midway between the anterior and posterior horns, in the upper part of the cervical portion of the cord, and in the thoracic part between the brachial and crural enlargements.

The course of the fibres in the cord and their relations to the nerve cells should now be considered. There can be no doubt that of the longitudinal fibres some ascend from below upwards, and conduct either excito-motory impulses to the regions of the spinal cord itself, or sensory impulses to the brain. Other longitudinal fibres again descend from the brain and higher regions of the cord to the lower, and conduct motor and vaso-motor impulses from above downwards. The horizontal and oblique fibres of an anterior or motor nerve root enter the grey matter of the anterior cornu, and seem to have the following arrangement: some become directly continuous with the axial cylindrical processes of the nerve cells; others pass into the anterior commissure; others extend as far as the grey matter of the posterior horn. The nerve cells of the anterior cornu give origin, therefore, directly to nerve fibres by their unbranched processes. Gerlach's observations show that the branched processes of these cells become continuous with the network of extremely minute fibres already described in the grey matter; from this network medullated fibres appear to arise which leave the grey matter; some enter the lateral column, and ascend as the fibres of this structure; others pass as fibres of the anterior commissure to the opposite side of the cord, and ascend as the anterior column of that side. The anterior and lateral columns, therefore, are constantly receiving accessions of fibres from the enclosed grey matter.

The fibres of a posterior or sensory nerve root on entering the cord subdivide into two bundles; one does not enter the grey matter, but applies itself to the posterior column, of which it forms some of the vertical fibres. These fibres may ascend to the brain, or they may at some higher point in the cord enter the grey matter of the posterior horn. The other bundle of posterior root fibres at once enters the posterior horn of grey matter. The connections and ultimate arrangement of these fibres in the grey matter have not been satisfactorily made out. Gerlach states that, as they frequently subdivide on entering the grey matter, it

is possible they may form the fine nerve fibre plexus of the grey substance; but a direct continuity between them and the axial-cylinder processes of the cells of the posterior horn does not seem to have been observed. From the plexus, formed by the much subdivided processes of these cells, fibres arise, which, forming the fibres of the posterior commissure, pass both in front of and behind the central canal to the opposite side, where they ascend towards the brain, "partly in the vertical fasciculi of the posterior cornua and partly in the posterior columns."

The structure of the spinal cord shows it to be both a nerve centre and a conductor of nervous impulses. The nerve cells in its grey matter give rise either directly, or through the delicate plexus formed by their branching processes, to nerve fibres, which may either pass out of the cord as the anterior and posterior roots of the spinal nerves, or may ascend to the brain as the columns of the cord. Hence the cord is anatomically continuous, on the one hand, through the nerves which arise from it, with the peripheral end-organs in the skin, and muscular system in which those nerves terminate; and, on the other hand, it is continuous with the brain. It serves, therefore, to conduct the impulses of touch-sensation from the skin upwards to the brain, and the motor impulses from the brain downwards to the muscles. But further, the cord is the great nerve centre concerned in reflex excito-motory actions. It must, also, be remembered that the two halves of the cord are anatomically continuous with each other through the nerve fibres of the commissures, so that it acts as a single organ, and not as two organs. Experiments have shown that sensory impulses are conducted upwards through the cord, not by that half from which the nerves arise that have been excited, but by the opposite half of the cord, which is obviously due to the crossing of the fibres of the posterior commissure. Motor impressions are, however, conducted downwards by that half of the cord from which the nerves arise that pass to supply the muscles to be moved.

The spinal cord is well supplied with blood by numerous arteries, which terminate in a diffused capillary network. The capillaries are much more numerous in the grey matter of the cord than in the white columns.

Spinal nerves.

ORIGIN, ARRANGEMENT, AND DISTRIBUTION OF THE SPINAL NERVES.—The spinal cord gives origin to thirty-one pairs of SPINAL nerves, which pass out of the spinal canal through the intervertebral foramina. These nerves are arranged in groups, according to the region of the spine through the foramina in which they proceed. There are eight pairs of cervical nerves; the first or *sub-occipital* emerges between the occipital bone and the atlas, the eighth between the seventh cervical and first dorsal vertebræ. Twelve dorsal or thoracic nerves pass out on each side in relation to the dorsal vertebræ: five pairs of lumbar nerves in the region of the loins; five pairs of sacral nerves through the sacral foramina; and one pair of coccygeal nerves through the lowest openings in the spinal canal. Each spinal nerve arises by two *roots*, an *anterior* and a *posterior*, from the side of the cord. These roots are distinguished from each other both anatomically and physiologically. The posterior root has a swelling or *ganglion* on it, whilst no ganglion exists on the anterior root. The posterior root consists of sensory nerve fibres, *i.e.*, of fibres which conduct impulses from the periphery into the nerve centre; whilst the anterior root is composed of motor nerve fibres, *i.e.*, of fibres which conduct impulses from the centre to the periphery. The ganglion is situated on the posterior root, as a rule, in the intervertebral foramen; but the lower sacral nerves have the ganglia on their posterior roots in the spinal canal. These ganglia contain bipolar nerve cells, and the nerve fibres, as they pass through each ganglion, are apparently connected with the poles of the cells. The roots of the spinal nerves vary in direction and length. Those of the cervical nerves are short, and run almost horizontally outwards to their respective intervertebral foramina; those of the dorsal are longer and more oblique; whilst the roots of the lumbar and sacral nerves, owing to the cord ending much above the foramina through which the nerves proceed, are very long, and form a leash of nerves in the lower part of the spinal canal, which surrounds the filum terminale, and, from its general resemblance in arrangement to the hairs of a horse's tail, has been named *cauda equina*.

The anterior nerve root joins the posterior immediately outside the ganglion, and by their junction a spinal nerve is formed. This nerve contains a mixture of both motor and sensory fibres, and is compound therefore in function. Almost immediately after its formation the nerve separates into two divisions, an anterior and a posterior, and each division, like the nerve itself, contains both motor and sensory fibres.

The *Posterior Primary Divisions* of the spinal nerves, smaller than the anterior, are distributed both to the muscles and skin on the back of the axial part of the body. Their general arrangement is as follows: each division, with some three or four exceptions, subdivides into an internal and an external branch. In the back of the neck and the back of the upper part of the chest, the external branches of these nerves supply the deep muscles; the internal branches pierce the muscles close to the spines of the vertebræ, and end in the skin; the internal branch of the second nerve, called *great occipital*, and that of the third cervical, pass to the skin over the occipital bone. In the back of the lower part of the chest and of the loins, the internal branches supply the deep muscles, the external branches pass to the skin, those of some of the lumbar nerves extending as far as the skin of the buttock.

The *Anterior Primary Divisions* are not so uniform either in arrangement or distribution as are the posterior. They supply the front and sides of the axial part of the neck and trunk, and the extremities. The anterior divisions of the twelve *thoracic nerves* have the most simple arrangement. Each nerve, called from its position an *intercostal* nerve, runs outwards, immediately below the lower border of a rib, and gives origin to three series of branches, named communicating, muscular, and cutaneous. By the *Communicating* branch each intercostal nerve is connected with an adjacent ganglion on the thoracic portion of the sympathetic system. By the *Muscular* or motor branches these nerves supply the intercostal muscles, the levatores costarum, and the triangularis sterni, whilst the lower intercostal nerves run forwards and downwards into the wall of the abdomen, and supply the two oblique, the transverse, rectus, and pyramidalis muscles. The skin of the sides of the thorax and abdomen receives its nervous supply from the *Lateral Cutaneous* branches, whilst the skin on the front of the trunk is supplied by the *Anterior Cutaneous* terminations of these nerves. The lateral cutaneous branches of the second and third intercostal nerves are comparatively large in size, and assist in the supply of the skin of the inner side of

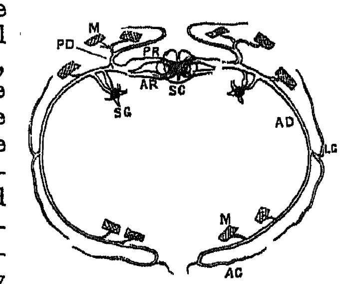


FIG. 65.—Diagram of the arrangement of a pair of thoracic spinal nerves. SC, spinal cord; AR, anterior nerve root; PR, posterior root, with its ganglion; PD, posterior primary division; AD, anterior primary division, or intercostal nerve; SG, sympathetic ganglion, with the communicating branches between it and the anterior division; M, muscles, with the motor branches entering them; LC, lateral cutaneous, and AC, anterior cutaneous nerves.

the upper arm; hence they are called *intercosto-humeral* nerves.

Nervous plexuses

In the regions of the neck, loins, and pelvis, the anterior divisions of the spinal nerves do not pass simply outwards to their distribution. In each region adjacent nerves interlace with each other, and form what is technically called a *nervous plexus*. When a branch arises from a thoracic nerve, it contains fibres derived from that nerve only; but when a branch arises from a plexus, it may contain fibres, not of one only, but of two or more of the nerves which, by their interlacement, form the plexus. Hence the parts which are supplied by these branches are brought into connection with a greater number of nerves, and consequently with a greater extent of the spinal cord or nerve centre, than are the parts which receive branches from a single nerve only. These plexuses are especially found in connection with the nerves which supply the extremities, where, owing to the complexity of the muscular movements, the co-ordination of these movements through the nervous system is rendered necessary.

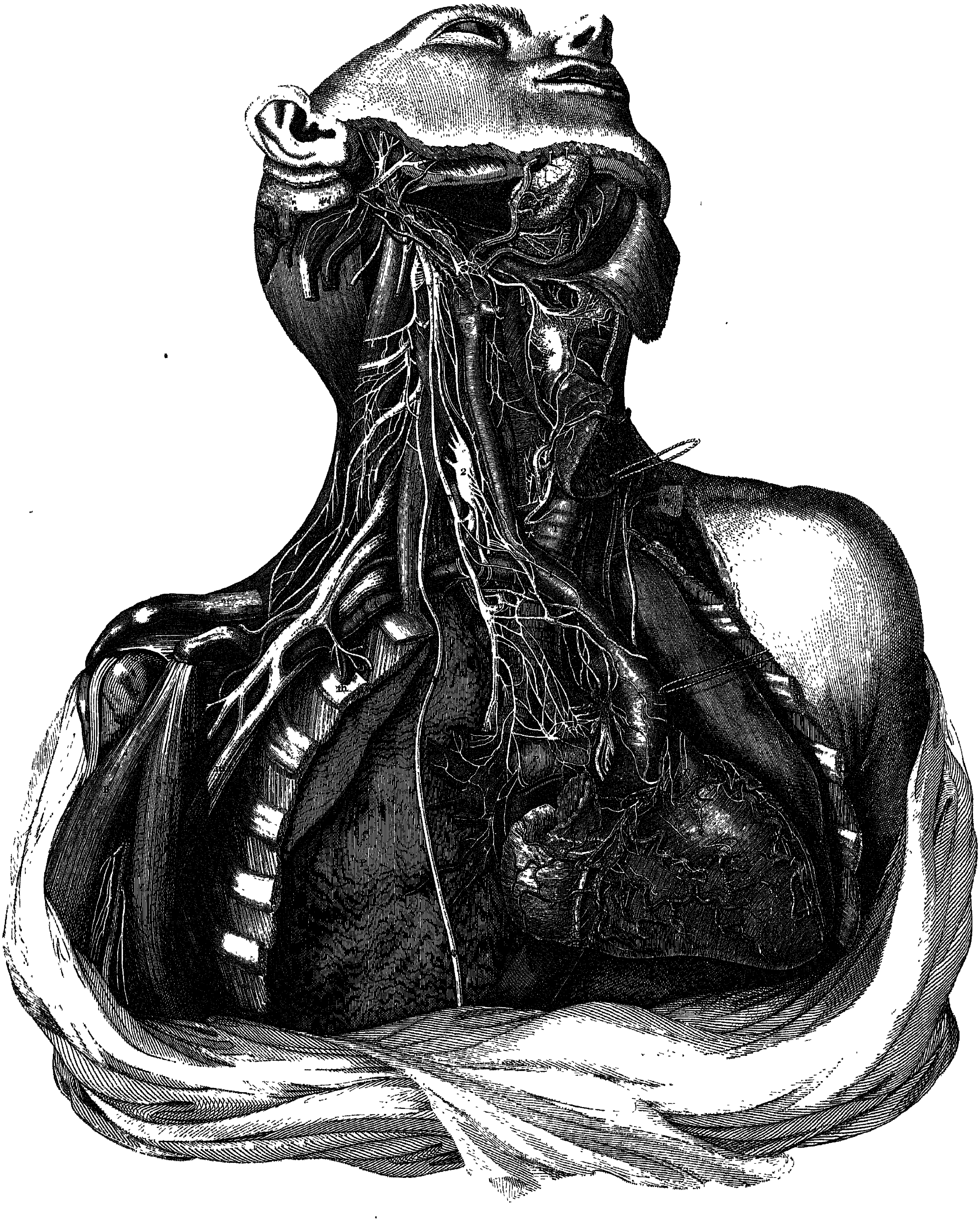
The anterior divisions of the eight cervical nerves are arranged in two plexuses, named cervical and brachial.

The *Cervical plexus* (Pl. XVII.) is formed of the four upper cervical nerves, which make, by interlacement with each other, a series of loops in front of the transverse processes of the cervical vertebræ. Arising either directly from these nerves, or from the plexus which they form, are communicating, muscular, and cutaneous branches. The *Communicating* branches connect these nerves with the large superior cervical ganglion of the sympathetic system, also with the vagus, accessory, and hypoglossal cranial nerves, and with the descending branch of the hypoglossal. The *Muscular* branches supply the anterior recti muscles of the neck, the levator scapulæ, the posterior scalenus, the diaphragm, and in part the sterno-mastoid and trapezius. The branch to the diaphragm, or the *phrenic* nerve, is the most important (Pl. XVII. φ); it springs from the third, fourth, and fifth cervical, and passes down the lower part of the neck, and through the thorax, to supply its own half of the diaphragm. The *Cutaneous* branches are as follows:—the *occipitalis minor*, to the skin of the occiput; the *auriculo-parotidean*, to the skin over the parotid gland and the adjacent part of the auricle; the *transversalis colli*, to the skin of the front of the side of the neck; the *supra-clavicular* nerves, to the skin of the lower part of the side of the neck, and upper part of the chest.

The *Brachial plexus* (Pl. XVII. 1, 2, 3, 4) is formed of the four lower cervical nerves, and of the larger portion of the first intercostal, called also first dorsal nerve. It is of large size, and is principally for the supply of the upper limb. Its exact mode of arrangement presents many variations, but the following is not unfrequently found:—The fifth and sixth nerves join to form a large nerve, which, after a short course, is joined by the seventh; in this manner the *upper cord* of the plexus is formed. The eighth cervical and the first dorsal then join, to form the *lower cord* of the plexus. These cords then pass behind the clavicle and subclavius muscle into the axilla, where they become modified in arrangement. From each a large branch arises, and these two branches then join to form a third cord. These three cords have special relations to the axillary artery: the one which lies to its outer side is named the *outer cord;* that to the inner, the *inner cord;* that behind, the *posterior cord.* These nerves and the cords formed by them give origin to communicating, muscular, cutaneous, and mixed branches. The *Communicating* branches join the middle and inferior cervical and first thoracic ganglia of the sympathetic system. The *Muscular* branches supply the scaleni, longus colli, rhomboid, and subclavius muscles; the supra and infra-spinatus muscles, through a branch called *supra-scapular;* the serratus magnus, through the *posterior thoracic* branch; the greater and lesser pectorals, through the two *anterior thoracic* branches; and the subscapularis, teres major, and latissimus dorsi, through the three *subscapular* branches. The *Cutaneous* branches arise from the inner cord, and are the *lesser internal cutaneous,* which ends in the skin of the inner side of the upper arm, and joins the intercosto-humeral; and the *internal cutaneous,* which not only sends branches to the skin of the upper arm, but supplies the skin of the inner side of the forearm, both on its anterior and posterior surfaces. The *Mixed* branches are large and very important:—*a*, The *Circumflex,* from the posterior cord, supplies the deltoid and teres minor muscles, the skin over the deltoid, and the shoulder joint. *b*, The *Musculo-Spiral,* also from the posterior cord, supplies the triceps and anconeus, the supinator longus and extensor carpi radialis longior muscles; and by its *external cutaneous* branch, the skin of the outer side of the back of the forearm. It then divides into the radial and posterior interosseous branches. The *radial* passes through the forearm to the hand, and supplies the skin on the back of the thumb, index and middle digits, and radial side of the ring digit. The *posterior interosseous* supplies the muscles on the back of the forearm and the articulations of the carpal joints. *c*, The *Musculo-Cutaneous* branch of the outer cord of the plexus supplies the biceps, brachialis anticus, and coraco-brachialis muscles, and ends in an *external cutaneous* branch, which supplies the skin of the outer side of the forearm, both in front and behind. *d*, The *Ulnar* nerve arises from the inner cord, passes through the upper arm, and enters the forearm between the inner condyle and olecranon, where it supplies the elbow joint. Here it may easily be compressed, when a pricking sensation is experienced in the course of its distribution. In this spot it is popularly called the "funny bone." In the forearm the ulnar nerve supplies the flexor carpi ulnaris and inner part of the flexor profundus digitorum muscles. In the hand it supplies the muscles of the ball of the little finger, the two inner lumbricales, the interossei muscles, and the adductor and deep part of the short flexor of the thumb. It also supplies a *dorsal* cutaneous branch to the back of the hand, and the back of the little and of the ulnar side of the ring digits. *Palmar* cutaneous branches are also given to the palm and the palmar aspects of the same digits. *e*, The *Median* nerve arises by two roots, one from the inner, the other from the outer cord of the plexus. It enters the forearm in front of the elbow joint, supplies, either directly or through its *anterior interosseous* branch, all the flexors and pronators, except those supplied by the ulnar; is continued to the hand, where it supplies the abductor, opponens, superficial part of the short flexor of the thumb, and two outer lumbrical muscles. It also supplies a *palmer* branch to the skin of the palm, and gives *digital* cutaneous branches to the thumb, index and middle digits, and radial side of the ring digit.

The *Lumbar plexus,* of large size, is situated at the back of the abdominal cavity in the region of the loins, and is formed by the four upper lumbar nerves, which form a series of loop-like interlacements in front of the transverse processes of the lumbar vertebræ. It gives origin to communicating, muscular, cutaneous, and mixed branches. The *Communicating* branches join the four upper lumbar ganglia of the sympathetic system. The *Muscular* branches supply the quadratus lumborum muscle, and give branches to the psoas. The *Cutaneous* branches are named—*a*, *Ilio-hypogastric,* which gives an iliac branch to the skin of the buttock, and a hypogastric branch to the skin of the abdomen above the pubic symphysis; *b*,

Nerves of the Neck and Thorax



W.& A.K. Johnston.

Ilio-inguinal, which supplies the skin of the groin; this nerve is by some said to send a branch to the internal oblique muscle; *c*, *External Cutaneous*, which supplies the skin on the outer aspect of the thigh. The *Mixed* branches are as follows:—*a*, *Genito-crural*, which supplies the cremaster muscle, and a cutaneous branch to the skin of the groin. *b*, *Anterior Crural*, a large nerve which enters the thigh by passing behind Poupart's ligament, and supplies the great extensor muscles of the knee-joint, and also the sartorius, the psoas-iliacus and the pectineus, which act as flexors of the hip-joint; it gives off the following cutaneous branches:—An *internal cutaneous* to the skin of the inner side, a *middle cutaneous* to the skin of the middle of the front of the thigh, and the *long saphenous* nerve, which supplies the skin of the inner side of the knee-joint, the inner side of the leg and the foot. *c*, *Obturator* nerve, which leaves the pelvis through the obturator foramen, and supplies the obturator externus and adductor muscles of the thigh, and sends a branch to the pectineus; it also supplies the hip and knee joints, and not unfrequently gives a branch to the skin of the lower part of the inner side of the thigh. *d*, An *Accessory Obturator* nerve is sometimes present, which goes to the pectineus, to the hip-joint, and also joins the obturator nerve.

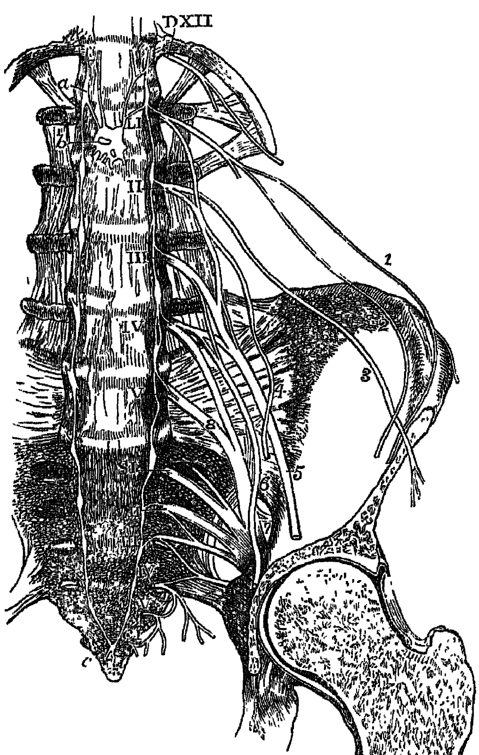


FIG. 66.—Lumbar, sacral, and sacro-coccygeal plexuses. DXII, the lowest thoracic nerve of the intercostal series; LI to IV, the nerves of the lumbar plexus; V, the fifth lumbar, with 8, the lumbo-sacral cord; SI to IV, sacral nerves going to form the sacral plexus; V and CI, the sacro-coccygeal plexus; *a*, chain of ganglia of the sympathetic system, showing the communicating branches with the spinal nerves; *c*, the last of these ganglia, called coccygeal ganglion, or ganglion impar; *b*, position of solar plexus; 1, ilio-hypogastric nerve; 2, ilio-inguinal; 3, external cutaneous; 4, genito-crural; 5, anterior crural; 6, obturator; 7, superior glutæal.

The *Lumbo-sacral Cord* is formed of the fifth lumbar nerve and of a branch from the fourth lumbar. It joins the sacral plexus. Before the junction it gives origin to a communicating and a muscular branch. The *Communicating* joins the fifth lumbar ganglion of the sympathetic. The *Muscular* branch, named the *superior glutæal* nerve, supplies the glutæus medius and minimus and the tensor fasciæ femoris muscle.

The *Sacral plexus* is situated in the cavity of the pelvis, and is the largest of all the plexuses. It is formed by the junction of the lumbo-sacral cord, the first, second, third, and part of the fourth sacral nerves, and appears as a flattened mass in front of the sacrum. It gives origin to communicating, muscular, and mixed branches. The *Communicating* branches join the upper sacral ganglia of the sympathetic system. The *Muscular* branches supply the upper fibres of the glutæus maximus, the pyriformis, gemelli, quadratus femoris, and obturator internus muscles. The *Mixed* nerves are as follows:—*a*, *Pudic*, which supplies the muscles and skin of the external organs of generation. *b*, *Small Sciatic*, which supplies not only the lower fibres of the glutæus maximus muscle, but the skin of the buttock, the back of the thigh, of the popliteal space, and of the leg; it also gives a *long pudendal* branch to the skin of the perineum. *c*, *Great Sciatic;* this is the largest nerve in the body. It leaves the pelvis through the great sciatic foramen, and passes down the back of the thigh, when it divides into external and internal popliteal branches. Before dividing it supplies the hamstring muscles, and gives a branch to the adductor magnus. The *external popliteal* branch gives offsets to the knee-joint, passes down the outer side of the leg, supplies the peronei longus and brevis, gives off the *communicans peronei* branch to the skin of the outer side of the back of the leg, and ends as the *external cutaneous* nerve for the dorsum of the foot and the dorsal surfaces of all the toes, except the outer side of the little and the adjacent sides of the great and second toes. The *internal popliteal* branch gives offsets to the knee-joint, and supplies the *communicans tibialis* nerve, which joins the communicans peronei, and forms with it the *external saphenous* nerve that passes to the outer side of the foot and little toe. The internal popliteal also supplies the muscles of the calf and the popliteus muscle, and is prolonged downwards as the posterior tibial nerve. The *anterior tibial* passes to the front of the leg, supplies the tibialis anticus, peroneus tertius, and extensor muscles of the toes, and terminates as the cutaneous *digital* nerve for the adjacent sides of the great and second toes. The *posterior tibial* nerve passes down the back of the leg, supplies the tibialis posticus and long flexors of the toes, gives off a *cutaneous* branch to the skin of the heel, and terminates by dividing into the internal and external plantar nerves. The *internal plantar* nerve supplies the skin of the sole and sends *digital* branches to the skin of the great, second, third, and tibial side of the fourth toes; it also supplies the abductor pollicis, flexor brevis digitorum, flexor brevis pollicis, and two inner lumbrical muscles. The *external plantar* nerve supplies *digital* branches to the skin of the little and fibular sides of the fourth toes, and branches to all the muscles of the sole of the foot which are not supplied by the internal plantar nerve.

The *Sacro-Coccygeal* is the smallest *plexus* belonging to the anterior divisions of the spinal nerves. It is formed by a part of the fourth sacral, the fifth sacral, and the coccygeal nerves. It lies in front of the last sacral and the first coccygeal vertebræ, and gives origin to communicating, visceral, muscular, and cutaneous branches. The *Communicating* branches join the lower sacral and the coccygeal ganglia of the sympathetic system; the *Visceral* pass to the pelvic plexus of the sympathetic, and through it to the bladder and rectum; the *Muscular* to the levator ani, coccygeus, and sphincter ani externus muscles; the *Cutaneous* to the skin about the anus and tip of the coccyx.

THE BRAIN.—By the term BRAIN or ENCEPHALON is meant all that part of the central nervous axis which is contained within the cavity of the skull. It is divided into several parts, named medulla oblongata, pons, cerebellum, and cerebrum. The medulla oblongata is directly Brain.

continuous with the spinal cord through the foramen magnum. The cerebellum lies above, and immediately behind the medulla oblongata, with which it is directly continuous. The pons lies above and in front of the medulla, with which it is directly continuous. The cerebrum is the highest division, and lies above both pons and cerebellum, with both of which it is directly continuous. Several figures of the brain are given in Plate XVIII.

Medulla oblongata.

The Medulla Oblongata rests upon the basi-occipital. It is somewhat pyramidal in form, about $1\frac{1}{4}$ inch long, and 1 inch broad in its widest part. It is a bilateral organ, and is divided into a right and a left half by shallow anterior and posterior median fissures, continuous with the corresponding fissures in the spinal cord; the posterior fissure ends above in the 4th ventricle. Each half is subdivided into elongated tracts of nervous matter. Next to, and parallel with the anterior fissure is the *anterior pyramid* (Pl. XVIII. figs. 1 and 2, P). This pyramid is continuous below with the cord, and the place of continuity is marked by the passage across the fissure of three or four bundles of nerve fibres, from each half of the cord to the opposite anterior pyramid; this crossing is called the *decussation of the pyramids.* To the side of the pyramid, and separated from it by a faint fissure, is the *olivary fasciculus,* which at its upper end is elevated into the projecting oval-shaped *olivary body* (Pl. XVIII. figs. 1 and 2, O). Behind the olive, and separated from it by a faint groove, is the strong tract named *restiform body;* as it ascends from the cord it diverges from its fellow in the opposite half of the medulla oblongata. By this divergence the central part of the medulla is opened up, and the lower half of the cavity of the 4th ventricle is formed. Internal to the restiform body is the *posterior pyramid,* which is continuous with the postero-median column, and bounds the postero-median fissure. Where the restiform bodies diverge from each other, there also the posterior pyramids diverge outwards from the sides of the postero-median fissure. At the upper part of the floor of the 4th ventricle a longitudinal tract of nerve fibres, the *fasciculus teres,* ascends on each side of its median furrow (Fig. 68, 7). Slender tracts of nerve fibres, the *arciform fibres,* arch across the side of the medulla immediately below the olive; and white slender tracts emerge from the median furrow of the 4th ventricle, pass outwards across its floor, and form the *striæ medullares* or *acousticæ,* the roots of origin of the auditory nerve (Fig. 68, 8).

The medulla oblongata, like the spinal cord, with which it is continuous, consists both of grey and white matter. But the exterior of the medulla is not so exclusively formed of white matter as is the outer part of the cord, for the divergence from each other of the restiform bodies and posterior pyramids of opposite sides opens out the central part of the medulla, and allows the grey matter to become superficial on the floor of the 4th ventricle. The nerve fibres which enter into the formation of the pyramids and the other tracts just described, are partly continuous below with the columns of the spinal cord, and are prolonged upwards either to the pons and cerebrum, or to the cerebellum, or they partly take their rise in the medulla oblongata itself from the cells of its grey matter. As the medulla is a bilateral organ, its two halves are united together by commissural fibres, which cross obliquely its mesial plane from one side to the other, and as they decussate in that plane, they form a well-marked mesial band or *raphé.* Further, the medulla is a centre of origin for several pairs of the more posterior encephalic nerves, and for the vaso-motor nerves. In the passage upwards through the medulla of the columns of the cord, a re-arrangement of their fibres takes place; just as in a great central railway station, the rails, which enter it in one direction, intersect and are rearranged before they emerge from it in the opposite direction. The fibres of the posterior median column of the cord are prolonged upwards as the posterior pyramid. The fibres of the posterior column of the cord are for the most part prolonged upwards into the restiform body, though some fibres pass to the front of the medulla to participate in the decussation of the anterior pyramids. The lateral column of the cord divides into three parts: *a,* the greater number of its fibres pass inwards across the anterior median fissure, to assist in forming the anterior pyramid of the opposite side, so as to produce the decussation already referred to; *b,* others join the restiform body; *c,* others form the fasciculus teres situated on the floor of the 4th ventricle. The anterior column of the cord also divides into three parts: *a,* some fibres form the arciform fibres and join the restiform body; *b,* others assist in the formation of the olivary fasciculus; *c,* others are prolonged upwards in the anterior pyramid of the same side (Fig. 67).

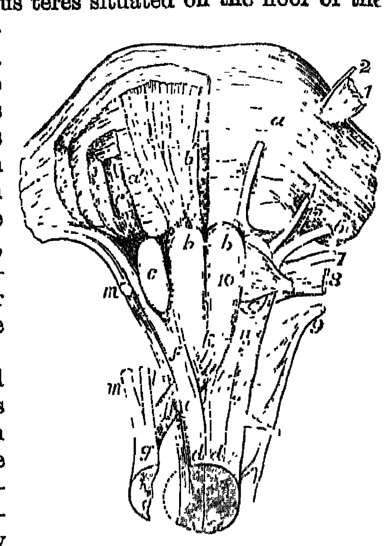
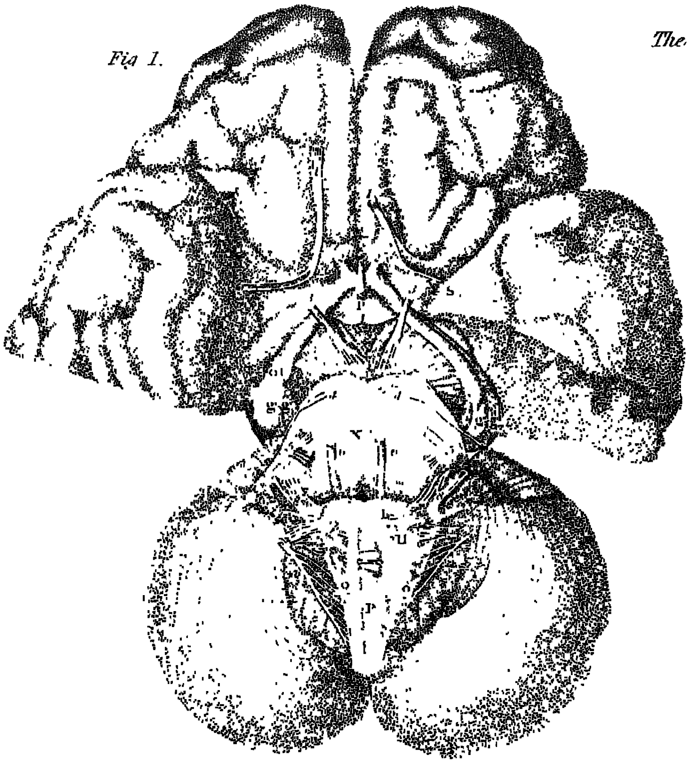


Fig. 67.—Diagrammatic dissection of the medulla oblongata and pons to show the course of the fibres. *a,* superficial, *a′,* deep transverse fibres of the pons; *b, b,* anterior pyramids ascending at *b′* through the pons; *c, c,* olivary bodies; *c′,* olivary fasciculus in the pons; *d, d,* anterior columns of cord; *e,* inner part of the right column joining the anterior pyramid; *f,* the outer part going to the olivary fasciculus; *g,* lateral column of cord; *h,* the part which decussates at *k,* the decussation of the pyramids; *l,* the part which joins the restiform body; *m,* that which forms the fasciculus teres; *n,* arciform fibres. 1 and 2, sensory and motor roots of fifth nerve; 3, sixth nerve; 4, portio dura; 5, portio intermedia; 6, portio mollis of seventh nerve; 7, glosso-pharyngeal; 8, pneumo-gastric; 9, spinal accessory of eighth nerve; 10, hypoglossal nerve.

The anterior pyramid consists partly of fibres of the anterior column of the cord of the same side, partly of decussating fibres of the anterior commissure, partly of decussating fibres from the posterior columns and posterior cornu of grey matter, but principally of the decussating fibres of the lateral column of the opposite side of the cord. The fibres of the anterior pyramid are prolonged through the pons to the cerebrum. Owing to the decussation of the lateral columns of the cord in the formation of the pyramids, the motor nerve fibres from one-half of the brain are transmitted to the opposite side of the cord, so that injuries affecting one side of the brain occasion paralysis of the motor nerves arising from the opposite half of the cord. The olivary fasciculus is formed partly of fibres of the anterior column of the same side, and partly of fibres arising from the grey matter of the olive. It is continued upwards through the pons to the cerebrum. The restiform body is formed principally of fibres of the posterior column of the same side, but partly of fibres of the lateral column, and also of the arciform fibres from the anterior column, and from the grey matter of the superior and inferior olives. As the restiform body is continued upwards to the cerebellum, and forms its inferior peduncles, the arciform fibres have been called by Solly the *superficial cerebellar fibres* of the medulla. Through the restiform body the cerebellum is connected with the posterior, lateral, and anterior columns of the cord as well as with the olivary nuclei in the grey matter of the medulla oblongata. The posterior pyramid consists of the posterior median column of the cord, and is prolonged through the pons to the cerebrum. The fasciculus teres is formed of a small part of the lateral column of the cord, and is also prolonged through the pons to the cerebrum.

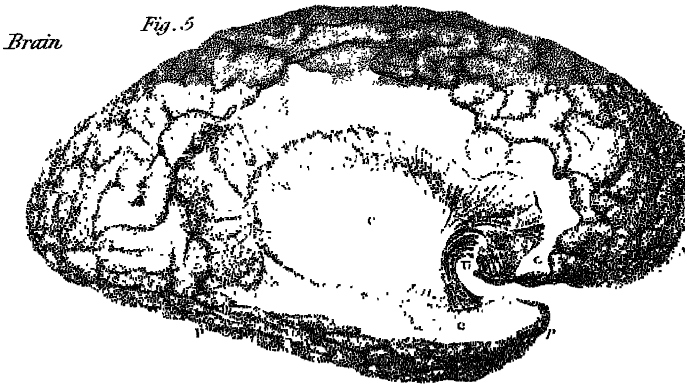
The Brain

Fig. 1.



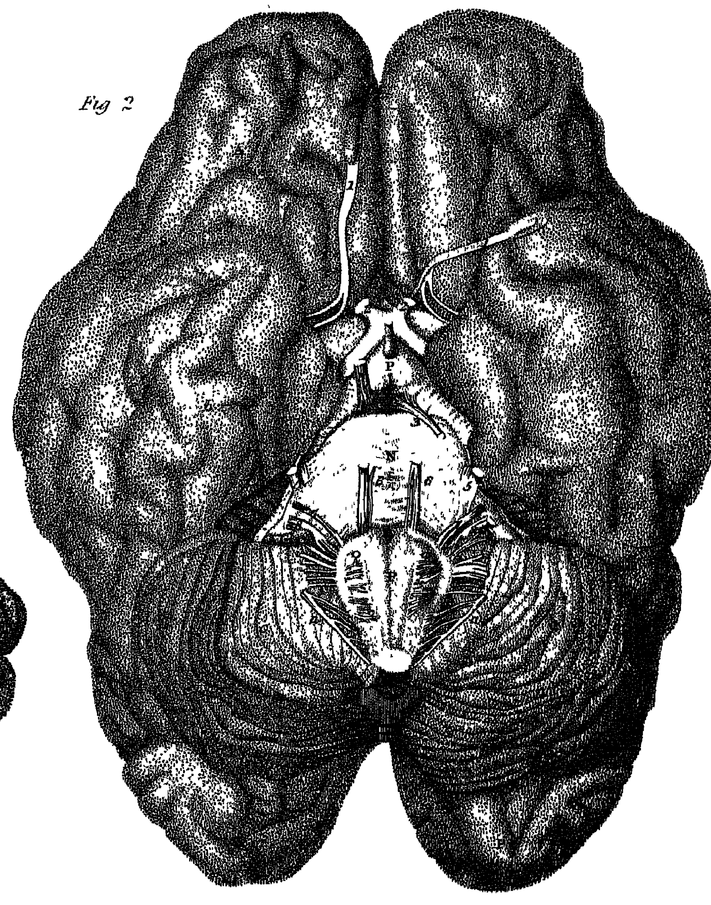
Origin of Cranial Nerves

Fig. 5



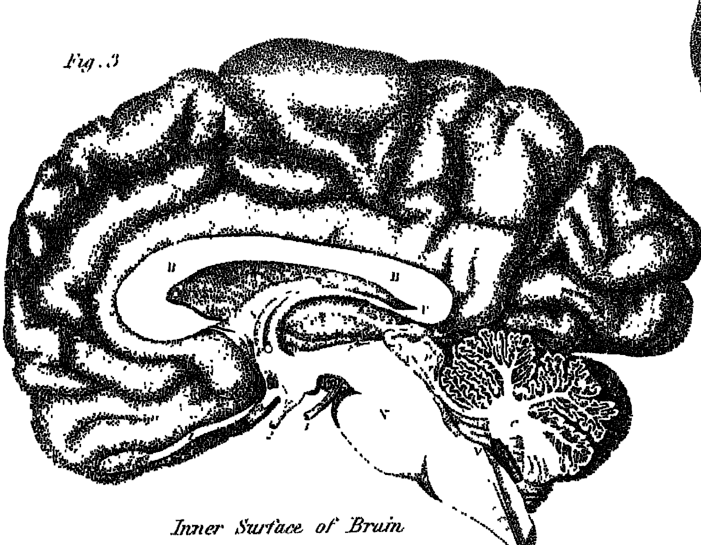
Fibres of Corona Radiata

Fig 2



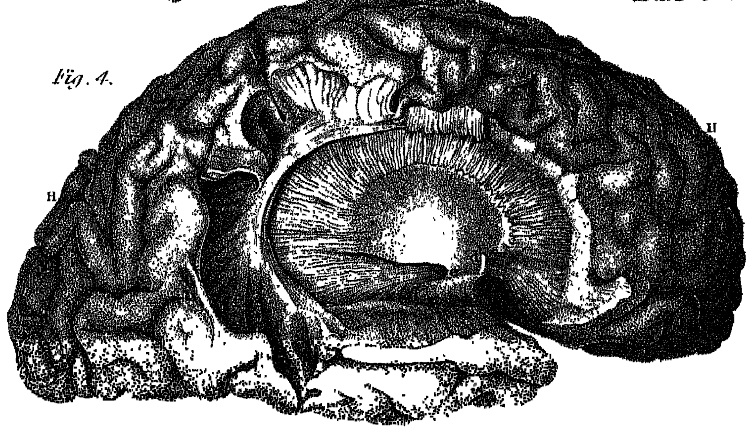
Base of Brain

Fig. 3



Inner Surface of Brain

Fig. 4.



Fibres of Corona Radiata

W & A K Johnston

The grey matter of the medulla oblongata, which contains numerous multipolar nerve cells, is in part continuous with the grey matter of the spinal cord, and in part consists of independent masses. As the grey matter of the cord enters the medulla it loses its crescentic arrangement. The posterior cornua are thrown outwards towards the surface, lose their pointed form, and dilate into rounded masses named the grey tubercles of Rolando, whilst portions are prolonged into both the posterior pyramid and the restiform body. The grey matter of the anterior cornua and of the intermedio-lateral tracts loses its continuity, and becomes subdivided into numerous small masses, owing to being traversed by bundles of nerve fibres, which give rise to a network termed *formatio reticularis*, in the meshes of which the groups of nerve cells are contained. In the lower part of the medulla a central canal continuous with that of the cord exists, but when the restiform bodies and posterior pyramids on the opposite sides of the medulla diverge from each other, the central canal loses its posterior boundary, and dilates into the cavity of the 4th ventricle. The grey matter in the interior of the medulla appears, therefore, on the floor of the ventricle; that which corresponds to the anterior cornua being situated immediately on each side of the median furrow, whilst that which is continuous with the grey tubercles of Rolando and the posterior cornua is some distance external to it. This grey matter forms collections of nerve cells, which are the centres of origin of several important encephalic nerves.

Of the independent masses of grey matter of the medulla, that which forms the *corpus dentatum* within the olivary body is the most important, and constitutes the nucleus of the inferior olive. It is folded on itself in a zig-zag or denticulated manner, and forms a sort of capsule open on the inner aspect, through which openings a bundle of nerve fibres from the interior of the capsule proceeds. These fibres aid in the formation of the olivary fasciculus, and as Deiters and Meynert have pointed out, in part arch across the mesial plane and join the restiform body on the opposite side, whilst some apparently join the posterior pyramid. The nerve cells of the olive are multipolar and flask-shaped, and in all probability give origin to the nerve fibres proceeding from the interior of the capsule. Separated from the inner part of the olive by a layer of reticular substance is a smaller grey mass, called by Stilling *nucleus olivaris accessorius*. Crossing the anterior surface of the medulla oblongata, immediately below the pons, in the majority of mammals is a transverse arrangement of fibres forming the *trapezium*, which contains a grey nucleus, named by Van der Kolk the *superior olive*. In the human brain the trapezium is concealed by the lower transverse fibres of the pons, but when sections are made through it, as L. Clarke pointed out, the grey matter of the superior olive can be seen. Meynert states that its nerve cells give origin to some fibres, which run straight backwards to the restiform body of the same side, and to others which pass across the mesial plane to the opposite corpus restiforme.

Pons Varolii.

The PONS VAROLII or BRIDGE (Pl. XVIII. figs. 1, 2, 3, N) is cuboidal in form: its anterior surface rests upon the dorsum sellæ of the sphenoid, and is marked by a median longitudinal groove; its inferior surface receives the pyramidal and olivary tracts of the medulla oblongata; at its superior surface are the two crura cerebri; each lateral surface is in relation to a hemisphere of the cerebellum, and a peduncle passes from the pons into the interior of each hemisphere; the posterior surface forms in part the upper portion of the floor of the 4th ventricle, and in part is in contact with the corpora quadrigemina.

The pons consists of white and grey matter: the nerve fibres of the white matter pass through the substance of the pons, either in a transverse or a longitudinal direction. The transverse fibres go from one hemisphere of the cerebellum to that of the opposite side; some are situated on the anterior surface of the pons, and form its superficial transverse fibres, whilst others pass through its substance and form the deep transverse fibres. The transverse fibres of the pons constitute, therefore, the commissural or connecting arrangement by which the two hemispheres of the cerebellum become anatomically continuous with each other. The longitudinal fibres of the pons ascend or pass vertically upwards from the medulla oblongata, and consist of the fibres of the anterior pyramids, olivary fasciculi, fasciculi teretes, and posterior pyramids. They leave the pons by emerging from its upper surface as fibres of the two crura cerebri. The pons possesses a median raphe continuous with that of the medulla oblongata, and formed like it by a decussation of fibres in the mesial plane.

The grey matter of the pons is scattered irregularly through its substance, and appears on its posterior surface; but not on the anterior surface, which is composed exclusively of the superficial transverse fibres. It is traversed both by the longitudinal and deep transverse fibres, which form a well-defined *formatio reticularis*. To a portion of grey matter, containing nerve cells charged with dark pigment, the name of *locus cæruleus* is applied. The locus lies on the floor of the 4th ventricle, close to the entrance to the aqueduct of Sylvius, and serves as the origin of the sensory root of the 5th, and perhaps of the posterior root of the 4th cranial nerve. The nerve cells of the pons are multipolar and stellate. The pons acts as a conductor of impressions through its nerve fibres, and as a centre of origin of nerve fibres from nerve cells. Meynert states that some of the fibres of the crura cerebri end in the nerve cells of the pons, which cells again give origin to fibres that pass outwards to the cerebellum.

The CEREBELLUM, LITTLE BRAIN, or AFTER BRAIN (Pl. XVIII. fig. 2, *c*), occupies the inferior pair of occipital fossæ, and, along with the pons and medulla oblongata, lies below the plane of the tentorium cerebelli. It consists of two hemispheres or lateral lobes, and of a median or central lobe, which in human anatomy is called the *vermiform process*. It is connected below with the medulla oblongata by the two restiform bodies which form its *inferior peduncles*, and above to the corpora quadrigemina of the cerebrum by two bands, which form its *superior peduncles;* whilst the two hemispheres are connected together by the transverse fibres of the pons, which form the *middle peduncles* of the cerebellum. On the superior or tentorial surface of the cerebellum the median or vermiform lobe is a mere elevation, but on its inferior or occipital surface this lobe forms a well-defined *inferior vermiform* process, which lies at the bottom of a deep fossa or *vallecula;* this fossa is prolonged to the posterior border of the cerebellum, and forms there a deep notch which separates the two hemispheres from each other; in this notch the falx cerebelli is lodged. Extending horizontally backwards from the middle cerebral peduncle, along the outer border of each hemisphere is the *great horizontal fissure*, which divides the hemisphere into its tentorial and occipital surfaces. Each of these surfaces is again subdivided by fissures into smaller lobes, of which the most important are the *amygdala* or *tonsil*, which forms the lateral boundary of the anterior part of the vallecula, and the *flocculus*, which is situated immediately behind the middle peduncle of the cerebellum. The inferior vermiform process is subdivided into a posterior part or *pyramid;* an elevation or *uvula*, situated between the two tonsils; and an anterior pointed process or *nodule*. Stretching between the two flocculi, and attached midway to the sides of the nodule, is a thin, white, semilunar-shaped plate of nervous matter, called the *posterior medullary velum*.

Cerebellum.

The whole outer surface of the cerebellum possesses a

characteristic foliated or laminated appearance, due to its subdivision into multitudes of thin plates or lamellæ by numerous fissures. The cerebellum consists both of grey and white matter. The grey matter forms the exterior or cortex of the lamellæ, and passes from one to the other across the bottoms of the several fissures. The white matter lies in the interior of the organ, and extends into the core of each lamella. When a vertical section is made through the organ, the prolongations of white matter branching off into the interior of the several lamellæ give to the section an arborescent appearance, known by the fanciful name of *arbor vitæ* (Pl. XVIII. fig. 3, *c*). Independent masses of grey matter are, however, found in the interior of the cerebellum. If the hemisphere be cut through a little to the outer side of the median lobe, a zig-zag arrangement of grey matter, similar in appearance and structure to the nucleus of the olivary body in the medulla oblongata, and known as the *corpus dentatum* of the cerebellum, is seen; it lies in the midst of the white core of the hemisphere, and encloses white fibres, which leave the interior of the corpus at its inner and lower side. Stilling has described, in connection with the anterior end of the inferior vermiform process, which projects forwards into the valve of Vieussens, and aids in the formation of the roof of the 4th ventricle, two grey masses, named *roof nuclei.* They possess flask-shaped nerve cells like those of the corpus dentatum. The white matter is more abundant in the hemispheres than in the median lobe, and is for the most part directly continuous with the fibres of the peduncles of the cerebellum. Thus the restiform or inferior peduncles pass from below upwards through the white core, to end in the grey matter of the tentorial surface of the cerebellum, more especially in that of the central lobe; on their way they are connected both with the grey matter of the corpus dentatum and of the roof nuclei. The superior peduncles, which descend from the corpora quadrigemina of the cerebrum, reach the grey cortical matter, more especially on the inferior surface of the cerebellum, though they also form connections with the corpus dentatum. The middle peduncles form a large proportion of the white core, and their fibres terminate in the grey matter of the foliated cortex of the hemispheres. But, in addition to these peduncular fibres, which connect the cerebellum to other subdivisions of the encephalon, its white matter contains fibres proper to the cerebellum itself. The *fibræ propriæ* have been especially described by Stilling; some, which he has termed the median fasciculi, lie near the mesial plane, and connect the grey matter on the tentorial aspect of the middle lobe with that of the inferior vermiform process, whilst others cross directly the mesial plane to unite opposite and symmetrical regions of the hemispheres. Further, the auditory nerve was said by Foville to derive some of its fibres of origin from the cerebellum; the connection of this nerve with the cerebellum has been strongly insisted on by Meynert, and this anatomist has also ascribed a cerebellar origin to a portion of the sensory root of the 5th cranial nerve.

The grey matter of the cortex is divided into two well-defined layers, an external grey, and an inner rust coloured layer of about equal thickness. The rust coloured layer is distinguished by containing multitudes of so-called "granules," the well-defined nucleus in which, as described by Strachan, is invested by a small quantity of branched protoplasm. These "granules" are, therefore, minute stellate cells. Where the rust coloured layer joins the grey layer the characteristic nerve cells of the cerebellum, named the *corpuscles of Purkinje*, are situated. A slender central process arising from each cell enters the rust coloured layer, and, as the observations of Hadlich and Koschennikoff show, becomes continuous with the axial cylinder of a medullated nerve fibre; for the nerve fibres of the white core enter this layer, divide into minute fibres, and ramify amidst the granules. From the opposite aspect of each cell two peripheral processes arise, and ramify in an antler-like manner in the external grey layer. Obersteiner and Hadlich maintain that the finer branches of these processes curve back towards the rust coloured layer, where, according to Boll, they form a network of extreme minuteness, from which it is believed that nerve fibres may arise. The substratum of the grey layer, in which the branched processes of the cells of Purkinje lie, consists of a very delicate neuroglia, in which scattered corpuscles are imbedded; but, in the outer part of this layer, delicate supporting connective tissue-like fibres are also met with.

Fourth Ventricle.

The *Fourth Ventricle* is the dilated upper end of the central canal of the medulla oblongata. Its shape is like an heraldic lozenge. Its floor is formed by the grey matter of

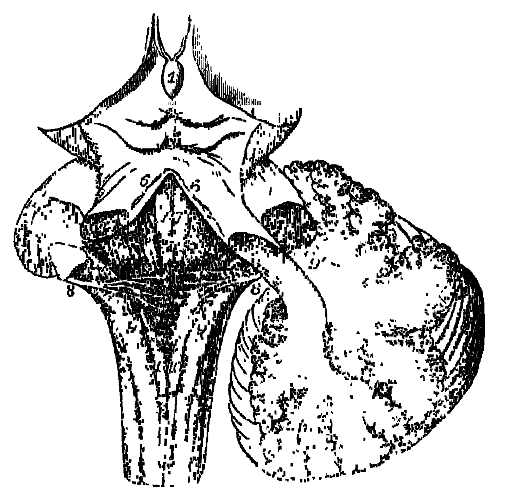


FIG. 68.—Floor of the fourth ventricle and adjacent structures. 1, pineal gland; 2, the nates, and 3, the testes of the corpora quadrigemina; 4, 4, middle peduncles, 5, 5, superior peduncles, 9, 9, inferior peduncles of the cerebellum; 6, 6, valve of Vieussens divided; 7, 7, fasciculi teretes; 8, 8, roots of the auditory nerves; 9′, corpus dentatum; 10, 10, posterior pyramids; 11, calamus scriptorius.

the posterior surfaces of the medulla oblongata and pons, its roof partly by the inferior vermiform process of the cerebellum, the *nodule* of which projects into its cavity, and partly by a thin layer, called *valve of Vieussens*, or *anterior medullary velum*; its lower lateral boundaries, by the divergent restiform bodies and posterior pyramids; its upper lateral boundaries, by the superior peduncles of the cerebellum; the reflection of the arachnoid membrane from the back of the medulla to the inferior vermiform process closes it in below, but allows of a communication between its cavity and the sub-arachnoid space; above, it communicates with the *aqueduct of Sylvius*, which is tunnelled through the substance of the corpora quadrigemina. Along the centre of the floor is the median furrow, which terminates below in a pen-shaped form, the so-called *calamus scriptorius* Situated on its floor are the fasciculi teretes, striæ acousticæ, and deposits of grey matter described in connection with the medulla oblongata. Its endothelial lining is continuous with that of the central canal.

The CEREBRUM or GREAT BRAIN lies above the plane of the tentorium, and forms much the largest division of the encephalon. It is customary in human anatomy to include under the name of cerebrum, not only the convolutions, the corpora striata, and the optic thalami, developed in the anterior cerebral vesicle, but also the corpora quadrigemina and crura cerebri developed in the middle cerebral vesicle. The cerebrum is ovoid in shape, and presents superiorly, anteriorly, and posteriorly a deep *median longitu-*

dinal fissure, which subdivides it into two hemispheres. Inferiorly there is a continuity of structure between the two hemispheres across the mesial plane, and if the two hemispheres be drawn asunder by opening out the longitudinal fissure, a broad white band, the *corpus callosum*, may be seen at the bottom of the fissure passing across the mesial plane from one hemisphere to the other. The outer surface of each hemisphere is convex, and adapted in shape to the concavity of the inner table of the cranial bones; its inner surface, which bounds the longitudinal fissure, is flat and is separated from the opposite hemisphere by the falx cerebri; its under surface, where it rests on the tentorium, is concave, and is separated by that membrane from the cerebellum and pons. From the front of the pons two strong white bands, the *crura cerebri* or *cerebral peduncles*, pass forwards and upwards to enter the optic thalami in their respective hemispheres. Winding round the outer side of each crus is a flat white band, the *optic tract*. These tracts converge in front, and join to form the *optic commissure*, from which the two *optic nerves* arise. The crura cerebri, optic tracts, and optic commissure enclose a lozenge-shaped space, which includes—*a*, a grey layer, called *pons Tarini*, which, from being perforated by several small arteries, is often called *locus perforatus posticus; b*, two white mammillæ, the *corpora albicantia*; *c*, a grey nodule, the *tuber cinereum*, from which, *d*, the *infundibulum* projects to join the *pituitary body*. Immediately in front of the optic commissure is a grey layer, the *lamina cinerea* or *lamina terminalis* of the 3d ventricle; and between the optic commissure and the inner end of each Sylvian fissure is a grey spot perforated by small arteries, the *locus perforatus anticus*.

The peripheral part of each hemisphere, which consists of grey matter, exhibits a characteristic folded appearance, known as the *convolutions* or *gyri* of the cerebrum. These convolutions are separated from each other by *fissures* or *sulci*, some of which are considered to subdivide the hemisphere into lobes, whilst others separate the convolutions in each lobe from each other. In each hemisphere of the human brain five lobes are recognised: the temporo-sphenoidal, frontal, parietal, occipital, and the central lobe or insula. Passing obliquely on the outer face of the hemisphere from before, upwards and backwards, is the well-marked *Sylvian fissure*, which is the first to appear in the development of the hemisphere. Below it lies the temporo-sphenoidal lobe, and above and in front of it, the parietal and frontal lobes. The frontal lobe is separated from the parietal by the *fissure of Rolando*, which extends on the outer face of the hemisphere from the longitudinal fissure obliquely downwards and forwards towards the Sylvian fissure. About two inches from the hinder end of the hemisphere is the *parieto-occipital fissure*, which, commencing at the longitudinal fissure, passes down the inner surface of the hemisphere, and transversely outwards for a short distance on the outer surface of the hemisphere; it separates the parietal and occipital lobes from each other.

The *Temporo-Sphenoidal Lobe* presents on the outer surface of the hemisphere three convolutions, arranged in parallel *tiers* from above downwards, and named *superior, middle, and inferior temporo-sphenoidal convolutions*. The fissure which separates the superior and middle of these convolutions is called the *parallel fissure*. The *Occipital Lobe* also consists from above downwards of three parallel convolutions, named *superior, middle, and inferior occipital*. The *Frontal Lobe* is more complex; immediately in front of the fissure of Rolando, and forming indeed its anterior boundary, is a convolution named *ascending frontal*, which ascends obliquely backwards and upwards from the Sylvian to the longitudinal fissure. Springing from the front of this convolution, and passing forwards to the anterior end of the cerebrum, are three convolutions, arranged in parallel *tiers* from above downwards, and named *superior, middle, and inferior frontal convolutions*, which are also prolonged on to the orbital face of the frontal lobe. The *Parietal Lobe* is also complex; its most anterior convolution, named *ascending parietal*, ascends parallel to and immediately behind the fissure of Rolando. Springing from the upper end of the back of this convolution is the *postero-parietal convolution*, which, forming the boundary of the longitudinal fissure, extends as far back as the parieto-occipital fissure; springing from the lower end of the back of this convolution is the *supra-marginal convolution*, which forms the upper boundary of the hinder part of the Sylvian

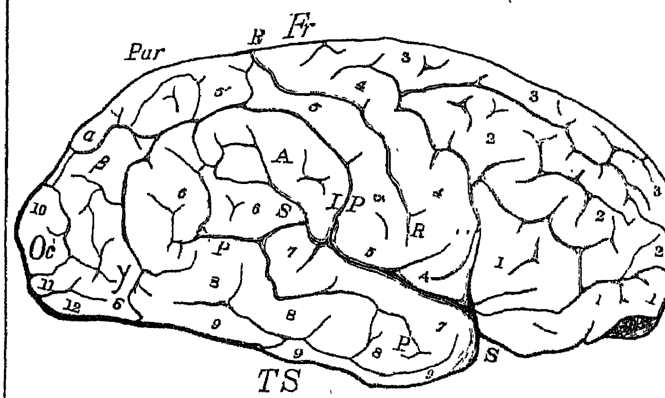


Fig. 69.

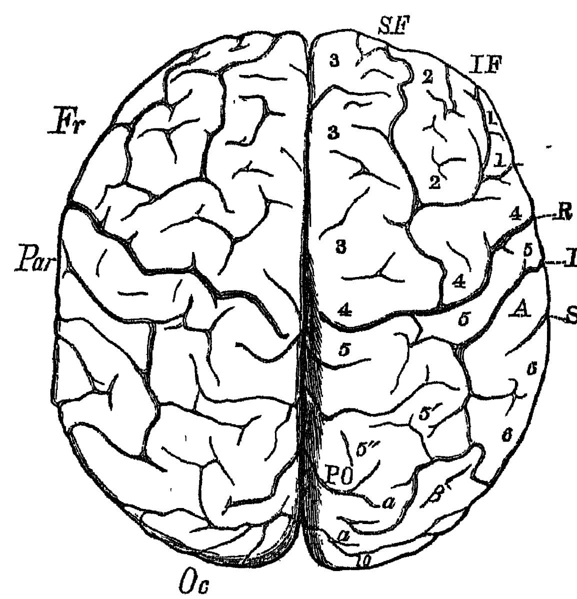


Fig. 70.

FIGS. 69 and 70.—Profile and vertex views of cerebrum. *Fr*, the frontal lobe; *Par*. parietal; *Oc*, occipital; *Ts*, temporo-sphenoidal lobe; *SS*, Sylvian fissure RR, fissure of Rolando; PO, parieto-occipital fissure; IP, intra-parietal fissure PP, Parallel fissure; SF and IF, supero- and infero-frontal fissures; 1, 1, 1 inferior, 2, 2, 2, middle, and 3, 3, 3, superior frontal convolutions; 4, 4, ascending frontal convolution; 5, 5, 5, ascending parietal, 5′, postero-parietal, and 6, 6, angular convolutions; A, supra-marginal, or convolution of the parietal eminence; 7, 7, superior, 8, 8, 8, middle, and 9, 9, 9, inferior temporo-sphenoidal convolutions; 10, superior. 11, middle, and 12, inferior occipital convolutions; *α, β, γ, δ*, four annectent convolutions.

fissure; as this gyrus occupies the hollow in the parietal bone, which corresponds to the eminence, it may appropriately be named the *convolution* of the *parietal eminence*. Continuous with the convolution of the parietal eminence is the *angular convolution*, which bends round the posterior extremity of the Sylvian fissure. Lying in the parietal lobe is the *intra-parietal fissure*, which separates the convolution of the parietal eminence from the postero-parietal con-

volution. The occipital is connected with the parietal lobe by two *annectent* or *bridging* gyri, which bridge across the transverse external part of the parieto-occipital fissure; the

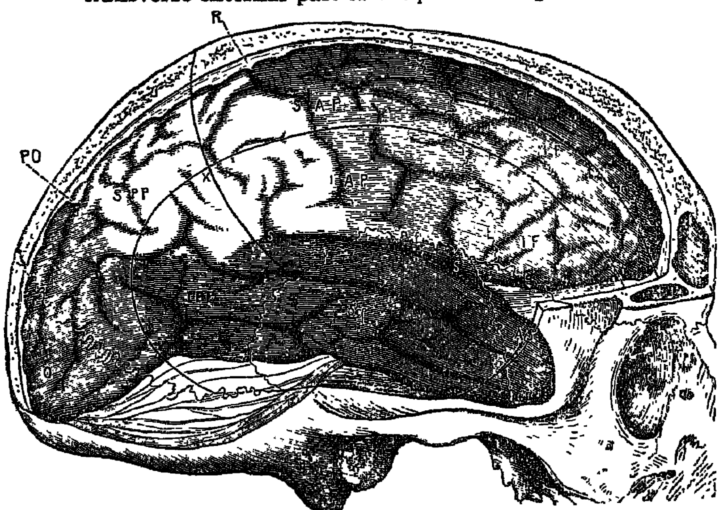


Fig. 71.—Side view of the Brain in the skull.[1]

depth and extent of this fissure vary in different brains in proportion to the size of these bridging convolutions. The *superior annectent gyrus* passes between the postero-parietal and the superior occipital convolutions, whilst the *second annectent gyrus* connects the middle occipital with the angular gyrus. Two annectent gyri also pass from the inferior occipital convolution to the lower convolutions of the temporo-sphenoidal lobe. These lobes of the cerebrum, though named after the bones which form the vault of the skull, are not exactly co-terminous with them. The frontal lobe not only lies under cover of the frontal bone, but extends backwards under the anterior part of the parietal; for the fissure of Rolando, which forms its posterior boundary, lies from $1\frac{1}{2}$ to 2 inches behind the coronal suture. The occipital lobe is not limited to the upper tabular part of the occipital bone, but extends forwards under cover of the posterior part of the parietal, for the parieto-occipital fissure lies about $\frac{3}{4}$ inch in front of the apex of the lambdoidal fissure. The temporo-sphenoidal lobe not only lies under the squamous-temporal and great wing of the sphenoid, but passes upwards under cover of the lower part of the parietal, for the Sylvian fissure passes from below obliquely upwards and backwards across the line of the squamous suture near its middle. The area covered by the parietal bone so far, then, from being co-terminous with the parietal lobe of the cerebrum, is trenched on anteriorly by the frontal, posteriorly by the occipital, and inferiorly by the temporo-sphenoidal lobe. The convolutions of the parietal lobe itself are grouped around the parietal eminence, and in the interval between it and the sagittal suture. The inner table of the cranial bones is an almost exact mould of the convolutions of these lobes; but this is not so with the exterior of the skull, the configuration of which is modified by the formation of ridges and processes for the attachment of muscles, by variations in the thickness of the diploë, and by the development of the frontal and mastoid air-sinuses. Hence the outer surface of the skull does not correspond in shape to the outside of the brain.

The *Central Lobe* of the hemisphere, more usually called the *insula* or *island of Reil*, does not come to the surface of the hemisphere, but lies deeply within the Sylvian fissure, the convolutions forming the margin of which conceal it. It consists of four or five short convolutions, which radiate from the *locus perforatus anticus*, situated at the inner end of the fissure. This lobe is almost entirely surrounded by a deep sulcus, which insulates it from the adjacent convolutions. It lies opposite the upper part of the ali-sphenoid, where it articulates with the parietal and squamous-temporal.

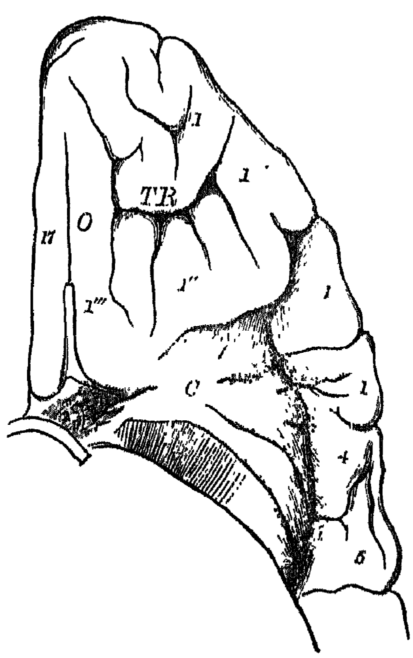


Fig. 72.—Orbital surface of the left frontal lobe and the island of Reil; the tip of the temporo-sphenoidal lobe has been removed to display the latter. 17, convolution of the margin of the longitudinal fissure; O, olfactory fissure, over which the olfactory peduncle and lobe are situated; TR, tri-radiate fissure; 1″ 1‴, convolutions on the orbital surface; 1, 1, 1, 1, under surface of infero-frontal convolution; 4, under surface of ascending frontal, and 5, of ascending parietal convolutions; C, central lobe or insula.

Convolutions also exist on the inner surface of the hemisphere, and on the under surface which rests on the tentorium, but these have no relation to the bones of the cranial vault. They may be studied in connection with the corpus callosum or great transverse commissure, which connects the two hemispheres, and with certain fissures situated on these surfaces of the hemisphere. The small convolutions which lie behind the internal part of the parieto-occipital fissure form the inner convolutions of the occipital lobe, or the *occipital lobule* (Fig. 73). Those which lie immediately in front of the same fissure belong to the inner face of the parietal lobe, and form the *quadrilateral lobule*. It is customary, however, to name the convolution which extends forwards from that fissure along the margin of the longitudinal fissure to the anterior end of the hemisphere, and which then turns back to the locus perforatus anticus as the *marginal convolution*. This is separated by a fissure called *calloso-marginal*, from the *callosal convolution* or *gyrus fornicatus*, which, commencing at the locus perforatus anticus, turns round the anterior end of the corpus callosum, extends parallel to its upper surface, and then turns round its posterior end. It is separated from the corpus callosum by the *callosal fissure*, at the bottom of which the grey matter of the gyrus fornicatus terminates in a well-defined edge

[1] The above view of the brain *in situ* shows the relations of the surface convolutions to the regions of the skull. R, fissure of Rolando, which separates the frontal from the parietal lobe. PO, parieto-occipital fissure between the parietal and occipital lobes. SS, fissure of Sylvius, which separates the temporo-sphenoidal from the frontal and parietal lobes. SF, MF, IF, the supero-, mid-, and infero-frontal subdivisions of the frontal area of the skull; the letters are placed on the superior, middle, and inferior frontal convolutions; the inferior frontal region is separated from the middle frontal by the frontal part of the curved line of the temporal ridge; the mid- from the supero-frontal by an antero-posterior line through the frontal eminence. SAP, the supero-antero-parietal area of the skull; S is placed on the ascending parietal convolution, AP on the ascending frontal convolution. IAP, the infero-antero-parietal area of the skull; I is placed on the ascending parietal, AP on the ascending frontal convolution. SPP, the supero-postero-parietal area of the skull; the letters are placed on the angular convolution. IPP, the infero-postero-parietal area of the skull; the letters are placed on the mid-temporo-sphenoidal convolution; the temporal ridge separates the supero- and infero-parietal regions from each other; a vertical line drawn through the parietal eminence separates the antero- and postero-parietal regions. X, the convolution of the parietal eminence, or supra-marginal gyrus. O, the occipital area of the skull; the letter is placed on the mid-occipital convolution. Sq, the squamoso-temporal region of the skull; the letters are placed on the mid-temporo-sphenoidal convolution. AS, the ali-sphenoid region of the skull; the letters are placed on the tip of the supero-temporo-sphenoidal convolution. The black lines mark the boundaries of different cranial regions.

The callosal convolution encloses the corpus callosum within the concavity of its arch, and from its direction is

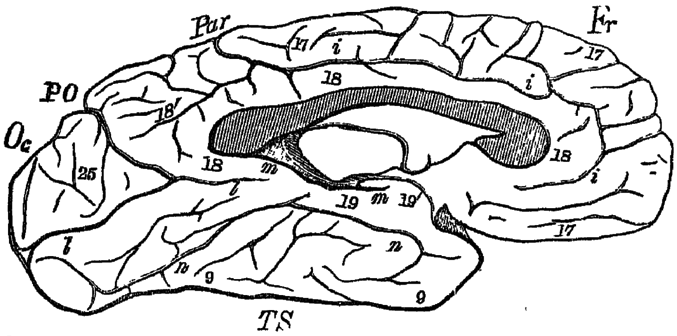


FIG. 73.—Convolutions of the inner and tentorial surfaces of the left hemisphere. *i*, *i*, *i*, calloso-marginal fissure; *l*, *l*, calcarine fissure; *m*, *m*, hippocampal fissure; *n*, *n*, collateral fissure; PO, parieto-occipital fissure; 17, 17, marginal convolution; 18, 18, gyrus fornicatus; 18′, quadrilateral lobule; 19, hippocampal gyrus; 19′, its recurved end; 25, occipital lobule; 9, 9, inferior temporo-sphenoidal convolution.

appropriately called *fornicatus* (arch-shaped). The posterior end of the callosal convolution curves downwards and then forwards, under the name of *gyrus hippocampi*, to the tip of the inner surface of the temporo-sphenoidal lobe. This gyrus is separated anteriorly by a narrow curved fissure called *hippocampal fissure*, from a white band, the *tænia hippocampi*, which band possesses a free curved border, round which the pia mater and choroidal artery enter the lateral ventricle through the great transverse fissure of the cerebrum. The hippocampal fissure is continuous round the posterior end of the corpus callosum with the callosal fissure, and at the bottom of the hippocampal fissure the grey matter of the gyrus hippocampi terminates in a well-defined dentated border (*fascia dentata*). The hippocampal fissure on this surface of the hemisphere marks the position of an eminence in the descending cornu of the ventricle called *hippocampus major*. The gyrus hippocampi is separated posteriorly from the adjacent temporo-sphenoidal convolution by a fissure, named *collateral*, which marks the position on this surface of the hemisphere of the *collateral eminence* in the interior of the ventricle. From the lower end of the parieto-occipital fissure an offshoot, called the *calcarine fissure*, passes almost horizontally backwards in the occipital lobe, which fissure marks on this surface of the hemisphere the eminence named *calcar avis*, or *hippocampus minor*, in the posterior cornu of the ventricle.

If a horizontal slice be removed from the upper part of each hemisphere, the peripheral grey matter of the convolutions will be seen to follow their various windings, whilst the core of each convolution consists of white matter continuous with a mass of white matter in the interior of the hemisphere. If a deeper slice be now made down to the plane of the corpus callosum, the white matter of that structure will be seen to be continuous with the white centre of each hemisphere. The *corpus callosum* does not equal the hemispheres in length, but approaches nearer to their anterior than their posterior ends (Pl. XVIII. fig. 3, B.) It terminates behind in a free rounded end, whilst in front it forms a knee-shaped bend, and passes downwards and backwards as far as the lamina cinerea. If the dissection be performed on a brain which has been hardened in spirit, the corpus callosum is seen to consist almost entirely of bundles of nerve fibres, passing transversely across the mesial plane between the two hemispheres; these fibres may be traced into the white cores and grey matter of the convolutions, and apparently connect the corresponding convolutions in the opposite hemispheres. Hence the corpus callosum is a connecting or commissural structure, which brings the convolutions of the two hemispheres into anatomical and physiological relation with each other. On the surface of the corpus callosum a few fibres, the *striæ longitudinales*, run in the antero-posterior or longitudinal

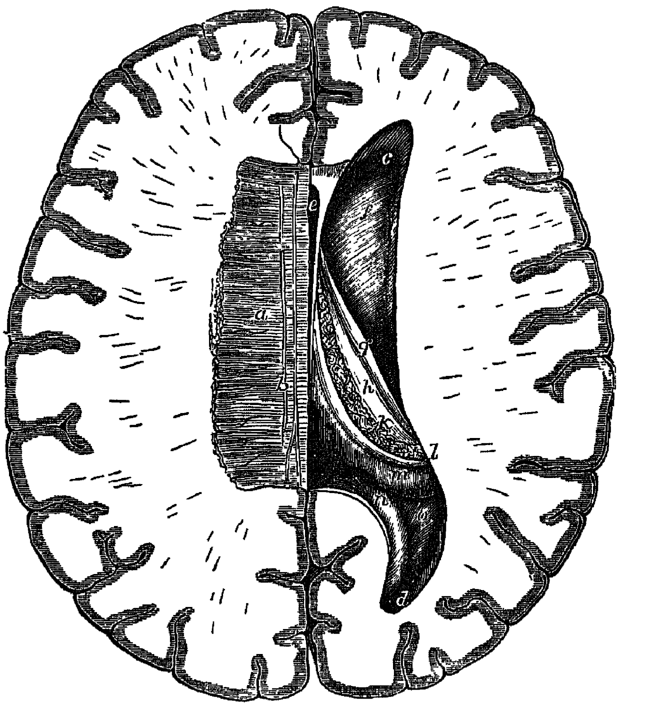


FIG. 74.—To show the right ventricle and the left half of the corpus callosum. *a*, transverse fibres, and *b*, longitudinal fibres of corpus callosum; *c*, anterior, and *d*, posterior cornua of lateral ventricle; *e*, septum lucidum; *f*, corpus striatum; *g*, tænia semicircularis; *h*, optic thalamus; *k*, choroid plexus; *l*, tænia hippocampi; *m*, hippocampus major; *n*, hippocampus minor; *o*, eminentia collateralis.

direction. If the corpus callosum be now cut through on each side of its mesial line, the large cavity or *lateral ventricle* in each hemisphere will be opened into.

The lateral ventricle is subdivided into a *central space* or body, and three bent prolongations or *cornua;* the *anterior cornu* extends forwards and outwards into the frontal lobe; the *posterior cornu* curves backwards, outwards, and inwards into the occipital lobe; the *descending cornu* curves backwards, outwards, downwards, forwards, and inwards, behind and below the optic thalamus into the temporo-sphenoidal lobe. On the floor of the central space may be seen from before backwards the grey upper surface of the pear-shaped *corpus striatum,* and to its inner and posterior part a small portion of the *optic thalamus*, whilst between the two is the curved flat band, the *tænia semicircularis.* Resting on the upper surface of the thalamus is the vascular fringe of the velum interpositum, named *choroid plexus,* and immediately internal to this fringe is the free edge of the white *posterior pillar of the fornix.* The anterior cornu has the anterior end of the corpus striatum projecting into it. The posterior cornu has an elevation on its floor, the *hippocampus minor*, and between this cornu and the descending cornu is the elevation called *eminentia collateralis.*

Extending down the descending cornu and following its curvature is the *hippocampus major*, which terminates below in a nodular end, the *pes hippocampi ;* on its inner border is the white *tænia hippocampi,* continuous above with the posterior pillar of the fornix. If the tænia be drawn on one side the hippocampal fissure is exposed, at the bottom of which the grey matter of the gyrus hippocampi may be seen to form a well-defined dentated border (the so-called *fascia dentata*). The choroid plexus of the pia mater turns round the gyrus hippocampi, and enters the descending cornu through the great transverse fissure between the tænia hippocampi and optic thalamus. The lateral ventricle is lined by a cylindrical endothelium.

which is in many parts ciliated, and which rests on a layer of neuroglia. This lining is continuous through the foramen of Monro with that of the third ventricle, which again is continuous with the lining of the fourth ventricle through the aqueduct of Sylvius. A little fluid is contained in the cerebral ventricles, which, under some pathological conditions, may increase greatly in quantity, so as to occasion considerable dilatation of the ventricular cavities.

If the corpus callosum be now divided about its middle

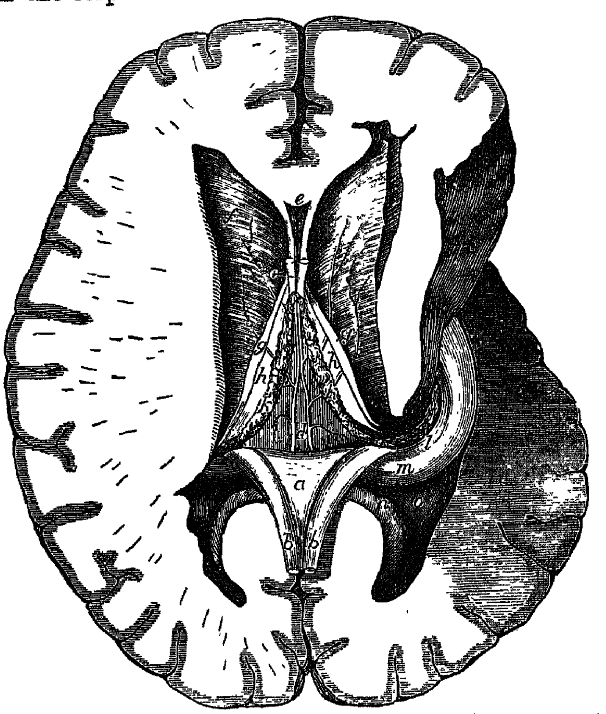


FIG. 75.—A deeper dissection of the lateral ventricle, and of the velum interpositum. *a*, under surface of corpus callosum, turned back; *b*, *b*, posterior pillars of the fornix, turned back; *c*, *c*, anterior pillars of the fornix; *d*, velum interpositum and veins of Galen; *e*, fifth ventricle; *f*, *f*, corpus striatum; *g*, *g*, tænia semicircularis; *h*, *h*, optic thalamus; *k*, choroid plexus; *l*, tænia hippocampi; *m*, hippocampus major in descending cornu; *n*, hippocampus minor; *o*, eminentia collateralis.

by a transverse incision, and the posterior half of this structure be turned back, the body of the fornix on which the corpus callosum rests is exposed. If the anterior half of the corpus callosum be now turned forward, the grey partition, or *septum lucidum*, between the two lateral ventricles is exposed. This septum fits into the interval between the under surface of the corpus callosum and the upper surface of the anterior part of the fornix. It consists of two layers of grey matter, between which is a narrow vertical mesial space, the *fifth ventricle*. If the septum be now removed, the anterior part of the fornix is brought into view.

The *fornix* or arch is an arch-shaped band of nerve fibres extending in the antero-posterior direction. Its anterior end forms the *anterior piers* or pillars of the arch, its posterior end the *posterior piers* or *pillars*, whilst the intermediate *body* of the fornix forms the summit or crown of the arch. It consists of two lateral halves, one belonging to each hemisphere. At the summit of the arch the two lateral halves are conjoined to form the *body;* but in front of the body the two halves separate from each other, and form two anterior pillars, which descend in front of the third ventricle to the base of the cerebrum, where they form the *corpora albicantia*, and then enter the substance of the optic thalamus. Behind the body the two halves diverge much more from each other, and form the posterior pillars; each of which curves downwards and outwards into the descending cornu of the ventricle, and, under the name of *tænia hippocampi*, forms the free border of the hippocampus major. If the body of the fornix be now divided by a transverse incision, its anterior part thrown forwards, and its posterior part backwards, the great transverse fissure of the cerebrum is opened into, and the velum interpositum lying in that fissure is exposed.

The *velum interpositum* is an expanded fold of pia mater, which passes into the interior of the hemispheres through the great transverse fissure. It is triangular in shape; its base is in a line with the posterior end of the corpus callosum, where it is continuous with the external pia mater; its lateral margins are fringed by the choroid plexuses, which are seen in the bodies and descending cornua of the lateral ventricles, where they are invested by the endothelial lining of those cavities. Its apex, where the two choroid plexuses blend with each other, lies just behind the anterior pillars of the fornix. The interval between the apex and these pillars is the aperture of communication between the two lateral ventricles and the third, already referred to as the foramen of Monro. The choroid plexuses contain the small *choroidal arteries*, which supply the corpora striata, optic thalami, and corpora quadrigemina; and the blood from these bodies is returned by small veins, which join to form the *veins of Galen* (Fig. 75). These veins pass along the centre of the velum, and, as is shown in Fig. 63, open into the straight sinus. If the velum interpositum be now carefully raised from before backwards, the optic thalami, third ventricle, pineal gland, and corpora quadrigemina are exposed.

The *optic thalamus* is a large, somewhat ovoid body situated behind the corpus striatum, and above the crus cerebri. Its upper surface is partly seen in the floor of the body of the lateral ventricle, but is for the most part covered by the fornix and velum interpositum. Its postero-inferior surface forms the roof of the descending cornu of the ventricle, whilst its inner surface forms the side wall of the third ventricle. At its outer and posterior part are two slight elevations, placed one on each side of the optic tract, and named respectively *corpus geniculatum internum* and *externum*.

The *third ventricle* is a cavity situated in the mesial plane between the two optic thalami. Its roof is formed by the velum interpositum and body of fornix; its floor, by the pons Tarini, corpora albicantia, tuber cinereum, infundibulum, and optic commissure; its anterior boundary, by the anterior pillars of the fornix, anterior commissure, and lamina cinerea; its posterior boundary, by the corpora quadrigemina and posterior commissure. The cavity of this ventricle is of small size in the living head, for the inner surfaces of the two thalami are connected together by intermediate grey matter, named the *middle* or *soft commissure;* but in taking the brain out of the cranial cavity this commissure is usually more or less torn through, and the cavity is consequently enlarged. Immediately in front of the corpora quadrigemina, the white fibres of the *posterior commissure* pass across between the two optic thalami. If the anterior pillars of the fornix be separated from each other, the white fibres of the *anterior commissure* may be seen entering the two corpora striata.

The *pineal body* is a reddish cone-shaped body, enveloped by the velum interpositum, and situated upon the more anterior pair of the corpora quadrigemina. From its broad anterior end two white bands, the *peduncles of the pineal body*, pass forwards, one on the inner side of each optic thalamus. Each peduncle joins, along with the tænia semicircularis, the anterior pillar of the fornix of its own side. In its structure this body consists of a vascular stroma of connective tissue, in the meshes of which lymphoid cells are contained. Branched corpuscles are also found not unlike nerve cells. Amylaceous and gritty

calcareous particles, constituting the *brain sand*, are also found in it. Usually it is hollowed out into two or more small cavities. The function of the pineal body is not understood, but both it and the pituitary body, which possess a certain structural correspondence, are usually referred to the type of the ductless glands.

The *corpora quadrigemina* or *optic lobes* are situated behind and between the two optic thalami, and rest upon the posterior surface of the crura cerebri. The division into two lateral halves is marked by a shallow longitudinal fissure, and the subdivision of each half into an anterior and a posterior eminence, by a shallow transverse fissure. The anterior pair of eminences are called *nates;* the posterior, *testes.* From each testis a strong white band, the *superior peduncle of the cerebellum,* passes backwards to the cerebellum, and stretching between the pair of peduncles is the *valve of Vieussens* or *anterior medullary velum.* The corpora quadrigemina are tunnelled in the antero-posterior direction by the *aqueduct of Sylvius,* which opens anteriorly into the third ventricle immediately below the posterior commissure, and posteriorly into the fourth ventricle under cover of the valve of Vieussens. It is lined by a cylindrical ciliated endothelium.

INTERNAL STRUCTURE OF THE CEREBRUM.—The cerebrum is composed both of grey and white matter, the general relations of these two forms of nerve matter to each other may be seen by making sections through the cerebrum. The determination, however, of their minute structure, and of the relations and connections of the nerve fibres to the nerve cells is, owing to the delicacy of the organ, one of the most difficult departments of anatomical study. Several anatomists have endeavoured to trace out the course of the nerve fibres in the organ, and though our knowledge is by no means complete, yet many important facts have undoubtedly been ascertained. These facts have been summarised, and numerous valuable additions made to them by Meynert in a recent elaborate memoir, which has been frequently consulted and made use of in writing the following description.

The *Grey Matter* of the cerebrum is disposed in three great groups: *a,* The grey matter of the cortex of the hemispheres; *b,* the grey matter of the great ganglia of the base of the cerebrum; *c,* the central grey matter which forms the wall of the cerebral end of the cerebro-spinal tube.

a, The grey matter of the cortex of the hemisphere forms the superficial part of the convolutions, and is known as the great hemispherical ganglion, but in some localities, as at the loci perforati antici and the septum lucidum, it has received distinctive names. When a convolution is divided vertically the grey matter is seen to be confined to the surface and to enclose a white core. The grey matter presents a laminated appearance, and as a rule consists of five or six layers, which are composed of the characteristic pyramidal nerve cells of the cortex of the cerebrum, of nerve fibres, of matrix or neuroglia, and of blood-vessels. The most superficial layer consists of neuroglia, in which nerve fibres extend parallel to the surface of the convolutions. In the deeper layers are found the pyramidal nerve cells, which lie with their long axes vertical to the surface of the convolutions, and which contain angular nuclei. From the observations of Lockhart Clarke, Arndt, Cleland, and Meynert, there can be no doubt that the pyramidal nerve cells vary in relative size and in numbers in the different layers of the grey cortex, and that the largest sized pyramidal cells lie in the third and fourth layers. L. Clarke stated that the cells of all the layers of the posterior or occipital lobe were small and of nearly uniform size, whilst in the convolutions anterior to it numerous cells of a much larger kind were found; but though it is undoubtedly true that large pyramidal cells are found in the frontal lobe in considerable numbers, and that the greater number of the cells of the occipital lobe are small and nearly uniform in size, there is no difficulty in recognising in the occipital lobe a small proportion of cells, quite equal in magnitude to the largest cells of the frontal lobe, interspersed amongst the smaller pyramidal cells. The nerve fibres which ascend into the grey matter from the white core of the convolution radiate into its several layers, and are apparently continuous with the basal axis-cylinder processes of the nerve cells. According to Cleland, the elongated apices of the cells, which are directed to the surface of the convolution, are continuous with the nerve fibres situated in the superficial layer of horizontal fibres. Immediately subjacent to the large pyramidal cells numerous small, irregularly shaped nerve corpuscles, like those of the internal granule layer of the retina, form the so-called *granule layer* of the grey matter. Fusiform cells, which give off lateral processes, are found in the deepest layer of the grey matter, and form the *claustral layer* of Meynert. Gerlach has described here, as in the spinal cord, a network of extremely minute nerve fibres, with which the branched lateral processes of the nerve cells are apparently continuous. The neuroglia contains multitudes of small rounded corpuscles. In it also are found small stellate cells, provided with minute branched processes, which cells, as Meynert states, are so pellucid, that in the healthy brain they seem to be only free nuclei; it is difficult to say whether these cells belong to the neuroglia, or are nerve cell elements. The grey cortex of the cerebrum is much more vascular than the white matter. The arteries derived from the pia mater pass vertically into it, and end in a close polygonal network of capillaries; but it is also traversed by the arteries, which terminate in the capillary network of supply for the white matter.

Grey matter.

In the grey matter of the cortex of the occipital lobe eight layers have been described by Clarke and Meynert. The increase in number is due to the intercalation of two additional granule layers, which coalesce and form a distinct white band in the grey matter, owing, as Meynert states, to the absence of pigment in the cells of the granule layers.

The grey matter of the cortex of the island of Reil and of the convolutions bounding the Sylvian fissure contains a very large proportion of fusiform cells. They form the chief constituent of the grey *claustrum,* situated deeper than the grey matter of the island, and separated from the outer part of the corpus striatum by a thin layer of white matter. Fusiform cells also occur abundantly in the *nucleus amygdalæ,* a grey mass situated below the corpus striatum, which in some sections seems as if isolated, but in reality is continuous with the grey matter of the inferior temporo-sphenoidal convolution.

The grey matter of the cortex of the gyrus hippocampi and of the hippocampus major is apparently destitute of both the granule and claustral layers of cells. Its superficial layer has been named the *nuclear lamina,* and contains small and scattered nerve corpuscles. Next this lamina lies the *striatum reticulare,* in which the apices of the numerous pyramidal cells of the third layer branch and again unite to form a delicate network. Deeper than the pyramidal cells is a thick layer of so-called "granules," which A. B. Stirling recognised some years ago as like the granules of the rust coloured layer of the cerebellum; like them they consist of a well-defined nucleus invested by delicate branched protoplasm. The grey matter of the two layers of the septum lucidum, though included between the corpus callosum and fornix, is yet in the same plane as the grey matter of the cortex of the inner surface of the hemispheres, but is cut off from it by the development of the transverse fibres of the corpus callosum. The grey matter of the locus perforatus anticus contains

clusters of minute granules and a compact arrangement of small nerve cells.

b, The great ganglia of the base of the cerebrum are the corpora striata, the optic thalami, the corpora geniculata, the corpora quadrigemina, and the locus niger in each crus cerebri.

The corpus striatum cerebri consists of two masses of grey matter separated from each other by numerous striæ of white fibres, which ascend from below upwards through its substance. The upper mass of grey matter projects into the lateral ventricle, and is called the intra-ventricular portion or *nucleus caudatus*. The lower extra-ventricular portion or *nucleus lenticularis* forms the outer and lower part of the corpus striatum, and is separated by the claustrum from the island of Reil. Multipolar nerve cells are found in both the caudate and lenticular masses, and in the latter cells of large size have been seen. The optic thalamus forms an almost continuous mass of grey matter traversed by nerve fibres, which are not, however, collected into definite striæ. The nerve cells in the grey matter are both multipolar and fusiform. The external corpus geniculatum consists of alternate layers of grey and white matter, due to the zig-zag folding of the grey matter; the nerve cells are multipolar, and contain pigment. In the internal corpus geniculatum the cells are smaller in size and fusiform. The grey matter of the corpora quadrigemina consists of two distinct masses. One, the *zonular layer*, lies near the surface, and contains small multipolar nerve cells; the other, the *Sylvian* or *central layer*, lies at the sides of the Sylvian fissure and belongs to the grey matter of the wall of the cerebro-spinal tube, and serves as a centre of origin for the roots of both the 3d and 4th cranial nerves. The grey matter of the crus cerebri occupies the centre of the cerebral peduncle. Its cells are multipolar, and contain dark brown or black pigment, so that the name *locus niger* is applied to this collection of nerve cells.

c, The central grey matter of the cerebrum is in series with the grey matter of the floor of the 4th ventricle and the grey matter of the spinal cord. It is situated around the Sylvian aqueduct, and at the sides and floor of the third ventricle, which form the cerebral portion of the cerebro-spinal tube. That which is situated in relation with the aqueduct of Sylvius forms the *Sylvian* or *central layer* just described in the corpora quadrigemina. That which lies in relation to the third ventricle forms the middle or soft commissure, and the well-defined grey layer which covers the inner wall of each optic thalamus; also the grey masses situated at the base of the brain between and in front of the crura cerebri, viz., the pons Tarini, tuber cinereum, lamina cinerea, infundibulum, and the grey matter of the pituitary body. By some anatomists the grey matter of the pineal body is referred to the same category, but Arnold has pointed out that it is separated by its peduncle from the soft commissure; and Meynert is disposed to regard it as a ganglion of origin of the tegmentum. Both the pituitary and pineal bodies contain, besides the nervous matter, structures of the type of the glands without ducts.

The *White Matter* of the cerebrum consists of tracts or fasciculi of nerve fibres, of which—*a*, some connect the cerebrum with the lower divisions of the encephalon; *b*, others connect the two hemispheres together; *c*, others connect different structures in the same hemisphere; *d*, others serve as roots of origin for the more anterior encephalic nerves.

a, The tracts of fibres which connect the cerebrum with the lower divisions of the encephalon are called *peduncular* fibres. The largest of these peduncles are the two *crura cerebri* or *cerebral peduncles*. Continuous below with the longitudinal fibres of the pons they ascend into the optic thalami and corpora striata, and their fibres are named the *peduncular* fibres. From the corpora striata and optic thalami fibres radiate into the convolutions of the lobes of the hemisphere and form the *corona radiata*. To some extent the fibres of the *corona* are directly continuous with those of the cerebral peduncles, but there can be no doubt that a large portion of the peduncular fibres terminate in the grey matter of the ganglia of the base of the cerebrum, and that a still larger number arise from their nerve cells to aid in the formation of the corona radiata. The direct continuity, therefore, of many of the peduncular fibres with those of the corona is broken or interrupted by the interposition of the cerebral ganglia, which Meynert has named *ganglia of interruption*. The peduncular fibres and those White
of the corona constitute the cerebral portion of the *projection* matter.
system of fibres of Meynert, a term devised to express that they conduct upwards to the grey cortex of the hemispheres sensory impulses derived from the external world, the image of which is projected upon the cortex. But it should also not be forgotten that many of the fibres of this system conduct motor impulses downwards to be propagated along the motor cranial and spinal nerves. The peduncular fibres of the crura cerebri are arranged in two groups, named respectively *crusta* and *tegmentum*, which are separated from each other by the nerve cells of the locus niger. The *crusta* forms the superficial or anterior part of the crus. Its fibres are in greater part continuous with the longitudinal fibres of the pons derived from the anterior pyramids of the medulla; but it receives additional fibres from the grey matter of the locus niger, and from the cells of the Sylvian layer in the corpora quadrigemina. Some of the fibres of the crusta pass directly upwards as radiating fibres to the grey cortex of the occipital and temporal lobes, but the larger number terminate in the nucleus caudatus and nucleus lenticularis of the corpus striatum. From these nuclei a great mass of fibres radiates into the cortex of the fronto-parietal lobes, more especially the frontal, but a few also, bearing the special name of *stria cornea*, pass to the grey matter of the apex of the temporal lobe; fibres also enter the convolutions of the insula. In addition to the radiating fibres, the grey matter of the corpus striatum gives origin to fibres of the middle root of the olfactory peduncle, and to connecting fibres with the grey matter of the septum lucidum. The *tegmentum* forms the posterior or deeper part of the crus cerebri. Its fibres are continuous with the longitudinal fibres of the pons derived from the olivary fasciculi, fasciculi teretes, and posterior pyramids of the medulla. A few of the fibres of the tegmentum enter the corpora quadrigemina and corpora geniculata, but the great majority enter the optic thalami, in the grey matter of which many evidently terminate, though some may pass through into the cortex of the hemispheres as fibres of the corona radiata. But the grey matter of the thalamus gives origin to numerous radiating fibres: those which arise in its posterior part radiate into the occipital and temporal lobes, whilst those proceeding out of its anterior part radiate into the frontal, parietal, and temporal lobes, and the insula. In the optic thalamus the *fornix* arises. Its fibres emerge from the under surface of the thalamus, form the corpus albicans, and then pass backwards as the upper boundary of the great transverse fissure to end as the tænia hippocampi in the gyrus hippocampi; hence this convolution has a special connection with the optic thalamus through the fornix. In the corpus albicans the fibres of the fornix are arranged in loops, in the concavities of which nerve cells are situated. The optic thalamus also gives origin to the middle root of the optic tract. Owing to the connections of the locus niger, nucleus caudatus, and nucleus lenticularis with the crusta, Meynert has named them the *ganglia of the crusta*; whilst the optic thalami, corpora quadrigemina, and geniculata are the *ganglia of the tegmentum*. The comparison of the human brain with those of different

mammals has shown that the development of the hemispheres bears a direct relation to the size of the crusta and its ganglia, whilst the development of the hemispheres is in inverse relation to the size of the tegmentum and its ganglia.

The *superior peduncles* of the cerebellum connect that organ with the cerebrum. They arise in the grey matter of the vermiform process, ascend to the corpora quadrigemina, and some fibres are even prolonged apparently into the tegmentum, and through it doubtless into the optic thalamus.

b, The fibres which connect together the two hemispheres are called *commissural* fibres. The largest of these commissures is the *corpus callosum*, which, as has already been described, connects corresponding convolutions in the opposite hemispheres. As its fibres lie on a plane superior to those of the corona radiata, the two systems of fibres intersect with each other on their way to the convolutions. The *anterior commissure*, though often described as connecting the two corpora striata, yet, as Spurzheim pointed out half a century ago, passes through these bodies to the convolutions around the Sylvian fissure, and gives a root of origin to the olfactory nerve. The *posterior commissure* passes into the two optic thalami; some of its fibres are said to extend into the tegmentum, and others into the substance of the hemisphere.

c, The tracts which connect different convolutions in the same hemisphere are named *arcuate fibres*, or *fibræ propriæ*. The arcuate fibres are situated immediately beneath the inner surface of the cortex of the hemispheres, and connect together the grey matter of adjacent convolutions. In some localities they are strongly marked, and have received special names.

The *fasciculus uncinatus* passes across the Sylvian fissure, traverses the claustrum and amygdala, and connects the convolutions of the frontal with those of the temporo-sphenoidal lobe. The *fillet of the gyrus fornicatus* extends longitudinally in that convolution, immediately above the corpus callosum, from its anterior to its posterior ends, and connects two different parts of its grey matter together. The *longitudinal fibres* of the *corpus callosum*, or *nerves of Lancisi*, also connect the anterior and posterior ends of the callosal convolution. The *longitudinal inferior fasciculus* connects the convolutions of the occipital with those of the temporal lobe. Longitudinal fibres lie on the inner surface of the septum lucidum, and extend into the gyrus fornicatus.

The corpora quadrigemina are connected with the optic thalami by nervous tracts called *brachia*, and smaller tracts also connect the thalami with the corpora geniculata. The peduncles of the pineal gland connect that body with the fornix, and are probably continued into the optic thalamus. The tænia semicircularis is also at one end apparently connected with the optic thalamus, but its posterior termination is not well ascertained.

The great cerebral ganglia and the central masses of grey matter are centres of origin for sensori-motor nerves. The hemispherical ganglia, again, are the parts of the brain associated with the intellectual processes. The question has often been put, Are not the individual convolutions distinct organs, each endowed with special properties? and various arguments based on physiological, pathological, and anatomical grounds have been advanced in support of this proposition. In connection with the anatomical branch of the argument it may be stated that the convolutions possess, not only in man, but in all animals with convoluted brains, great regularity both in position and arrangement; but specialisation of form is not in itself a sufficient test of specialisation of function. Again, though the convolutions have definite forms they are not disconnected from each other, for the grey matter forms a continuous layer over the whole surface of the hemisphere. Hence a group of cerebral convolutions differs from a group of muscles, each member of which is undoubtedly a distinct organ, for each muscle is isolated from those around it by a definite investing sheath. As regards internal structure, evidence has already been given that all the convolutions are not constructed on precisely the same plan, and it has also been pointed out that the convolutions are not all connected in the same way with the great cerebral ganglia. These structural modifications unquestionably point to functional differences in the several parts in which they are found. But further, special connections through the arcuate fibres are established between certain convolutions and not between others, and it is possible not only that particular combinations of convolutions through an interchange of internuncial fibres may condition a particular state of intellectual activity, but that these combinations associate various convolutions together in the performance of a given intellectual act, just as in the muscular system several muscles are as a rule associated together for the performance of a given movement. A clue to the special functions of the convolutions may perhaps be obtained by studying their connections, just as the action of the members of a group of muscles is ascertained by examining the direction of their fibres and the attachment of their terminal tendons.

Weight of brain.

MASS AND WEIGHT OF THE BRAIN.—The human brain is absolutely bigger and heavier than the brain of any animal, except the elephant and the larger whales. It is also heavier relatively to the bulk and weight of the body than are the brains of lower animals, except in some small birds and mammals. Considerable variations, however, exist in the size and weight of the human brain, not only in the different races of mankind, but in individuals of the same race and in the two sexes. The heaviest brains occur in the white races. The average weight of the adult European male brain is 49 to 50 oz., that of the adult female 44 to 45 oz.; so that the brain of a man is on the average fully 10 per cent. heavier than that of a woman. The greater weight of the brain in man as compared with woman is not in relation merely to his greater bulk, but is a fundamental sexual distinction; for, whilst there is a difference of 10 per cent. in the brain weight, the average stature of women is, as Thurnam has calculated, only 8 per cent. less than that of men. Dr Boyd states that the average weight of the brain in the newly born male infant is 11·67 oz.; in the female only 10 oz. The exact age at which the brain reaches its maximum size has been variously placed at from the 3d to the 8th years by different authors; but it continues to increase in weight to 25 or 30, or even 40. After 60 the brain begins to diminish in weight; in aged males the average weight is about 45 oz., in females about 41 oz. In some cases the adult brain considerably exceeds the average weight. The brains of several men distinguished for their intellectual attainments have been weighed: the brain of Cuvier weighed 64½ oz.; of Dr Abercrombie, 63 oz.; of Professor Goodsir, 57½ oz.; of Spurzheim, 55 oz.; of Sir J. Y. Simpson, 54 oz.; of Agassiz, 53·4 oz.; and of Dr Chalmers, 53 oz. But high brain weights have also been found where there was no evidence of great intellectual capacity. Peacock weighed four male brains which ranged from 62·75 to 61 oz.; Boyd, a specimen of 60·75 oz.; and Turner has recorded one of a boy aged fifteen which weighed 60 oz. In the brains of the insane high brain weights have also been observed. Bucknill met with a brain in a male epileptic which weighed 64½ oz.; Thurnam, one which weighed 62 oz.; and in the West Riding Asylum, out of 375 males examined, the weight of the brain in 30 cases was 55 oz. or upwards, and the highest weights were

61 oz. in a case of senile dementia, 60½ oz. in a case of dementia, and 60 oz. in one of melancholia. No case has as yet been recorded of the weight of the brain in a woman possessing intellectual eminence; but Boyd met with a woman's brain as high as 55·25 oz., and many instances of upwards of 50 oz. in women where there was no evidence of high mental endowment. Skae, in a female monomaniac, observed a brain which weighed 61½ oz.; and of 300 females examined in the West Riding Asylum the weight of the brain in 26 cases was 50 oz. or upwards, the highest weights being 56 and 55 oz. in two cases of mania. The size and weight of the brain do not therefore, *per se*, give an exact method of estimating the intellectual power of the individual, and a high brain weight and great intellectual capacity are not necessarily correlated with each other. It seems certain, if the human brain, even amongst the most uncultivated peoples, falls below 30 oz., that this low weight is not merely incompatible with intellectual power and activity, but is invariably associated with idiocy or imbecility; so that the human brain has a minimum weight below which intellectual action is impossible. Amongst the more cultivated races the minimum weight-limit of intelligence is, however, in all probability higher than 30 oz. It has been placed by Broca at 32 oz. for the female, and 37 oz. for the male brain; and Thurnam's numbers are almost the same. To how low a weight the brain in the microcephalous idiot may fall is well shown in a case recorded by Theile, where it weighed only 10·6 oz., in Gore's case of 10 oz. 5 grs., and in Marshall's case, 8½ oz. But instances are not wanting in which the brains of idiots have exceeded even 50 oz. Langdon Down observed the brain of a male idiot aged 22, which weighed 59½ oz.; and J. B. Tuke has recently met with a brain of 60 oz. in a male idiot aged 37, the capacity of whose cranium was 110½ cubic inches. In the West Riding Asylum tables the brain weights in 10 idiots were not less than 34 oz., and in 5 cases exceeded 40 oz. As yet the opportunities of weighing the brain in the coloured races of men have been but scanty. But from a very extensive series of observations made by Barnard Davis, not on the brains themselves, but on the cubic capacities of crania, from which an approximate estimate of the brain weight may be obtained with a fair measure of accuracy, the following facts are derived:—The average weight of the male brain in the African races is 45·6 oz.; of the female brain, 42·7 oz.: the average weight of the male brain in the Australian races is 42·8 oz.; of the female brain, 39·2 oz.: the average weight of the male brain in the Oceanic races, 46·5 oz.; of the female brain, 43 oz. The conclusions which may legitimately be drawn from an analysis of Barnard Davis's observations are as follows:—1st, That the average brain weight is considerably higher in the civilised European than in the savage races; 2d, That the range of variation is much greater in the former than in the latter; 3d, That there is an absence, almost complete, of specimens heavier than 54 oz. in the exotic races, so that the higher terms of the series are not represented; 4th, That though the male brains are heavier than the female, there is not the same amount of difference in the average brain weight between the two sexes in the uncultivated as in the cultivated peoples.

No reliable determinations have as yet been made of the exact proportion, as regards bulk and weight, which the convolutions bear to the corpora striata, optic thalami, and corpora quadrigemina, but data are obtainable of the relative weight of the pons, cerebellum, and medulla to the entire encephalon. Between the ages of 20 and 70 the ratio of weight of the pons, cerebellum, and medulla, to the entire brain, is as 13 to 100, and this relative weight is virtually the same in both sexes.

ORIGIN, ARRANGEMENT, AND DISTRIBUTION OF THE ENCEPHALIC NERVES.—Several pairs of nerves, called CRANIAL or ENCEPHALIC, arise from the under surface or base of the encephalon, and pass outwards through foramina situated in the floor of the cranial cavity. Continental anatomists usually enumerate twelve pairs of cranial nerves; but because in one locality two of these nerves lie together and pass through the same foramen, and in another spot three of these nerves emerge together from the skull, British anatomists have restricted the number to nine pairs. These nerves are numbered from before backwards, in the order in which they are seen at the base of the brain. The names applied to the individual nerves, and their numerical designations, according to both the Continental and British methods, are given in the following table:— Cranial nerves.

	Continental.	British.
Olfactory Nerves, ...	1st pair	1st pair
Optic Nerves, ...	2d ,,	2d ,,
Oculo-motor Nerves, ...	3rd ,,	3rd ,,
Trochlear Nerves, ...	4th ,,	4th ,,
Trifacial or Trigeminal Nerves, ...	5th ,,	5th ,,
Abducent Nerves, ...	6th ,,	6th ,,
Facial Nerves (Portio dura), ...	7th ,,	7th ,,
Auditory Nerves (Portio mollis),	8th ,,	
Glosso-pharyngeal Nerves, ...	9th ,,	
Pneumogastric Nerves (Vagus),	10th ,,	8th ,,
Spinal Accessory Nerves, ...	11th ,,	
Hypoglossal Nerves, ...	12th ,,	9th ,,

These nerves may be arranged in three groups according to the presence or absence of motor and sensory fibres.

First group.—*Sensory* nerves, or nerves of special sense: *a*, olfactory, the nerve of smell; *b*, optic, nerve of sight; *c*, auditory, nerve of hearing.

Second group.—*Motor* nerves: *a*, oculo-motor, the principal nerve of supply for the muscles of the eyeball; *b*, trochlear, the nerve for the superior oblique muscle; *c*, abducent, the nerve for the external rectus; *d*, portio dura, the nerve for the facial muscles of expression; *e*, spinal accessory, the nerve which gives a motor root to the pneumogastric, and supplies the sterno-mastoid and trapezius muscles; *f*, hypoglossal, the nerve for the muscles of the tongue.

Third group.—*Mixed* nerves: *a*, trifacial, distributed to the muscles of mastication, the skin of the face, various mucous membranes, and to the anterior and lateral surfaces of the tongue, where it may play the part of a nerve of the special sense of taste; *b*, glosso-pharyngeal, distributed to the mucous membrane of the pharynx, to certain palato-pharyngeal muscles, and to the mucous membrane of the back of the tongue, where it acts as a nerve of the special sense of taste; *c*, the pneumogastric, conjoined with the internal division of the spinal accessory, is distributed to several muscles, mucous membranes, and internal organs.

The consideration of the 1st group of cranial nerves may appropriately be deferred until the organs of sense, in which they terminate, are described. The anatomy of the motor nerves is as follows:—

The *Oculo-motor* or *third nerve* springs out of the inner surface of the crus cerebri. When its fibres are traced into the crus, some are seen to pass to the nerve cells of the locus niger, whilst others sink into the corpora quadrigemina, and extend as far as the Sylvian group of large nerve cells. The nerve, after it has emerged from the crus, runs forwards in the outer wall of the cavernous sinus, and enters the orbit through the sphenoidal fissure. It supplies the levator palpebræ superioris, the superior, inferior, and internal recti muscles, and the inferior oblique. It contributes the short or motor root to the ciliary ganglion, and through it influences the iris and ciliary muscles within the eyeball. It also communicates with the cavernous plexus of the sympathetic. Motor cranial nerves.

The *Trochlearis* or *fourth*, the smallest cranial nerve, lies at the outer side of the crus cerebri. When traced backwards to its origin it is seen to sink into the valve of Vieussens, where its fibres divide into three roots: one decussates across the valve with a root of the corresponding nerve on the opposite side; another passes backwards to the locus cæruleus; the third sinks into the corpora quadrigemina and reaches the Sylvian group of nerve cells, from which the third nerve also arises. The fourth nerve runs forward in the outer wall of the cavernous sinus, enters the orbit through the sphenoidal fissure, and ends in the superior oblique muscle. It also communicates with the cavernous plexus of the sympathetic.

The *Abducent* or *sixth nerve* springs out of the groove between the lower border of the pons and the anterior pyramid of the medulla oblongata. Its roots sink deeply into the pons, and arise from a nucleus of grey matter at the floor of the fourth ventricle, common to it and the portio dura. The sixth nerve runs forward in the inner wall of the cavernous sinus, enters the orbit through the sphenoidal fissure, and ends in the external rectus muscle. It communicates with the carotid plexus of the sympathetic.

The *Portio dura* or *motor facial* portion of the *seventh nerve* springs out of the groove between the lower border of the pons and the restiform body. Its roots sink deeply into the pons, and whilst some of its fibres arise from a grey nucleus, at the floor of the fourth ventricle, common to it and the sixth nerve, others ascend from a nucleus which, according to Meynert, lies just on the outer side of the superior olivary body, and others again decussate across the median raphe of the pons. An accessory portion, called *portio intermedia*, which is said to arise from the lateral columns of the cord, joins the portio dura. The portio dura enters the internal auditory meatus in the petrous-temporal bone along with the auditory nerve; but at the bottom of the meatus it leaves that nerve and enters the aqueduct of Fallopius along which it is conducted through the bone to emerge at the stylo-mastoid foramen. When in the aqueduct it forms a *knee-shaped bend*, and expands into a small *ganglion*, which is joined by the *great*, *small*, and *external petrosal nerves*, and through the external petrosal it communicates with the sympathetic. The portio dura gives off—*a*, a minute branch to the stapedius muscle; *b*, the *chorda tympani*, which, entering the tympanum, passes across that cavity, emerges through the Glaserian fissure, and joins the lingual branch of the fifth nerve, which it accompanies as far as the submaxillary ganglion; it gives a branch to the ganglion, and one to the lingualis muscle. After the portio dura has passed through the stylo-mastoid foramen it gives off—*c*, the *posterior auricular* branch to the occipital belly of the occipito-frontalis and to the retrahens aurem muscle, and *d*, the *digastric* branch to the posterior belly of the digastric and stylo-hyoid muscles; and then runs forwards through the parotid gland to the face, where it breaks up into numerous (*e*) *facial* branches to supply the facial muscles of expression and the buccinator muscle. The facial is also the secretory nerve for the salivary glands. Through the chorda tympani it influences the secretion of the submaxillary and sublingual glands, and through the connection between its lesser petrosal nerve and the auriculo-temporal in the otic ganglion it influences the parotid gland.

The *Spinal Accessory* is the lowest division of the *eighth nerve*. It springs out of the side of the medulla oblongata, and from the lateral column of the cervical part of the spinal cord as low as the fifth cervical nerve: its roots arise from the intermedio-lateral group of nerve cells in the cord, and from a nucleus of grey matter in the floor of the fourth ventricle. The spinal fibres of origin enter the skull through the foramen magnum, join the fibres from the medulla, and leave the cranial cavity through the jugular foramen. This nerve, purely motor in function, is subdivided into two parts, an internal and an external. The *external* passes obliquely outwards across the side of the neck, pierces the sterno-mastoid, and ends in the trapezius, both of which muscles it supplies. The *internal* joins the pneumogastric nerve, of which it forms the motor or accessory root, and is distributed along with it.

The *Hypoglossal* or *ninth nerve* springs out of the groove between the anterior pyramid and olivary body of the medulla oblongata, in series with the anterior roots of the spinal nerves. Its roots pass through the medulla to the floor of the fourth ventricle, to arise from the nerve cells in two nuclei of grey matter situated close to the median furrow. This grey matter is in series with the anterior cornua in the spinal cord. The nerve passes out of the skull through the anterior condyloid foramen, and arches across the side of the neck to the tongue, to end in *glossal* branches for the supply of the intrinsic and extrinsic muscles of the tongue. It also gives off—*a*, the *descendens noni* branch, which, after been joined by the *communicantes noni* from the cervical plexus, supplies the omo-hyoid, sterno-hyoid, and sterno-thyroid muscles; *b*, the *thyro-hyoid* branch to the thyro-hyoid muscle; *c*, the *genio-hyoid* branch to the genio-hyoid muscle. It communicates in the neck with the sympathetic, vagus, lingual branch of the fifth, and cervical plexus.

The group of mixed nerves will now be considered.

Mixed cranial nerves.

The *Trifacial* or *fifth* is the largest cranial nerve. It springs by two distinct roots out of the side of the pons. The smaller or motor root arises from the nerve cells of a nucleus of grey matter situated in the back of the pons, near the floor of the upper part of the fourth ventricle. The larger or sensory root has, according to Meynert, a complex origin—*a*, from a nucleus of grey matter in the pons to the outer side of the origin of the motor root; *b*, by descending fibres which arise from nerve cells in the substance of the corpora quadrigemina, from the grey matter of the locus cæruleus, and from the longitudinal fibres of the pons; *c*, by ascending fibres which apparently arise from the grey tubercle of Rolando; *d*, probably by fibres which traverse and embrace the superior peduncle of the cerebellum. As the large sensory root of the fifth lies on the petrous bone it expands into the Gasserian ganglion, which resembles in structure the ganglion on the posterior root of a spinal nerve. From this ganglion three large branches arise, named respectively the 1st, 2d, and 3d divisions of the ganglion.

The 1*st* or *Ophthalmic division* is the upper sensory nerve of the face, and divides into three branches, which pass out of the cranial cavity through the sphenoidal fissure. By its *lachrymal* branch it supplies the lachrymal gland, and the outer part of the skin and conjunctiva of the upper eyelid; by its *frontal* branch, the inner part of the skin and conjunctiva of the upper lid, and the skin of the forehead; by its *oculo-nasal* branch, it gives *long ciliary* nerves to the eyeball, and a nasal nerve to the mucous membrane of the nose, and the skin of the side of the nose. From the oculo-nasal nerve arises the long or sensory root of the *ciliary ganglion*, which lies in the cavity of the orbit, and which receives also a motor root from the third nerve, and a root from the sympathetic. This ganglion gives origin in the *short ciliary* nerves for the eyeball.

The 2*d* or *Superior Maxillary division* is the sensory nerve for the middle part of the face. It leaves the skull by the foramen rotundum, passes across the spheno-maxillary fissure, then lies in the canal in the floor of the orbit, from which it emerges on the face through the infra-orbital foramen as the *infra-orbital* nerve. It gives off a small *orbital* branch to a small part of the skin of the temple,

and that over the cheek bone; *dental* branches to the teeth in the upper jaw; *palpebral* branches to the skin and conjunctiva of the lower eye-lid; *nasal* branches to the skin and mucous membrane of the nose; *labial* branches to the skin and mucous membrane of the upper lip. It also gives off, when in the spheno-maxillary fossa, *spheno-palatine* branches, which form the sensory root of the *spheno-palatine* or *Meckel's* ganglion. This ganglion receives a motor root through the great petrosal nerve from the knee-shaped bend of the portio dura, and a sympathetic root from the carotid plexus, which runs along with the great petrosal, and forms with it the *vidian* nerve. The ganglion gives origin to—*a*, an *orbital* branch, which supplies a layer of non-striped muscular fibres, described by H. Müller and Turner as developed in connection with the periosteum of the orbit, where it covers the spheno-maxillary fissure; *b*, *upper nasal* and *naso-palatine* branches to the mucous membrane of the nose and hard palate; *c*, *descending palatine* branches to the mucous membrane of the hard and soft palate; *d*, *pterygo-palatine* to the mucous membrane of the upper part of the pharnyx.

The 3*d* or *Inferior Maxillary division* passes out of the skull through the foramen ovale, and as it does so is joined by the motor root of the 5th. By the junction a mixed nerve is formed, which is the sensory nerve for the lower part of the face, and the skin of the temple, and the motor nerve for the muscles of mastication. Immediately after passing through the foramen this nerve divides into a small and large division, in each of which motor and sensory fibres are found. The *small division* supplies *motor masticatory* branches to the masseter, temporal, external, and internal pterygoid muscles; but further it gives off a *long buccal* branch, which, though often described as the motor nerve for the buccinator muscle, is really a sensory nerve for the skin and mucous membrane of the cheek. The sensory nature of this nerve is proved, not only by physiological and pathological experiments, but by tracing its fibres through the buccinator muscle to the mucous membrane. Turner has also recorded two cases in which the long buccal nerve arose as a branch of the sensory superior maxillary nerve. The *large division* separates into three branches—*a*, *auriculo-temporal*, which ascends to supply the parotid gland, the skin of the auricle, external meatus, and temple, and the temporo-maxillary joint; *b*, *inferior dental*, which enters the dental canal in the lower jaw, and supplies the lower set of teeth and the skin and mucous membrane of the lower lip; it also gives off a *mylo-hyoid* branch to the mylo-hyoid and anterior belly of the digastric muscle; *c*, *lingual* or *gustatory*, which runs forward along the side of the tongue to end in the filiform and fungiform papillæ of its mucous membrane. The lingual branches are sensory nerves of touch, though some physiologists believe that they are also nerves of taste. Connected with the branches of the inferior maxillary division are two small ganglia, which, like the ciliary and spheno-palatine ganglia, are of a greyish colour, contain nerve cells, and receive roots from motor, sensory, and sympathetic nerves. The *submaxillary ganglion* lies under cover of the mylo-hyoid muscle, and receives a root from the motor chorda tympani nerve, a root from the sensory lingual, and a sympathetic root. It gives branches to the sub-maxillary and sublingual salivary glands. The *otic ganglion* lies close to the Eustachian tube, and receives a root from the muscular nerve to the internal pterygoid, a root from the sensory auriculo-temporal, and a sympathetic root. It also receives the *small petrosal* nerve, by which it is connected to the knee-shaped bend of the portio dura and to the glosso-pharyngeal nerve. It supplies the tensor tympani and tensor palati muscles. The branches of the three divisions of the fifth cranial nerve, which pass to the skin of the temple, forehead, and face, freely communicate with the branches of the portio dura, which supply the muscles situated in those regions.

The *Glosso-pharyngeal* or uppermost division of the *eighth* nerve springs out of the side of the medulla oblongata between the olivary and restiform bodies; its roots arise from two small masses or nuclei of grey matter in the floor of the 4th ventricle. The nerve passes out of the skull through the jugular foramen, where it possesses two small *ganglia*, named *jugular* and *petrous*. It then passes across the side of the neck and gives off *carotid* branches, which run along the internal carotid artery; *pharyngeal* branches to the mucous membrane of the pharynx; *tonsilitic* branches to the tonsil and soft palate; *glossal* branches to the base of the tongue and the circumvallate papillæ, which branches are unquestionably nerves of the special sense of taste; *muscular* branches to the stylo-pharyngeus and perhaps the constrictor muscles. Through the jugular and petrous ganglia the nerve communicates with the vagus and sympathetic. The petrous ganglion gives off the *tympanic* branch or *nerve of Jacobson*, which enters the tympanic cavity, supplies its mucous membrane, and gives off three communicating branches—one to the sympathetic; a second to the great petrosal, and through it to the knee-shaped bend of the facial; a third to the small petrosal, and through it to the otic ganglion.

The *Pneumogastric* or *Vagus* is the middle subdivision of the *eighth* cranial nerve. It springs out of the side of the medulla oblongata, between the olivary and restiform bodies; its roots arise from a nucleus of grey matter in the floor of the 4th ventricle, which nucleus, along with those for the glosso-pharyngeal nerve, is in series with the posterior cornu of grey matter in the spinal cord. It goes through the jugular foramen, is joined by the inner division of the spinal accessory which is its motor root, then passes down the side of the neck, enters the thorax, reaches the outer wall of the œsophagus, accompanies that tube through the diaphragm, and terminates in the wall of the stomach. The left nerve lies on a plane anterior to the right: it crosses in front of the arch of the aorta, and is distributed to the anterior wall of the stomach, whilst the right nerve supplies the posterior wall. Each nerve possesses high in the neck two enlargements, named *upper* and *lower ganglia*. The branches of the vagus are numerous and important. The upper ganglion gives origin to the *auricular* branch, which traversing a small canal in the petrous temporal bone, is distributed to the skin of the back of the auricle. The lower ganglion gives origin to—*a*, the *pharyngeal* branch, which forms a plexus with the glosso-pharyngeal and sympathetic nerves, from which the muscles of the pharynx are supplied; *b*, the *superior laryngeal*, which divides into an *external* branch to supply the crico-thyroid muscle, and an *internal*, which pierces the thyro-hyoid membrane, and supplies the mucous lining of the larynx and the mucous covering of the epiglottis. The trunk of the nerve gives origin to—*a*, the *recurrent laryngeal* branch, which on the right side turns round the subclavian artery, and on the left round the arch of the aorta, and ascends to the larynx to supply its intrinsic muscles except the crico-thyroid; *b*, *cardiac* branches, which arise from the nerve partly in the neck and partly in the chest, and join the great cardiac plexus for the heart; *c*, *pulmonary* branches, which arise in the chest, pass into the substance of the lungs, and form along with the sympathetic an *anterior plexus* in front of, and a *posterior plexus* behind the root of the lung; *d*, *œsophageal* branches, which supply the coats of the œsophagus; *e*, *gastric* branches, which supply the coats of the stomach, and give important offshoots to the great solar plexus of the sympathetic situated at the pit of the stomach.

Descriptive Anatomy of the Sympathetic Nervous System.

Sympathetic nervous system.

The Sympathetic Nervous System consists of a pair of gangliated cords, situated one on each side of the spinal column; of three great gangliated prevertebral plexuses situated in the thoracic and abdominal cavities; of numerous smaller ganglia lying more especially in relation with the thoracic and abdominal viscera; of multitudes of fine distributory nerves.

Gangliated cord and branches.

Each *Gangliated Cord* of the sympathetic extends along the side of the spine from the base of the skull to the coccyx. In the neck it lies in front of the transverse processes of the vertebræ; in the thorax, in front of the heads of the ribs; in the abdomen, on the sides of the vertebral bodies; and as it descends in front of the sacrum it approaches its fellow, so that in front of the coccyx the two are united in a single ganglion, the *ganglion impar* (Fig. 66, *c*). Each cord consists of a number of ganglia united into a continuous cord by intermediate nerves. As a rule, the ganglia equal in number the vertebræ of the region. Thus, in the sacral region there are five ganglia, in the lumbar five, and in the thorax twelve; but in the neck there are only three, named superior, middle, and inferior; of these the superior is very large, and represents without doubt several smaller ganglia. From the superior cervical ganglion the cord is prolonged upwards by an *ascending* or cranial offshoot through the carotid canal into the cranial cavity, and forms a plexus around the internal carotid artery, both in the carotid canal, named the *carotid plexus*, and in the inner wall of the cavernous sinus, named the *cavernous plexus*. Through branches derived either directly or indirectly from these plexuses the sympathetic roots for the ciliary and spheno-palatine ganglia, described in connection with the fifth nerve, are derived.

From the gangliated cord and its ascending or cranial prolongation a communicating and a distributory series of branches are derived.

By the *Communicating* branches this portion of the sympathetic is connected with most of the cranial and with the anterior divisions of all the spinal nerves, so as to bring the cerebro-spinal and sympathetic systems into close anatomical and physiological relation with each other. It is important also to observe that each communicating branch contains not only non-medullated nerve fibres from the sympathetic system to the cerebro-spinal nerves, but medullated fibres from the cerebro-spinal to the sympathetic, so that a double interchange takes place between the two systems. The cranial prolongation of the sympathetic and the superior cervical ganglion communicate with the 3d and 4th nerves, the Gasserian ganglion of the 5th, the 6th, the portio dura of the 7th, the glosso-pharyngeal and pneumogastric of the 8th, and the 9th cranial nerves, and with the anterior divisions of the four upper cervical spinal nerves. The middle cervical ganglion communicates with the 5th and 6th cervical nerves, the inferior cervical ganglion with the 7th and 8th cervical nerves, the twelve thoracic ganglia with the series of intercostal nerves, the five lumbar ganglia with the series of lumbar spinal nerves, the sacral and coccygeal ganglia with the sacral nerves and the coccygeal nerve.

The *Distributory* branches of the gangliated cord are as follows:—*a*, *Pharyngeal* branches from the superior cervical ganglion, which join the pharyngeal branches of the glosso-pharyngeal and pneumogastric nerves, to form the *pharyngeal plexus*, which supplies the muscles and mucous membrane of the pharynx. *b*, *Articular* branches from the upper thoracic and the lumbar ganglia to the articulations between the adjacent vertebræ. *c*, *Pulmonary* branches from the 3d or 4th thoracic ganglia, which join the posterior pulmonary plexus. *d*, *Vaso-motor* branches or *nervi molles*, which supply the muscular coat of the arteries: those which arise from the cranial prolongation of the superior cervical ganglion supply the internal carotid artery and its branches to the brain and eyeball: those which arise from the superior cervical ganglia itself supply the external carotid artery and its branches; from the branch accompanying the facial artery the submaxilliary ganglion derives its sympathetic root; from that accompanying the middle meningeal artery the otic ganglion derives its sympathetic root: the vaso-motor nerves which arise from the middle cervical ganglion supply the inferior thyroid artery, and pass to the thyroid gland: the vaso-motor branches of the inferior cervical ganglion supply the vertebral and basilar arteries and their several branches, which pass to the spinal cord and the hinder part of the encephalon. Vaso-motor nerves also arise from the thoracic ganglia, which pass to the thoracic aorta, from the lumbar ganglia to the abdominal aorta, and from the sacral ganglia to the middle sacral artery; the ganglion impar gives branches to a peculiar vascular structure, named the *coccygeal body*, developed in connection with the end of the middle sacral artery; a body of similar structure, called *intercarotic body*, situated in the angle of bifurcation of the common carotid artery, receives branches from the superior cervical ganglion. *e*, *Cardiac* branches from the superior, middle, and inferior cervical and the 1st thoracic ganglia, which pass into the thorax to join the prevertebral cardiac plexus. *f*, *Splanchnic* branches as follows: *great splanchnic nerve*, by the union of branches from the thoracic ganglia, the 3d to the 10th inclusive; it pierces the crus of the diaphragm, and passes to the prevertebral solar plexus; *small splanchnic nerve*, also to the solar plexus from the 10th or 11th thoracic ganglia; *smallest splanchnic nerve*, from the 12th thoracic ganglion to the renal plexus. *g*, *Hypogastric* branches, from the lumbar and sacral ganglia to the prevertebral hypogastric plexus.

Gangliated prevertebral plexuses.

The *Prevertebral Cardiac plexus* (Pl. XVII. *c*) is situated at the base of the heart, and is divided into a *superficial* part, which lies in the concavity of the arch of the aorta, and a *deep* part between the aorta and trachea. It receives the cardiac branches of the pneumogastric and the cervical ganglia of the sympathetic. It contains collections of nerve cells and a dense plexiform arrangement of nerve fibres. It gives off branches to the heart, which wind around the surface of that organ and penetrate its muscular substance: on these branches minute ganglia are found which regulate its rhythmical movements. Through these branches and the cardiac plexus the heart is brought into connection with both the cerebro-spinal and sympathetic systems of nerves. The sympathetic apparently regulates its contraction, for when this nerve is stimulated the action of the heart is accelerated. The pneumogastric again exercises an inhibitory or restraining influence on the contractions of the organ, for when this nerve is irritated the activity of contraction is diminished, but when divided it is greatly increased. The cardiac plexus also sends offsets to the *anterior* and *posterior pulmonary plexuses* for the supply of nerves to the lungs.

The *Prevertebral Solar* or *Epigastric plexus* is situated at the pit of the stomach around the cœliac axis, a branch of the abdominal aorta. It receives the great and small splanchnic nerves from the thoracic ganglia of the sympathetic, and some of the terminal branches of the pneumogastric nerve. It contains large collections of nerve cells, which form the two *semilunar ganglia*, and a dense plexiform arrangement of nerve fibres. It gives origin, either directly or indirectly, to numerous plexiform branches, which accompany, and are named after, the abdominal aorta and its various branches given off to the walls and viscera of the abdomen proper. In this manner, not only

do the arteries which supply the abdominal viscera receive their vaso-motor nerves, but the muscular and mucous coats of the stomach, intestines, gall bladder, bile ducts, ureters, and seminal ducts, and the glandular structures of the liver, pancreas, kidneys, spleen, and supra-renal capsules. It is important also to observe that these plexuses of distribution not unfrequently contain small ganglia, and the branches which supply the muscular coat of the stomach and intestines have minute microscopic ganglia, with stellate nerve cells lying amidst them. The distribution of the pneumogastric nerve to the stomach, and its connection with the solar plexus, enables that nerve to stimulate its peristaltic contraction, and, according to some experimenters, that of the small intestine also; but the precise action of the sympathetic on these organs is still a disputed question.

The *Prevertebral Hypogastric plexus* is situated in front of the last lumbar vertebra. It receives branches from the lumbar ganglia of the sympathetic, and from the plexus surrounding the abdominal aorta. It divides into two parts, which lie one on each side of the rectum, and are called the *pelvic plexuses;* these plexuses are joined by branches from the sacral ganglia of the sympathetic, and from the 3d and 4th sacral spinal nerves, and contain small gangliform collections of nerve cells. From the pelvic plexuses numerous plexiform nerves arise, which accompany the internal iliac artery and its branches to the walls and viscera of the pelvis, and are named after them. These nerves not only supply the vaso-motor nerves for these blood-vessels, but also the muscular coat and mucous membrane of the bladder, rectum, and urethra, besides the prostate gland in the male, and the uterus and vagina, and in part the ovary, in the female; in connection with their distribution to these viscera, minute ganglia are found lying amidst the nerves, the nerve cells in which act undoubtedly as centres of reinforcement for the origin of additional nerve fibres.

From the distribution of the branches of the gangliated cord of the sympathetic, and of the gangliated prevertebral plexuses, it will be seen that this nerve is especially related to the blood-vessels and to the viscera contained within the great cavities of the body. As the cerebro-spinal system is engaged in the supply of nerves to the voluntary muscles, the sympathetic is the medium of supply for the involuntary muscular apparatus, both in the coats of the vessels and in the walls of the hollow viscera. But though the vaso-motor nerves branch from the sympathetic ganglia, it must not be supposed that they have no connection with the cerebro-spinal system. The communicating branches between the sympathetic ganglia and the anterior divisions of the spinal nerves establish a connection between them and the cerebro-spinal nervous axis. By recent experiments, the tract of transmission of the vaso-motor fibres has been traced along with the anterior roots of the spinal nerves, through the lateral columns of the cord to the medulla oblongata, in which the vaso-motor nerve centre lies a little to one side of the mesial plane, above the calamus scriptorius. In the distribution of the sympathetic to the glandular viscera, not only is it important to attend to their terminations in the muscular coat of the blood-vessels of the glands, but the termination of the nerves in connection with the secreting cells themselves must be taken into consideration. The communications between the cerebro-spinal and sympathetic systems, not only through the spinal nerves, but also through the pneumogastric, are to be kept in mind in connection with the effects produced by varying mental conditions on the secretions of the glands.

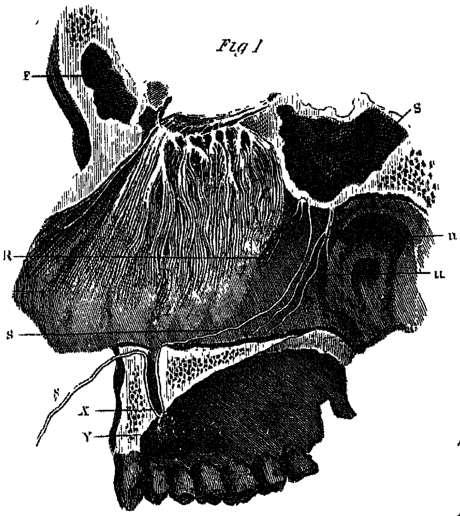
ORGANS OF SENSE.

The organs of sense are the organs through the intermediation of which the mind becomes cognisant of the appearance and properties of the various objects in the external world. These organs are severally named nose, eye, ear, tongue, and skin. For the excitation and perception of a sensation three sets of structures are necessary: *a*, a peripheral end-organ; *b*, a sensory nerve; *c*, a central organ. The peripheral end-organ is the part of the apparatus to which the stimulus necessary for the production of the sensation is applied. This stimulus causes nervous impulses to be propagated from the end-organ along the fibres of the sensory nerve to the central organ, in which that nerve terminates at its central extremity. These nervous impulses occasion molecular changes in the nerve cells of the brain, and the mind becomes conscious of a sensation. The shape and construction of each organ of sense is adapted to the application of the stimulus required for the production of the particular sensation to which the organ is subservient. Each organ of sense possesses its own characteristic form of end-organ. The touch corpuscles of the skin, the end bulbs found in several mucous membranes, and the Pacinian corpuscles, are the end-organs occurring in their several localities; they have the peripheral ends of the sensory nerves terminating in their substance, and the axial cylinder of the nerve fibre ends in their interior. The rods and cones of the retina, the rods of Corti in the cochlea, the olfactory cells of the nose, and the gustatory bodies in the tongue, are the end-organs belonging to their several organs of sense; the sensory nerve fibres which terminate in relation with them have not yet, however, been traced into actual continuity with their substance. A stimulus, whatever may be its nature, applied to any organ of sense can excite only that kind of sensation for the production of which the organ is subservient. Thus a stimulus applied to the eye, whether it be the natural stimulus of the waves of light, the mechanical stimulus of a blow, or an electric stimulus, can only excite the sensation of light. Stimuli applied to the ear can only excite the sensation of sound, and in like manner with the other senses. In studying the anatomy of the organs of sense the arrangement of numerous accessory structures, which assist either in conducting stimuli or in modifying their effects, the arrangement and structure of the peripheral end-organs, and the origin, course, and distribution of the sensory nerves, will have to be considered.

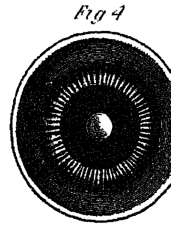
The NOSE or organ of smell is a large cavity situated in the face, between the orbits, above the mouth, and below the cribriform plate of the ethmoid bone. It communicates by the *anterior nares*, or nostrils, with the external atmosphere, by the *posterior nares* with the pharynx, and through it with the larynx, trachea, and lungs. It is the proper entrance to the respiratory passage, is accessory to the production of the voice, aids in the sense of taste, and forms one of the most important features of the face. It is subdivided into a right and a left chamber by a vertical mesial partition, the *septum nasi*, so that the nose is a double organ in the same sense as the eyes or ears are double. The walls of the cavity of the nose are formed partly of bone and partly of cartilage. The osseous walls are referred to on page 826. The cartilages form the point, the alæ, and a part of the septum nasi. The *mesial* or *septal cartilage* is triangular in shape, and fits into the interval between the vomer, the mesial plate of the ethmoid, and the nasal spine of the superior maxilla. Anteriorly and inferiorly its border is free, projects on to the face, and forms the *columna* of the nose. The *lateral cartilages* form the tip and alæ. On each side is an *upper lateral cartilage* attached by its

Nose.

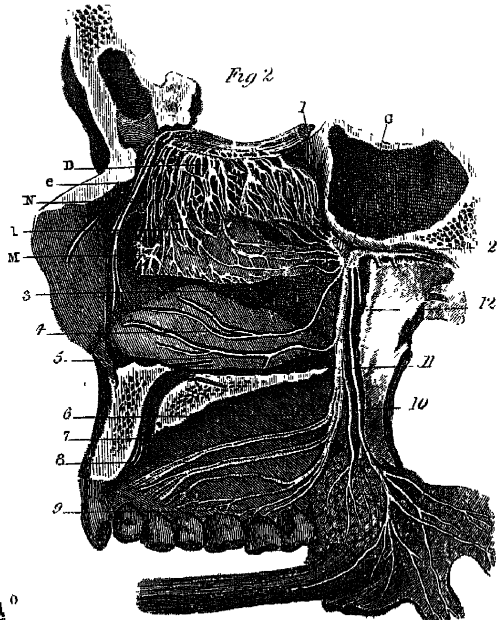
Organs of Sense



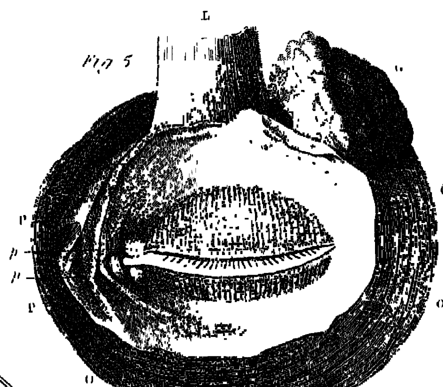
Septum of Nose



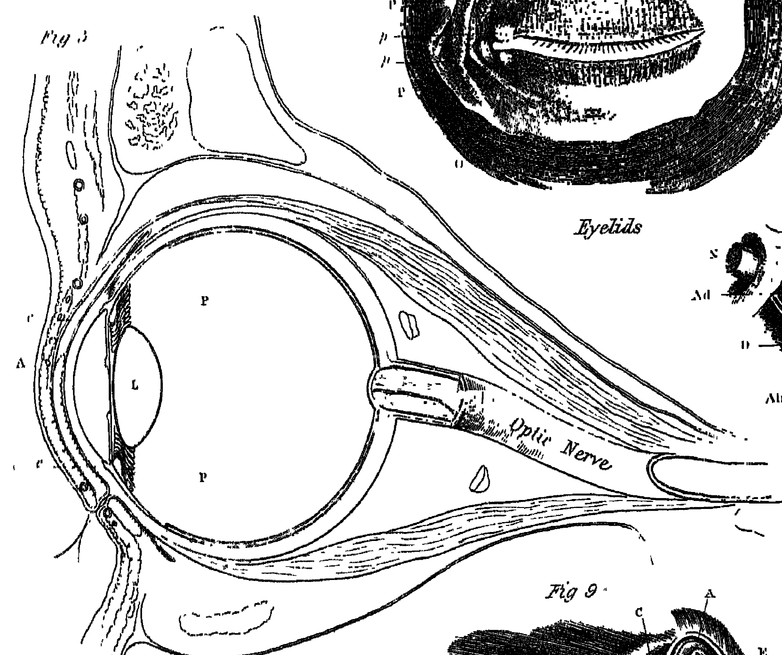
Ciliary Processes



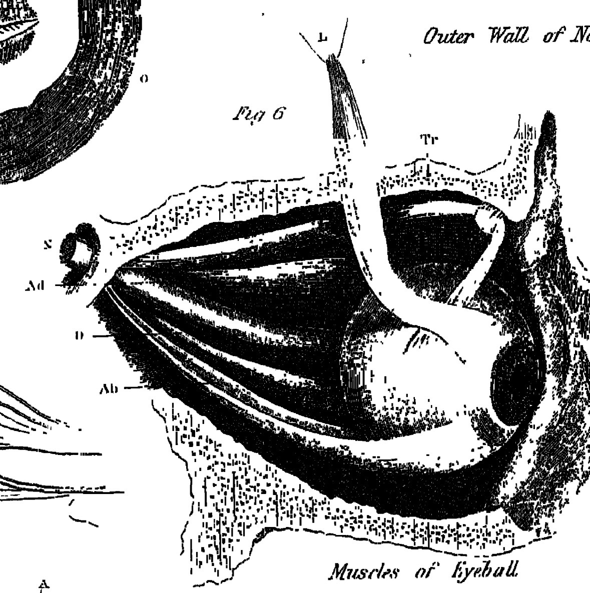
Outer Wall of Nose



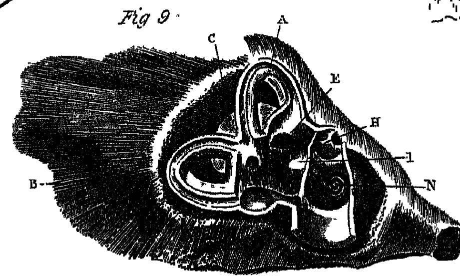
Eyelids



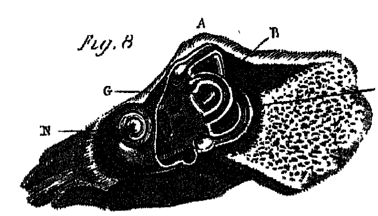
Section Through Eyeball



Muscles of Eyeball

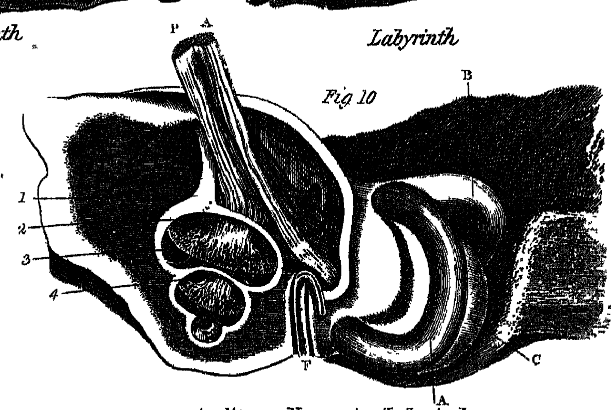


Labyrinth



Labyrinth

Nerves of Eyeball



Auditory Nerve in Labyrinth.

W.&A.K.Johnston

outer margin to the free edge of the nasal bone and superior maxilla, whilst by its inner it is continuous with the anterior border of the septal cartilage. The *lower lateral cartilage* curves inwards upon itself, touches its fellow in the mesial plane at the tip, and forms the anterior and lateral boundary of the orifice of the nostril. It is connected by fibrous membrane above to the upper lateral cartilage, and behind to the anterior edge of the superior maxilla. In this membrane two to five small cartilaginous plates, called the *epactal cartilages*, are often found imbedded. The skin of the nose which covers the lower lateral cartilages contains numerous sebaceous follicles, which open by comparatively large orifices on the surface. It is closely connected to these cartilages, and to the muscles of the alæ. The lower lateral cartilage forms the wall of the *vestibule* or entrance to the nasal chamber, and the vestibule is lined by a prolongation of the integument, which is studded with numerous short hairs or *vibrissæ*. Each nasal chamber is lined by a mucous membrane called the *pituitary* or *Schneiderian*. This membrane is prolonged into the meatuses and the air sinuses which open into them; posteriorly it is continuous with the mucous lining of the pharynx, and anteriorly it blends with the cutaneous lining of the vestibule. The pituitary membrane is thick and soft, and diminishes the size of the meatuses and the openings of the air sinuses as seen in the skeleton. The mucous membrane is divided into a respiratory and an olfactory region. The *respiratory region* corresponds to the floor of the nose, to the inferior turbinated bone, and to the lower third of the nasal septum. It is covered by a ciliated columnar epithelium, and contains numerous racemose glands for the secretion of mucus or *pituita*. It is also vascular, and the veins which ramify in it have a plexiform arrangement. The mucous lining of the air sinuses is also ciliated, but almost devoid of glands, except in the antrum, in which region the glands sometimes dilate into cystic tumours.

Nerve of smell.

The *olfactory region* is the seat of distribution of the olfactory nerve and of its peripheral end-organs. It corresponds to the roof of the nose, to the superior and middle turbinals, and the upper ⅔rds of the septum. The mucous membrane is thick, soft, easily destroyed, of a yellowish brown colour, and blended with the periosteum. When vertical sections through this membrane are examined microscopically the tubular glands discovered by Bowman may be seen in its vascular connective tissue layer. These glands contain roundish secreting cells with yellowish-brown pigment-stained contents. The epithelium is cylindrical, but not usually ciliated, though patches of ciliated epithelium cells are said to occur in man. Long, slender, and even branched processes proceed from the deeper end of each cell towards or even into the sub-epithelial connective tissue. The cells usually contain pigment granules. Between the epithelium cells the characteristic olfactory cells of Schultze are situated. Each *olfactory cell* consists of a globular or fusiform body, from which two long processes arise: one, the *peripheral process*, passes vertically between the adjacent cylindrical epithelium cells to the free surface of the mucous membrane: in amphibia, reptiles, and birds it projects beyond the plane of the epithelium as a simple hair-like structure, or subdivided into several slender "*olfactory hairs*;" in fish and mammals, man inclusive, it ends, without forming a hair-like prolongation, on the general plane of the mucous surface. The second or *central process* of the olfactory cell extends towards the sub-epithelial connective tissue: it is finer than the peripheral process, and has not unfrequently a varicose appearance like a nerve fibre.

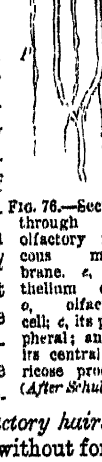


FIG. 76.—Section through the olfactory mucous membrane. *e*, epithelium cell; *o*, olfactory cell; *c*, its peripheral; and *p*, its central varicose process. (*After Schultze.*)

In the description of the development of the brain (p. 864), the origin of the olfactory bulb and peduncle from the hemisphere vesicle was referred to. In the adult brain the *olfactory peduncle* is in contact with the under surface of the frontal lobe. It is a white band, which divides in front of the locus perforatus anticus into three so-called roots of the olfactory nerve. The *external* or *long root* passes outwards across the Sylvian fissure to the gyrus hippocampi, and perhaps also to the insula: a few fibres are continuous with the anterior commissure; but in mammals, where the olfactory peduncle forms a good-sized lobe, it receives many fibres from the commissure. The *middle* or *grey root* contains white fibres which proceed from the corpus striatum. The *internal* or *short root* has been traced into the anterior end of the gyrus fornicatus; hence the inner and outer roots of the olfactory peduncle are connected with the anterior and posterior extremities of the arch-shaped gyrus. The *olfactory bulbs* rest on the upper surface of the cribriform plate of the ethmoid, one on each side of the crista galli. The bulb consists both of grey and white matter, and sometimes retains the central cavity lined by a ciliated epithelium. The grey matter contains fusiform and pyramidal nerve cells imbedded in neuroglia (the *stratum gelatinosum* of L. Clarke). Between it and the central cavity is the white matter formed of nerve fibres interspersed with "granules," similar to those seen in the rust coloured layer of the cerebellum. Between the grey matter and the surface is the *stratum glomerulosum* of Meynert, which apparently consists of coils of the olfactory nerve fibres with interspersed "granules." The *olfactory nerve fibres* form the first pair of cranial nerves or nerves of smell; they leave these glomeruli in from 15 to 25 bundles, and enter the roof of the nose through the holes in the cribriform plate (Pl. XIX. figs. 1, 2); they lie in grooves in the bones of the olfactory region, and form a network from which bundles of fine non-medullated fibres arise that enter the mucous membrane and run between the glands into the epithelial layer. These nerves have a varicose appearance, and though their terminations have not been precisely ascertained, it is believed that they are connected with the central processes of the olfactory cells, which cells are therefore regarded as the peripheral end-organs of the olfactory nerve fibres. The mucous membrane of the nose also receives branches from the 1st and 2d divisions of the 5th cranial nerve. Their mode of termination in that membrane is not known, but they are associated with the sense of touch, and not with the special sense of smell.

Eyeball.

The EYEBALL, globe of the eye, or organ of vision, is a complex optical apparatus situated in the cavity of the orbit, imbedded to a large extent in loose fat, and with several muscles attached to it. Its form approximates to the spheroidal, but it actually consists of segments of two spheres, the posterior of which is the larger.

The eyeball consists of three coats or tunics, which enclose three translucent refracting media. The first or external coat consists of a posterior, white, opaque part, the *sclerotic*, which corresponds in its area with the posterior larger segment of the ball, and of an anterior, translucent part, the *cornea*, which corresponds in its area with the anterior smaller segment of the eyeball. Piercing the sclerotic coat is the optic nerve, which enters the globe about ⅛th inch to the nasal or inner side of its antero-posterior axis. The second or middle coat, or tunica vasculosa, consists of a posterior part or *choroid*, the area of which corresponds almost exactly with the sclerotic;

this coat possesses anteriorly numerous folds, the *ciliary processes*, which are continuous with the *iris*, a structure which lies behind the cornea. The third or internal or nervous coat is named the *retina*, and in it the optic nerve

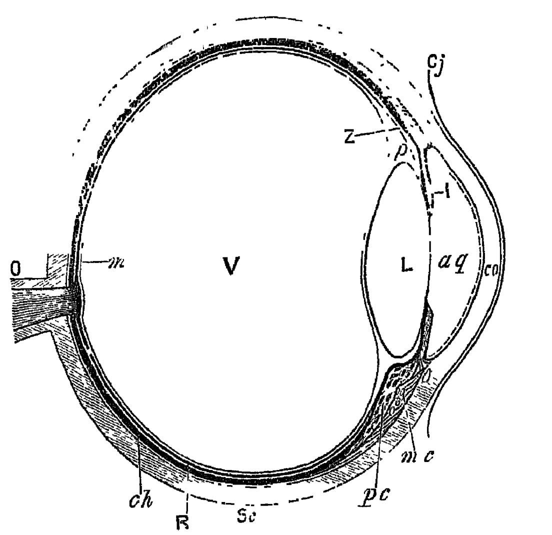


FIG. 77.—Diagrammatic section through the eyeball. *cj*, conjunctiva; *co*, cornea; *Sc*, sclerotic; *ch*, choroid; *pc*, ciliary processes; *mc*, ciliary muscle; O, optic nerve; R, retina; I, iris; *aq*, anterior chamber of aqueous humour; L, lens; V, vitreous body; Z, zonule of Zinn, the ciliary process being removed to show it; *p*, canal of Petit; *m*, yellow spot. The dotted line behind the cornea represents its posterior epithelium.

terminates. The enclosed refracting media occupy the axis of the globe, and are named from before backwards the *aqueous humour*, *crystalline lens*, and *vitreous body*.

Sclerotic coat.

The *Sclerotic coat*, called from its white appearance the white of the eye, is a firm, unyielding fibrous membrane, which forms the posterior $\frac{5}{6}$ths of the outer coat of the eyeball. It is thicker behind than in front, and where pierced by the optic nerve it has a cribriform structure, as the bundles of nerve fibres do not pass through one large, but several small openings. The sclerotic consists of the white fibrous form of connective tissue, intermingled with a small proportion of elastic fibres. The bundles of white fibres lie in two directions; some pass in the meridian of the globe from the optic nerve towards the cornea, others lie parallel to its equator. The sclerotic is joined by accessory fibres behind, derived from the perineurium of the optic nerve, where the nerve pierces it; and in front from the tendons of the recti and obliqui muscles, which are inserted into it. In the cetacea the sclerotic possesses extraordinary thickness. In fish and amphibia it consists largely of cartilage, and in birds a ring of bone is developed around its anterior margin. It is the protecting coat of the eyeball.

Cornea.

The *Cornea* forms the translucent anterior $\frac{1}{6}$th of the outer coat of the eyeball. It is almost circular in form, and is blended at its circumference with the anterior border of the sclerotic. Its anterior surface is convex, and covered by the conjunctival epithelium. The forward projection of the cornea is always greater in young than in aged persons. Its posterior surface is concave, and bounds the chamber in which the aqueous humour is contained: if the chamber be punctured, and the humour evacuated, the cornea loses its translucency, its tension, and its forward convexity, and becomes flaccid and opaque. It has considerable thickness, and can be readily split up into laminæ. When antero-posterior sections are made through it and the epithelium on its anterior and posterior surfaces, four distinct series of structures may be seen, viz., the anterior epithelium, the proper tissue of the cornea, the posterior elastic lamina, and the posterior epi-(endo)-thelium.

The *anterior epithelium* of the cornea, often called the conjunctival epithelium, is stratified. The deepest layer, which lies next the cornea, is formed of elongated cells, which lie vertically to the plane of the surface of the cornea. The more superficial layers are squamous cells, often with fluted surfaces and serrated or spinous edges. The intermediate layers are irregular in shape, and often possess, as Cleland pointed out, long digitate processes, which interlock with those of the adjacent cells.

The *proper tissue of the cornea* is a modified form of connective tissue. When examined fresh it appears as if perfectly homogeneous, but after a time, and more especially if hardened in alcohol, chloride of gold, and other reagents, it is seen to consist of cells and an intercellular matrix. The cells consist of two kinds,—those which belong to the cornea, and those which have migrated into it. The proper cornea cells or *cornea corpuscles* were first seen by Toynbee, and have been carefully studied by numerous subsequent observers. They are large stellate, flattened cells, and lie with their surfaces parallel to the surfaces of the cornea; they possess many branching processes, and the processes of adjacent cells anastomose to form a cell network. They consist of nucleated masses of protoplasm, which Kühne showed to be contractile, and are apparently destitute of a cell wall. In vertical sections through the cornea the corpuscles seem as if shaped like elongated spindles. The *migrating cells* of the cornea were first seen by Von Recklinghausen. They resemble white blood corpuscles, and possess active amœboid movements, so that they can wander through the corneal tissue. In a healthy cornea they have migrated out of the marginal blood-vessels; but in an inflamed cornea, where their number is greatly increased, they are in part white corpuscles derived from the blood, and in part produced by proliferation of the proper cornea corpuscles. The *intercellular matrix* of the cornea consists of a laminated substance, the lamellæ being arranged parallel to the surfaces of the cornea. The lamellæ consist of fasciculi of extremely delicate filaments; immediately under the anterior epithelium the fasciculi decussate with each other, and at the circumference of the cornea the fasciculi run into the connective tissue of the sclerotic. Bowman described a translucent structureless layer or anterior *elastic lamina* between the conjunctival epithelium and the cornea proper, but it is doubtful if this layer exists as a constant arrangement. Bowman and other observers have injected tubular spaces in the cornea which are apparently situated between the lamellæ. The exact nature of these spaces is somewhat doubtful, but Thin believes them to be lymph-vessels traversing its substance, for he has seen an endothelial lining similar to the endothelial cells of the lymphatics. It is probable that these spaces serve as the channels for the migrating corpuscles to wander through. Thin also describes the proper cornea corpuscles as lying in lacunæ, which communicate with each other and with the lymph-vessels. The *posterior elastic lamina* forms a distinct translucent, structureless layer adherent to the back of the proper tissue of the cornea, from which it may be stripped off without much difficulty. When torn across, the edges curl inwards towards the corneal tissue. It is from $\frac{1}{2000}$ to $\frac{1}{3000}$th inch thick, and resists the action of various reagents. This lamina thins off at its circumference and splits into fibres, which become continuous with the pectinate ligament of the iris.

The *posterior epithelium* of the cornea, also called the endothelium of the aqueous humour, forms a single layer of polygonal cells on the back of the posterior elastic lamina. It is continuous with the endothelial covering of the pectinate ligament and of the anterior surface of the iris.

The cornea is not in the adult traversed by blood-vessels, though in the fœtus a layer of capillaries lies near its anterior surface. In the adult, however, the margin of

the cornea is penetrated by a zone of capillary loops derived from the arteries of the conjunctiva; these loops, according to Lightbody, are invested by perivascular lymph spaces. The venous canal of Schlemm runs round the circumference of the cornea, at the junction of its deeper layers with the sclerotic. Leber states that it is not a simple canal, but a plexiform arrangement of veins. The nerves of the cornea first seen by Schlemm have been carefully examined by recent observers. They arise from the ciliary nerves, and enter the margin of the cornea in from twenty to forty fasciculi, which run from the circumference to the centre and to the anterior surface of the cornea, and give off numerous branches. The nerve fibres soon lose their medullary sheath, and branch; adjacent branches then communicate, and form plexuses which possess nuclei at the points of intersection of the nerves. From these plexuses delicate branches again arise, some of which penetrate between the cells of the anterior epithelium, whilst others end in the proper tissue of the cornea. Kühne stated that the terminal fibres ended in the cornea corpuscles, but this statement has not been confirmed.

Choroid coat. The *Choroid coat* forms the largest portion of the middle coat of the eyeball. It lies immediately internal to the sclerotic, and extends as far forward as the corpus ciliare, or annulus albidus, where it forms the ciliary processes; it is pierced posteriorly by the optic nerve. It has a deep black colour, from the numerous pigment cells it contains, and is abundantly provided with blood-vessels and nerves. The *Corpus ciliare*, or annulus albidus, is a greyish-white ring which surrounds the anterior border of the choroid close to the junction of the sclerotic and cornea. It consists of two portions—an external, the *ciliary muscle*, which lies next the sclerotic, and an internal, the *ciliary processes* (Plate XIX. fig. 4). These processes, about 80 in number, are folds, separated from each other by furrows which extend forwards in the meridional direction as far as the iris, and form collectively a zone-like plated frill around the circumference of the iris. On the one hand, they are continuous with the vasculo-pigmentary structures of the choroid; on the other, with the vasculo-pigmentary structures of the iris.

Iris. The *Iris* is a circular, flattened disc-shaped diaphragm, situated behind the cornea, in front of the crystalline lens, and bathed by the aqueous humour. By its circumference or ciliary border the iris is not only continuous with the ciliary processes, but is connected by fibres, termed *ligamentum pectinatum*, with the posterior elastic lamina of the cornea. The iris is the structure which gives the characteristic colour to the eye—blue, grey, brown, hazel, as the case may be. It is perforated at, or immediately to the inner side of, its centre by a circular aperture, the *pupil*, the size of which is regulated by the contraction or relaxation of the muscular tissue of the iris.

The structure of the several divisions of the middle coat will now be considered. The *Choroid coat* has its inner or anterior surface formed by a distinct *pigmentary layer* of hexagonal pigment cells (Fig. 43). In the eyes of Albinos, though the cells are present, they contain no pigment. In many mammals also, the pigment is absent from the inner surface, so that the choroid possesses a beautiful iridescent lustre, the *tapetum lucidum*. In ruminant animals and in the horse the iridescence is due to the reflection of the light by the bundles of the connective tissue stroma, but in cats from polygonal nucleated cells, which Schultze states contain double refracting crystals. Next the inner pigmentary layer is the *lamina vitrea*, the *elastic layer* of Kölliker. It forms a translucent membrane, described by some as structureless, but by Kölliker as faintly fibrous, which is intimately connected with the stroma of the choroid. The *stroma* consists of a plexiform arrangement of bundles of connective tissue, in the intervals between which numerous stellate pigment cells are situated, which give to the entire thickness of the choroid its black appearance. This stroma connects the outer surface of the choroid with the inner surface of the sclerotic, and forms the *lamina fusca*. Ramifying in the stroma are the blood-vessels and nerves. The vessels of the choroid are arranged in two layers. Next the lamina vitrea is a plexiform capillary layer, the meshes of which are so minute, and the vessels so compacted together, as to give the appearance of a vascular membrane, long known as the *membrana Ruyschiana*. The capillaries radiate like minute stars from the terminal twigs of the choroidal arteries and veins. The choroidal arteries and veins form a layer external to the capillaries, *i.e.*, next the lamina fusca. The arteries are the short posterior ciliary branches of the ophthalmic artery, which pierce the sclerotic close to the entrance of the optic nerve, and, running forwards in a tortuous manner, divide dichotomously before ending in the capillaries. The veins of the choroid are arranged in a series of remarkable whorls, named the *venæ vorticosæ*, which receive the blood not only from the capillaries of the choroid proper, but from those of the iris and ciliary body; they discharge their blood by means of from 4 to 6 veins into the ophthalmic vein. The *ciliary muscle* is the greyish white structure which forms the outer part of the ciliary body. It was at one time called the ciliary ligament, but its muscular nature was discovered almost simultaneously by Bowman and Brücke. It consists of smooth involuntary muscle, the fibres of which are arranged in two layers. The outer and thicker part of the muscle consists of fasciculi, which arise close to the canal of Schlemm, *i.e.*, opposite the junction of the sclerotic and cornea, and radiate from before backwards in the meridian of the eyeball, between the ciliary processes and the sclerotic. The inner part of the muscle forms a ring-like arrangement of fasciculi close to the circumference of the iris, and is often called the annular muscle of Müller. Iwanoff has shown that in long-sighted persons (hypermetropic) the annular muscle is strongly developed; whilst in short-sighted (myopic) eyes its fasciculi are very feeble. The *Ciliary Processes* have on their inner surface a black pigmentary layer of cells continuous with that of the choroid. The vitreous layer is also present, but according to H. Müller is no longer smooth but reticulated. The stroma does not contain so large a proportion of stellate pigment cells as in the choroid. The arteries have been carefully studied by Leber; they are the long posterior ciliary branches of the ophthalmic, and the anterior ciliary branches of the muscular branches of the ophthalmic. They pierce the sclerotic, run forwards, and at the anterior border of the ciliary muscle form by their anastomoses the *circulus arteriosus*, which gives origin to the arteries for the ciliary processes and the iris. The arteries for the ciliary processes are short, and divide into tortuous branches, which frequently anastomose, and form highly complex vascular plexuses, from which arise veins that join the venæ vorticosæ. Before the long ciliary arteries contribute to the formation of the arterial circle they send branches to the ciliary muscle, and recurrent branches to the anterior part of the proper choroid coat.

The iris has its anterior surface covered by a layer of cells continuous with the endothelium of the aqueous humour. This layer is continuous at the pupillary border with a thick layer of cells filled with black pigment granules, the *uvea*, which covers the posterior surface of the iris, and is continuous at its ciliary border with the pigmentary layer of the ciliary processes. The connective tissue stroma of the iris also contains stellate pigment cells. The variations in colour of the iris in different eyes depends upon the distribution and amount of the pigment in the uvea and the

stellate cells: in dark-coloured eyes, both are filled with dark pigment granules; whilst in light-coloured eyes the stellate cells of the stroma are either devoid of pigment or only faintly coloured. The iris contains numerous fasciculi of involuntary or non-striped muscular fibre arranged in two directions. Circularly arranged fibres surround the aperture of the pupil, and form the sphincter muscle, by the contraction of which the size of the pupil is diminished. Smooth muscular fibres also radiate from the pupillary to the ciliary border of the iris and form the dilatator muscle. The muscular nature of these fibres in the human iris was long disputed, but was satisfactorily demonstrated in 1852 by Lister. Jeropheef has also described circular fasciculi surrounding the ciliary border. In birds and reptiles the muscular tissue of the iris consists of transversely striped fibres. The arteries of the iris arise from the circulus arteriosus, and run radially forwards towards the pupil, where they anastomose and form the *circulus iridis minor*. They possess relatively thick external and muscular coats. The capillaries form a plexus not so compact as that of the choroid coat. The veins of the iris end in the venæ vorticosæ. In the fœtus the pupil is closed in by a delicate membrane, *membrana pupillaris*, into which the blood-vessels of the iris are prolonged. This membrane disappears by absorption during the later months of embryo life. The nerves of the middle coat of the eyeball are the long ciliary branches of the ophthalmic division of the 5th and the short ciliary branches of the ciliary ganglion (Pl. XIX. fig. 7, $\frac{c}{5}$). They pierce the sclerotic near the optic nerve, and run forward in the lamina fusca of the choroid. They give off branches to the choroid which form in it a plexus in which H. Müller found nerve cells. From this plexus delicate branches pass to the muscular coat of the choroidal arteries. The ciliary nerves then enter the ciliary muscle, and form plexuses with interspersed nerve cells, from which branches pass to the muscular fibres. Other branches of the ciliary nerves enter the iris, and form plexuses, from which branches proceed to the muscular tissue.

Retina. The *Retina* is the delicate nervous coat of the eyeball which lies immediately internal to the choroid, and extends

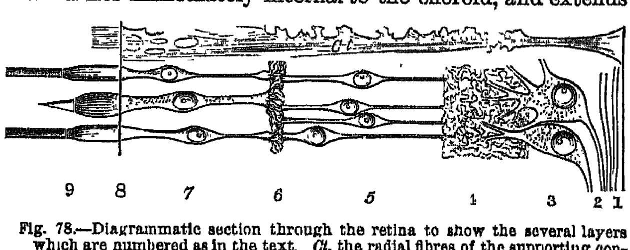


Fig. 78.—Diagrammatic section through the retina to show the several layers which are numbered as in the text. *Ct*, the radial fibres of the supporting connective tissue.

from the place of entrance of the optic nerve as far forward as the ciliary processes, where it forms a jagged border, the *ora serrata*. In the living eye it is translucent and colourless, but shortly after death it becomes grey: it is soft and so easily torn that it is difficult to display it in a dissection without injury. Its inner or anterior surface, concave forwards, is moulded on the vitreous body, and presents the following appearances:—Almost exactly in the antero-posterior axis of the eyeball is a transversely oval *yellow spot*, about $\frac{1}{20}$th inch in its long diameter, which amongst mammals is found only in man and apes, though, as Knox and Hulke have shown, it exists in reptiles; in the centre of this spot is a depression, the *fovea centralis*; about $\frac{1}{8}$th inch to the inner side of the yellow spot is a slight elevation, the *papilla optica*, which marks the disc-like entrance of the *optic nerve* into the retina; here the fibres of the nerve radiate outwards and forwards to the ora serrata, and branches of the *arteria centralis retinæ* accompany then.

The retina is highly complex in structure, and consists of nerve fibres and cells, of peripheral end-organs, of connective tissue, and of blood-vessels, arranged in several layers. Max Schultze, who is the chief authority on the subject, recognises ten layers, but includes among these the layer of hexagonal pigment cells just described as the inner pigmentary layer of the choroid. If this layer be omitted, nine layers may then be recognised, and, following Schultze, be named from before backwards as follows:—1. Membrana limitans interna; 2. Layer of optic nerve fibres; 3. Layer of ganglion cells; 4. Internal granulated (molecular) layer; 5. Internal granule layer; 6. External granulated layer; 7. External granule layer; 8. Membrana limitans externa; 9. Bacillary layer (Fig. 78).

The nervous elements of the retina will first be considered. The *optic nerve fibres* (2), where they pierce the sclerotic, as a rule lose the medullary sheath, and radiate outwards as non-medullated fibres from the optic disc to the ora serrata immediately behind and parallel to the membrana limitans interna. These fibres vary greatly in size, and are frequently varicose. When any of the optic nerve fibres retain the medullary sheath the retina is there rendered opaque. Immediately behind the nerve fibres is the *layer of ganglionic nerve cells* (3). These cells are either bipolar or multipolar. In the living eye the cell substance is hyaline and the nucleus transparent, but after death the substance both of the body of the cell and the processes assumes a fibrillated appearance, like the axial cylinder of an optic nerve fibre. One process, the central process, extends into the layer of optic nerve fibres; and another, the peripheral, into the internal granulated layer. The *internal granulated layer* (4) contains the branching processes of the nerve cells, some of which apparently become continuous with an arrangement of excessively fine fibrils, probably nervous in their nature. These fibrils are intermingled with a delicate plexus of connective tissue. The *internal granule layer* (5) contains numerous fusiform nucleated enlargements, the so-called internal granules, arranged in superimposed strata; from each fusiform enlargement a fibre proceeds in two directions, one centrally into the internal granulated layer, and one peripherally into the external granulated layer. These fibres possess varicosities, and resemble the optic nerve fibres. The *external granulated layer* (6) is very thin, and consists of an expanded network of minute fibres, with nuclei situated at the points of intersection of the fibres. Krause has called it the *membrana fenestrata*. The *external granule layer* (7) contains numerous fusiform nucleated enlargements, the so-called external granules, arranged in superimposed strata: from each enlargement a fibre proceeds in two directions, one centrally into the external granulated layer, and one peripherally through the membrana limitans externa to the bacillary layer, where it becomes continuous with the anterior end of either a rod or a cone, as the case may be. Hence these fibres of the external granule layer are called by Schultze rod and cone fibres, and the external granules are nucleated enlargements of these fibres. These fibres possess varicosities like those of the internal granule layer.

The *bacillary layer* (9) or membrane of Jacob consists of multitudes of elongated bodies arranged side by side like rows of palisades, and vertically to the surfaces of the retina. Some of these bodies are cylindrical, and are named the *rods* of the retina; others flask-shaped, and named the *cones* of the retina: the rods equal in length the entire thickness of the bacillary layer; the cones are shorter than the rods, and are interspersed at regular intervals between them; the apex of each cone is directed towards, but does not reach, the plane of the posterior or choroidal surface of the retina. The posterior or outer end of each rod rests against the pigmentary layer of the choroid.

The anterior or inner ends of both rods and cones are continuous with the rod and cone fibres of the external granule layer, as already described. Each rod and cone is subdivided into an outer strongly refractile and an inner feebly refractile segment. By the action of various reagents the outer segments both of the rods and cones exhibit a transverse striation, and ultimately break up into discs. Hensen has described a longitudinal striation in the outer segments, and Ritter has stated that both in the outer and inner segments of the rods an axial fibre exists. Max Schultze has also seen the inner segments of both rods and cones longitudinally striped on the surface. Modifications in the relative numbers and appearances of the rods and cones have been seen in the eyes of various vertebrata. In birds, for example, the cones are much more numerous than the rods, whilst the reverse is the case in mammals generally. In the cartilaginous fishes the cones are entirely absent; so also, as Schultze has shown, in the bat, hedge-hog, and mole; whilst in reptiles the bacillary layer is exclusively composed of cones. In all the vertebrata, except the mammalia, the twin or double cones described by Hannover probably exist. In the amphibia, lens-shaped bodies have been described in the inner segments of the cones. The rods and cones are the peripheral end-organs in connection with the fibres of the optic nerve, and their apparent relation to these fibres is as follows:—The optic nerve fibres are continuous with the central processes of the ganglion cells of the retina, the peripheral branching processes of which pass into the internal granulated layer, where they may possibly become continuous with the central processes of the inner granular layer. The peripheral processes of the inner granular layer enter the external granulated layer, but it is difficult to say whether or not they become continuous with the central processes of that layer. There can, however, be no doubt that the peripheral processes of this layer are directly continuous with the rods and cones of the bacillary layer. The entire arrangement is sometimes called the radial nervous fibres of the retina.

In addition to the nervous structures just described, the retina contains a delicate supporting connective tissue like the neuroglia of the brain and spinal cord. Not only does it lie between the fibres, cells, and so-called granules in the several nervous layers, and form in them a radial arrangement of supporting fibres, but it constitutes the two limitary membranes of the retina. The *membrana limitans externa* (8) is excessively thin, and appears in vertical sections through the retina as a mere line between the bacillary and external granular layers, continuous on the one hand with the connective tissue which passes for a short distance between the rods and cones, and on the other with the connective tissue framework of the external granule layer.

The *membrana limitans interna* (1) covers the anterior surface of the retina, and lies next the vitreous body; its posterior surface blends with the radial arrangement of connective tissue between the optic nerve fibres, but its anterior or hyaloid surface, as J. C. Ewart has recently shown, possesses a mosaic appearance, like that of a layer of squamous endothelium.

The *yellow spot* exhibits some structural differences from the rest of the retina. It owes its colour to the presence of yellow pigment deposited in the more anterior layers of the retina. Except at its central depression, the *fovea centralis*, it is thicker than the surrounding parts of the retina; but it is much softer, a condition which is due to the almost complete absence of the layer of optic nerve fibres, and a diminution in the amount of the supporting connective tissue; the membrana limitans interna is, however, relatively stronger. In the fovea centralis itself the rods of the bacillary layer have entirely disappeared, and are replaced by cones which are distinguished by their close arrangement, and the more slender form and increased length, especially of their outer segments. The external granule layer is well marked, and the central fibres belonging to it, instead of passing vertically forwards, incline very obliquely or almost horizontally outwards to the internal granule layer, which, together with the layers anterior to it, is so thin as almost to have disappeared. In the yellow spot surrounding the fovea the bacillary layer is also composed of cones which are not, however, so slender or so long as at the fovea itself. The layer of nerve cells and the inner part of the external granule layer are thicker than in the rest of the retina. The yellow spot is the part of the retina most sensitive to light.

At the *ora serrata* or anterior border of the retina the nervous layers, including the rods and cones, cease to exist. The radial connective tissue and internal limiting membrana are present; from the radial tissue a layer of cells is prolonged forward in contact with the deep surface of the ciliary processes as the *pars ciliaris retinæ*.

The retina is supplied with blood by the arteria centralis, which, traversing the axis of the optic nerve, reaches the retina at the optic disc. In the retina it branches dichotomously in the nerve fibre layer, avoiding however the yellow spot, and its terminal twigs reach the ora serrata. The capillaries form in the more anterior layers of the retina a distinct network, which does not enter the external granule and bacillary layers, but penetrates the yellow spot, though not the fovea centralis. The blood is conveyed from the retina by the central vein which accompanies the artery in the optic nerve, and opens either into the ophthalmic vein or directly into the cavernous sinus. The veins and capillaries of the retina have been described by His as completely invested by perivascular lymphatic sheaths, whilst the arteries only possess such sheaths for a limited part of their course.

The *Optic Nerve* itself passes from the orbit through the optic foramen into the cranial cavity, where it arises from the *optic commissure*. This commissure is a flattened band formed by the junction of the two *optic tracts*. Each tract winds backwards around the tuber cinereum and crus cerebri to arise from the optic thalamus, corpora quadrigemina, and geniculata; and some observers also state that it derives fibres from the tuber cinereum and lamina cinerea. In the commissure an interchange takes place between the fibres of opposite nerves and tracts, so that not only does an optic nerve contain fibres derived from the tract on its own side, but from the opposite tract, and it has even been stated that fibres pass across the commissure from one optic nerve to the other, and from one optic tract to the other. Nerve of sight.

The *Aqueous Humour* is a limpid watery fluid, containing a little common salt in solution, which occupies the space between the cornea and the front of the crystalline lens. In this space the iris lies, and imperfectly divides it into two chambers, an anterior and a posterior, which communicate with each other through the pupil. The anterior chamber, of some size, is situated between the iris and cornea; but as the iris is in contact with the front of the lens, the posterior chamber is reduced to a mere chink between the circumference of the iris and that of the lens. Refracting media.

The *Crystalline Lens* is situated behind the iris and pupil, and in front of the vitreous body. It is a transparent bi-convex lens, with its antero-posterior diameter ⅓d less than the transverse, its posterior surface more convex than the anterior, and with its circumference rounded. It consists of a capsule and the body of the lens enclosed by the capsule. The *lens capsule* is a transparent, smooth, structureless, and very elastic membrane, about twice as thick on the anterior as on the posterior surface of the lens. It is non-vascular in the adult, though in the fœtus a branch of the central artery of the retina which traverses the

vitreous humour, ramifies in its posterior portion. A single layer of polygonal cells lies between the body of the lens and the anterior portion of the capsule. The *lens body* is softer at its periphery than in its centre. It is built up of concentric layers, and on both the anterior and posterior surfaces lines are to be seen radiating from the central pole of each surface towards the circumference of the body. The radiated pattern varies in different animals. In the human fœtus there are usually three lines, but in the adult they are more numerous. The lines on one surface do not lie immediately opposite those on the other, but are intermediate. By the action of strong spirit and other reagents the body of the lens can be split up from the periphery towards the centre in the direction of these lines, so that they mark the edges of apposition of its concentric laminæ. Each lamina consists of numerous hexagonal fibres about $\frac{1}{8000}$th inch wide, which extend from one surface to the other over the circumference of the lens, so that a fibre which begins at the polar end of a radius on the one surface terminates at the circumferential end of a radius on the opposite. The edges of the fibres are sinuous in man, but denticulated in many animals, especially fishes, so that the fibres, not only in the same, but in superimposed layers, are closely interlocked. The lens fibres are nucleated, a structural fact which gives a clue to their true nature, and they are now regarded as peculiarly modified elongated cells. Babuchin states that he can trace the transition from the cells of the layer between the lens-body and capsule to the proper lens fibres. The lens-body is non-vascular and non-nervous. The surfaces of the lens become more flattened in old age, and its substance hardens and is less transparent.

The *Vitreous Body* is much the largest of the refracting media, and occupies the largest part of the space enclosed by the tunics. Anteriorly it is hollowed out to receive the posterior convexity of the lens, but posteriorly it is convex, and the retina is moulded on it. It is as translucent as glass, jelly-like in consistency, and when punctured a watery fluid drains out. Its minute structure is difficult to ascertain, but as it, like the subcutaneous tissue of the embryo, contains rounded, stellate, and fusiform cells, it is customary to refer it to the gelatinous form of connective tissue; concentric lamellæ, and even a radiated arrangement of fibres, have also been described. It has been customary also to consider it as invested by a delicate structureless membrane, the *hyaloid membrane*; but this is now regarded as belonging to the retina, where it is known as the *membrana limitans interna*. Almost opposite the ora serrata a membrane springs from the vitreous body, passes forwards for some distance in relation to the deep surface of the ciliary processes, but separated from them by the pars ciliaris retinæ, and then inclines inwards to become attached to the anterior surface of the capsule of the lens close to its circumference. It is so closely connected at its origin with the membrana limitans that it is difficult to recognise it as a distinct membrane. It is named the *suspensory ligament of the lens*, or *zonule of Zinn*, and contains fibres, which run in the meridional direction. Where it leaves the vitreous body a narrow space is enclosed between it and that body, which space surrounds the circumference of the lens, and is called the *canal of Petit*. From the relation of the suspensory ligament to the ciliary processes it has a plicated surface, and when these processes are torn away from it a portion of the pigment of the processes is often left behind, so that the zonule is sometimes named the *ciliary processes of the vitreous body*.

The eye an optical instrument. The Eyeball is an optical instrument, constructed on the plan of the camera obscura. The sclerotic forms the wall of the chamber. The choroid represents the black lining for absorbing the surplus rays of light. The cornea, aqueous humour, lens, and vitreous body are the translucent media which, like the glass lens of the camera obscura, bring the rays of light to a focus. The retina is the sensitive plate on which the optical picture is thrown. In considering the relation of the retina to the visual rays, it must be kept in mind that the place of entrance of the optic nerve is insensible to light, and that the most sensitive part of the retina is the yellow spot, with its fovea centralis, where the optic nerve fibres are absent, but where the bacillary layer reaches its maximum size. It is clear, therefore, that the rods and cones of this layer, and not the optic nerve fibres, are the structures in the retina which are stimulated by the light; and it is probable, as was suggested many years ago by Goodsir, that these rods and cones are impressed by the light, not as it enters the eye directly, but as it is reflected backwards from the choroid along their axes. The iris is the diaphragm which, by opening or closing the pupil, admits or cuts off the rays of light. The ciliary muscle represents the adjusting screw of the camera; through its attachment to the ciliary processes and their relation to the suspensory ligament of the lens, it is able to act upon the lens and modify the curvature of its anterior surface; for when the eye is to be accommodated to the vision of near objects the anterior surface of the lens becomes more convex than when distant objects are being examined.

Development of eye. It has already been stated on p. 864 that the retina is formed in the *primary optic vesicle*, which grows forwards to the integument. By the involution and growth of the skin at this spot a hollow is produced at the front of the vesicle, which gradually deepening forms a pouch, the *secondary optic vesicle*, in which the involuted part of the skin is lodged. From the included sub-epidermal tissue the vitreous body is derived; from the included epidermis, the lens; whilst the cornea sclerotic and iris are produced by the subcutaneous connective tissue. The optic nerve and retina are formed from the primary optic vesicle and its peduncle, and it is probable that the bacillary layer is a special development of its internal epithelial lining. The choroid coat again is derived from the pia mater. Hence the eyeball is compounded of structures derived partly from the integument and partly from the embryo brain.

Accessory Parts to the Eyeball.—In relation to the eyeball several accessory parts are found.

The *Eye-Brows* are projections of the integument, from which short, stiff hairs grow.

Eyelids. The *Eye-Lids*, or *palpebræ*, are two movable curtains, an upper and a lower, which protect the front of the globe. Between each pair of lids is a horizontal fissure, the *palpebral fissure*. From the free margins of the two lids project short hairs, the *eye-lashes* or *cilia*; the upper set curve downwards and forwards, the lower set upwards and forwards; they also protect the front of the globe. Each eye-lid consists of skin; of the fibres of the orbicular sphincter muscle; of a thin plate of fibro cartilage, the *tarsal cartilage*, to the inner end of which a fibrous band, the *tendo palpebrarum*, is attached, this tendon springing from the ascending process of the superior maxilla; and of the conjunctiva. Between the conjunctiva and the tarsal cartilage is a layer of glands, the *Meibomian glands*; each gland consists of a short duct, which expands at its sides into small sacculi. The sacculi contain short columnar cells; these secrete a sebaceous material, which escapes through the orifice of the duct at the border of the eye lid.

Conjunctiva. The *Conjunctiva* is a mucous membrane, which forms the posterior layer of the eye-lid, and is reflected on to the anterior part of the sclerotic. At the inner angle of junction of the eye-lids is a soft reddish elevation of the conjunctiva, the *caruncula lachrymalis*, and immediately external to it is a vertical fold, the *plica semilunaris*, the

rudiment of the third eye-lid, or membrana nictitans, so well developed in birds. The palpebral conjunctiva has small papillæ scattered over its surface; its epithelium is stratified, with scaly cells on the free surface and elongated cells in the deepest layer. In the sub-epithelial tissue are small branched mucous glands, which are numerous in the caruncula. Little masses of adenoid tissue (p. 849) with lymphatic vessels are also found in it, and the conjunctiva of the front of the eyeball is thinner than the palpebral part. It is not glandular, and its nerves terminate in end-bulbs (p. 862). The palpebral conjunctiva, and in part that of the eyeball, receive their blood-vessels from those of the eye-lids, but the portion of the conjunctiva next the cornea is supplied by the arteries of the sclerotic coat.

Lachrymal apparatus.

The *Lachrymal Apparatus* is engaged in the secretion of the tears, and in conveying them away from the front of the globe. The *lachrymal gland* occupies a depression in the outer part of the roof of the orbit. It is smaller than an almond, is sub-divided into lobules, and belongs to the group of compound racemose glands. It consists of the ramifications of short ducts, which terminate in small sacculi. The wall of each sacculus consists of a delicate membrana propria, and the cavity contains the polyhedral secreting cells. Outside the membrana propria is a capillary network derived from the lachrymal artery, but Giannuzzi and Boll have recently described a space between this network and the membrana propria which they believe to be continuous with the lymphatic system. Pflüger has described nerves as terminating in connection with the secreting cells. The excretory ducts of the gland are from six to eight, and open on the back of the upper eye-lid. The tears are washed over the surface of the globe by the involuntary winking of this lid. When the secretion is increased in quantity, in the act of crying, the tears flow over the cheek, but in ordinary circumstances they are conveyed away by two slender tubes, the *lachrymal canals*, which open by minute orifices, the *puncta lachrymalia*, one at the inner end of the free border of each eye-lid. These tubes open at their opposite ends into a small reservoir, the *lachrymal sac*, situated in a hollow in the lachrymal bone. From this sac a duct, the *nasal* or *lachrymal duct*, proceeds which opens into the inferior meatus of the nose, and here the tears mingle with the mucous secretion of that cavity.

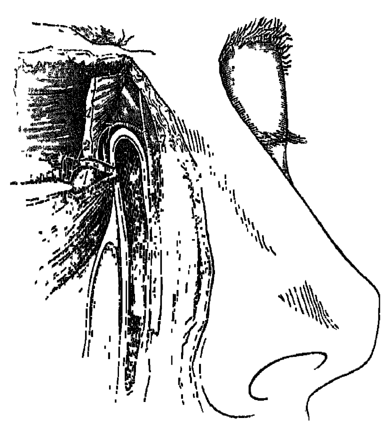


FIG. 79.—Lachrymal canals and duct. 1, orbicular muscle; 2, lachrymal canal; 3, punctum; 4, caruncula; 5, lachrymal sac; 6, lachrymal duct; 7, angular artery.

Muscles of eyeball.

Muscles of the Eyeball.—The sclerotic coat of the eyeball has six muscles inserted into it. Four of the muscles are called *recti*, and are situated, one superior, one inferior, one external to, another internal to, the globe. They all arise from the rim of bone which bounds the optic foramen; the external and internal muscles are inserted vertically into the sides of the sclerotic, but the superior and inferior recti have oblique insertions into its upper and lower aspects. The other two muscles are called *obliqui*. The superior oblique arises along with the recti, passes to the inner end of the upper border of the orbit, where its tendon goes through a pulley, and is directed back to be inserted obliquely into the upper and outer part of the sclerotic. The inferior oblique arises from the lower border of the orbit, passes outwards and upwards to be inserted obliquely into the sclerotic. These muscles roll the eyeball in the orbit, and, without entering into a minute analysis of their actions, their office may be stated generally as follows:—The internal rectus rolls it inwards, the external outwards, about its vertical axis; the superior rectus rolls it upwards, the inferior downwards, about its transverse horizontal axis, though from the obliquity of their insertions they give it at the same time a slight inward or outward movement as the case may be; the superior and inferior oblique roll the globe around its antero-posterior or sagittal axis, the superior upwards and outwards, the inferior downwards and outwards.

Periosteal Muscle of the Orbit.—The periosteum of the orbit contains, as H. Müller and Turner have described, a layer of non-striped muscular fibre in the part which covers over the spheno-maxillary fissure. In man it is rudimentary, but in the sheep, deer, elephant, &c., where the osseous wall of the orbit is deficient, this muscle forms a well-defined structure. It has been suggested that it acts as a protractor muscle of the globe.

Ear.

The EAR, or organ of hearing, is a complex acoustic apparatus, situated in connection with the temporal bone. It is divided into three parts, named external, middle, and internal ear.

External ear.

The *External Ear* consists of the pinna or auricle and the external auditory meatus. The *auricle* is the oblong convoluted body situated at the side of the head. Its incurved outer border is named the *helix*. Within this lies a curved ridge, the *anti-helix*, in front of which is a deep hollow, the *concha*, which leads into the external meatus. The concha is bounded in front by a prominence, the *tragus*, and behind by a smaller prominence, the *anti-tragus*; below the anti-tragus is the *lobule*, which forms the most depending part of the auricle. The framework of the auricle is formed of yellow elastic fibro-cartilage invested by integument, except the lobule, which consists merely of a fold of integument containing fat. Attached to the cartilage are not only the three auricular muscles referred to on page 836, but also certain smaller muscles called the proper muscles of the pinna. Thus the *greater muscle of the helix* is placed on its anterior border; the *lesser muscle of the*

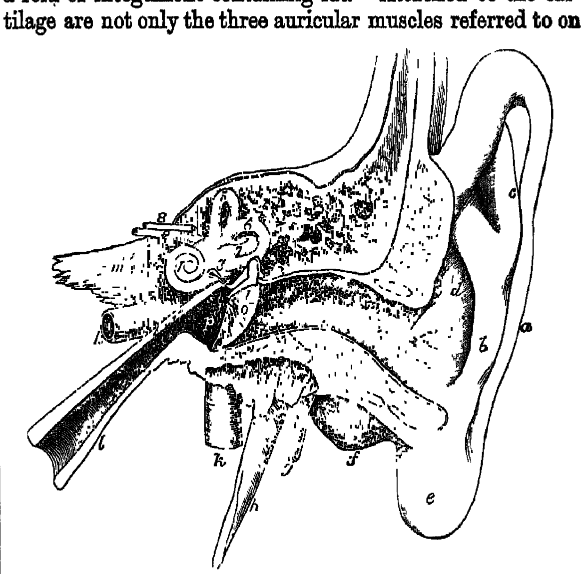


FIG. 80.—The ear as seen in section. *a*, helix; *b*, anti-tragus; *c*, anti-helix; *d*, concha; *e*, lobule; *f*, mastoid process; *g*, portio dura; *h*, styloid process; *k*, internal carotid artery; *l*, Eustachian tube; *m*, tip of petrous process; *n*, external auditory meatus; *o*, membrani tympani; *p*, tympanum; 1, points to malleus; 2, to incus; 3, to stapes; 4, to cochlea; 5, 6, 7, the three semicircular canals; 8 and 9, portio dura and portio mollis.

helix is situated where it arises out of the concha; the *muscle of the tragus* lies on the front of that prominence; the *muscle of the anti-tragus* is placed on the back of that prominence; the *transverse muscle* on the posterior or cranial surface of the auricle.

The *External Meatus* leads from the bottom of the concha into the temporal bone, and is separated from the tympanum or middle ear by the membrana tympani. It is a crooked passage one and quarter inch long, inclined at first forwards and upwards, then downwards and inwards. The wall of the outer end of the passage is formed of fibro-cartilage continuous with the cartilage of the auricle, whilst that of the deeper end is formed of the plate-like tympanic part of the temporal bone. The passage is lined with integument continuous with the skin of the auricle, in which are situated numerous hairs, together with ceruminous glands which secrete the well-known yellow "wax."

Middle ear. The *Tympanum*, or *Drum*, or *Middle Ear*, is a chamber irregularly cuboidal in form, situated in the temporal bone between the bottom of the meatus and the internal ear. The outer wall is formed of the *membrani tympani*, which inclines obliquely downwards and inwards at the bottom of the external meatus, at an angle of 55° to the axis of the meatus, whilst the membranes in the two ears form with each other an obtuse angle of 130° to 135°. The tympanic membrane is attached to a groove at the bottom of the meatus, and is concave on its outer, convex on its inner surface. It consists of three layers: an external tegumentary, continuous with the skin of the meatus, which contains no hairs or glands; an internal mucous, continuous with the mucous lining of the tympanum; and an intermediate membrana propria, which consists of unyielding fibres arranged both radially and circularly. The radial fibres radiate from the point of attachment of the handle of the malleus. The membrana propria is usually said to be destitute both of nerves and vessels, but Kessel states that nerves, blood, and lymph vessels exist in it as well as in the mucous and tegumentary layers. Immediately in front of the membrana tympani is the Glaserian fissure. The inner wall separates the tympanum from the labyrinth, and presents the following appearances: a rounded elevation or *promontory* caused by the first turn of the cochlea, on the surface of which promontory are grooves for the lodgment of the tympanic plexus of nerves; above the promontory is an oval opening closed in by a membrane, the *fenestra ovalis*, which corresponds with the vestibule; behind and below the promontory is a round opening closed in by a membrane, the *fenestra rotunda*, which corresponds with the tympanic passage in the cochlea. The floor of the tympanum is a narrow chink between the inner and outer walls; and the roof is formed by the anterior surface of the petrous-temporal bone. At its anterior wall the tympanum opens into the *Eustachian tube*, a canal which communicates with the nasal compartment of the pharynx immediately behind the inferior turbinal. The wall of the tympanic end of this tube is formed of bone, that of the pharyngeal end of a curved plate of hyaline cartilage, which is connected to the bone by fibro-cartilage; its pharyngeal orifice is dilated into a trumpet-shaped mouth; through this tube the ciliated mucous membrane of the nasal part of the pharynx is prolonged into the tympanum. The cartilaginous wall of the tube does not completely surround it, but is completed by a fibrous membrane, and a layer of voluntary muscle, named by Rüdinger the dilatator tubæ. Above the tympanic orifice of the Eustachian tube is a fine canal, through which the tensor tympani muscle enters the tympanum. At its posterior wall the tympanum communicates with the air-sinuses in the mastoid temporal; here also is found a small hollow eminence, the *pyramid*, through a hole at the apex of which the tendon of the stapedius muscle passes; and a foramen which transmits the chorda tympani nerve.

The tympanic cavity contains three small bones, named malleus, incus, and stapes, arranged so as to form an irregular chain, stretching across the cavity from the outer to the inner wall.

The *Malleus* or hammer is the most external bone. In it may be recognised a head separated by a constricted neck from an elongated handle. Close to the junction of the neck and handle a long slender process projects downwards and forwards to be inserted into the Glaserian fissure, and near the root of the long process a short process projects outwards. By its handle the malleus is intimately connected with the centre of the membrana tympani; by its head it articulates with the incus; whilst ligamentous fibres pass from it upwards, forwards, outwards, and backwards to the tympanic walls.

The *Incus*, or anvil-shaped bone, possesses a body and two processes; on the anterior surface of the body is a saddle-shaped hollow in which the head of the malleus fits; the short process projects almost horizontally backwards, and is attached by a ligament to the posterior wall of the tympanum; the long process extends at first downwards and then inwards, to end in a rounded projection, named *os orbiculare*, through which it articulates with the stapes.

The *Stapes*, or stirrup-shaped bone, possesses a head and neck, a base and two crura; the head articulates with the os orbiculare of the incus; from the constricted neck the two crura curve inwards to the base, which is attached to the fenestra ovalis. The joint between the malleus and incus is diarthrodial and saddle-shaped, and the articular surfaces are enclosed by a capsular ligament. The joint between the incus and stapes is also diarthrodial, and possesses an investing capsular ligament. Toynbee and Rüdinger have described the base of the stapes and the margin of the fenestra ovalis as each invested by hyaline cartilage. Between these plates elastic fibres extend in a plexiform manner, and the intervals between them are occupied by fluid; the joint seems, therefore, a modified amphiarthrosis. The bones are moved on each other at these joints by small muscles. The *tensor tympani* arises from the apex of the petrous temporal, and the cartilage of the Eustachian tube enters the tympanum at its anterior wall, and is inserted into the malleus near the root. The *laxator tympani* muscle arises from the spine of the sphenoid, and the cartilage of the Eustachian tube enters the tympanum through the Glaserian fissure, and is inserted into the neck of the malleus.* The *stapedius* arises within the pyramid, enters the tympanum through the hole at its apex, and is inserted into the neck of the stapes. The tympanum is lined by a mucous membrane continuous with that of the Eustachian tube, which invests the tympanic ossicles, ligaments, and muscles, and is prolonged backwards so as to line the mastoid air-sinuses. The epithelium covering this membrane, where it lines the floor and the adjacent part of the anterior, posterior, and internal walls, consists of ciliated columnar cells; but the epithelium covering the roof, the promontory, the membrani tympani, and the tympanic ossicles, is tessellated. In the sub-epithelial connective tissue the blood and lymph vessels and nerves of the tympanum ramify. Kessel has recently described in it certain *peculiar bodies*, which consist of a central axial band with a series of capsules, possessing a fibrillar structure, arranged concentrically around the axis the function of these bodies is not known.

The formation of the auricle and external meatus is well adapted for collecting and transmitting sound vibrations inwards to the middle ear and labyrinth These vibrations strike the membrana tympani, and are propagated by the

chain of bones across the tympanic cavity to the labyrinth. The pressure of the vibrations on the tympanic membrane forces that membrane inwards, so that its inner surface presses on the handle of the malleus, the effect of which is to rotate the hammer about its axis; but by the ligamentous attachment of the malleus to the tympanic walls and to the incus, and, as Helmholtz has shown, by the interlocking of cog-like processes connected with the articular surfaces of the two bones, the range of movement is so limited that the pressure on the malleus is transmitted through the incus upon the stapes, which presses, therefore, on the membrane of the fenestra ovalis, so that the movements of the membrana tympani are thus transmitted to fluid within the labyrinth. The tensor tympani muscle tightens the tympanic membrane by drawing the handle of the malleus inwards, and still further adapts the structures for the transmission of sound-vibrations. An antagonistic muscle, the laxator tympani, has also been described. There is some difficulty in determining the action of the stapedius, but if, as is probable, it draws the stapes from the fenestra ovalis, it will diminish the pressure of the chain of bones on that membrane.

Internal ear.

The *Internal Ear*, named the *Labyrinth*, from its complex construction, is the part of the auditory apparatus in which the nerve of hearing is distributed, and where the peripheral end-organs are situated. It is imbedded in the petrous bone, and is divided into three parts, viz., vestibule, semicircular canals, and cochlea, each of which consists of an osseous and a membranous portion (Pl. XIX. figs. 8, 9, 10).

The *Vestibule* lies immediately internal to the tympanum, between it and the bottom of the internal auditory meatus; behind it are the semicircular canals, and in front is situated the cochlea. It is the part of the labyrinth which first appears in animals, and is therefore the most constant part of the organ. In the myxinoid fishes a single semicircular canal is superadded to the vestibule, in the lamprey two canals, but in other fishes and in the higher vertebrates three canals exist. In amphibia, reptiles, and birds the cochlea is small and rudimentary in comparison with its development in mammals. The osseous vestibule is an ovoid chamber about $\frac{1}{5}$th inch in diameter. In its outer or tympanic wall is the *fenestra ovalis;* in its inner are small *auditory foramina*, which transmit from the internal meatus the vestibular branches of the auditory nerve; behind these holes is the opening of a minute canal, the *aqueductus vestibuli;* its anterior wall communicates with the *scala vestibuli* of the cochlea, and into its posterior wall open the five orifices of the three semicircular canals.

The *Semicircular Canals* are named superior, posterior, and external. The superior and posterior are sometimes called the vertical canals, and the external the horizontal canal, but, as Crum Brown has shown, the superior and posterior lie in planes equally inclined to the mesial plane of the head, and the external is in a plane at right angles to the mesial plane. Further, the canals in the two ears have definite relations to each other; for whilst the superior canal of each ear is nearly parallel to the posterior canal of the other, the external canals in both ears lie nearly in the same plane. The canals are bent, forming nearly $\frac{2}{3}$ds of a circle, and would have had six openings into the vestibule had not the contiguous ends of the superior and posterior blended together to open by a common orifice. The opposite end of each of these canals and the outer end of the external canal dilate close to the vestibule to twice their usual diameter, and form an *ampulla*. The osseous vestibule and semicircular canals are lined by a periosteum invested by a tessellated endothelium, and contain a little fluid, the *perilymph*. In this fluid the membranous labyrinth is suspended.

The membranous vestibule is formed of two small sac-like dilatations, the walls of which are directly continuous with each other, though the cavities are separated by an intermediate partition. The upper and posterior dilatation, named *utriculus*, is larger than the lower and anterior, named *sacculus*. The sacculus is continuous with the *ductus cochlearis* of the membranous cochlea, and both sacculus and utriculus communicate by slender tubes with a short diverticulum lodged in the aqueductus vestibuli, to which the name of *ductus vestibuli* may be given. The membranous semicircular canals are about $\frac{1}{3}$d the diameter of the osseous. Their walls are continuous with that of the utriculus, and they open by five orifices into it. Each has an ampulla within the ampulla of the osseous canal. Both the sacculus and utriculus are in places attached to the periosteal linings of the osseous vestibule, and delicate ligamentous bands connect the membranous semicircular canals to the periosteal lining of the tubes in which they are contained. The wall of the membranous vestibule and canals consists of a delicate fibrous membrane lined by a tessellated endothelium. The inner part of this membrane has a vitreous or hyaline lustre, and gives origin in the canals to short papillæ which project into the lumen. The membranous vestibule and canals are distended with the fluid *endolymph*. The sacculus, utriculus, and ampullæ are specially modified in connection with the peripheral termination of the vestibular branches of the auditory nerve. The membranous wall forms in each of these dilatations a projecting ridge, the *crista acoustica*, to which calcareous particles, the *otoliths*, which may be either amorphous or crystalline, are adherent. The endothelial investment of the crista is elongated into columnar cells, and intercalated between them are fusiform cells, the *auditory cells*, each of which, as Schultze and other observers have described, possesses a peripheral and a central process. The peripheral process projects beyond the plane of the free surface of the endothelium into the endolymph as the *auditory hair*, whilst the central process extends into the sub-endothelial tissue, where the nerve plexus belonging to the terminal branches of the auditory nerve ramifies, and with which it is probably continuous. These auditory cells are, therefore, the peripheral end-organs of the vestibular branches of the auditory nerve, and their general arrangement is not unlike that of the olfactory cells of the nose.

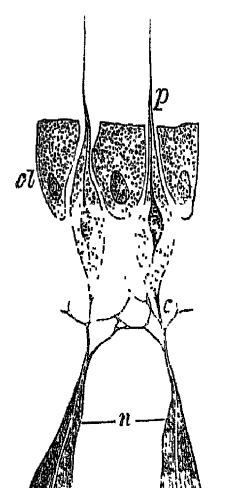


FIG. 81.—*cl*, columnar cells covering the *crista acoustica*, *p*, peripheral, and *c*, central processes of auditory cells, *n*, nerve fibres. (*After Rüdinger.*)

The *Cochlea* is by far the most complex part of the labyrinth. It is about $\frac{1}{4}$th inch long, and shaped like the shell of a common snail; its base lies near the internal meatus, and its apex is directed outwards. The osseous cochlea is a tube wound spirally two and a half times round a central pillar or *modiolus*. Both the pillar and the tube diminish rapidly in diameter from the base to the apex of the cochlea. The tube is imperfectly divided into two passages by a

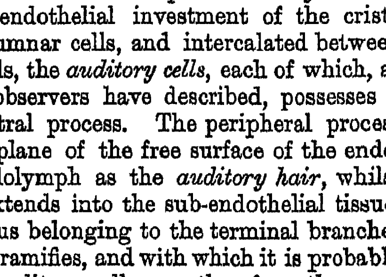


FIG. 82.—Diagram of the membranous labyrinth. DC, ductus cochlearis; *dr*, ductus reuniens; S, sacculus; U, utriculus; *dv*, ductus vestibuli; SC, semicircular canals. (*After Waldeyer.*)

plate of bone, the *osseous spiral lamina*, which, springing from the modiolus, winds spirally around it, and projects into the tube. When the membranous cochlea is in its place the division is completed by a membrane, the *membranous spiral lamina*, or *basilar membrane*, which bridges across the interval between the free edge of the osseous spiral lamina and the outer wall of the tube, to which it is attached by the *spiral cochlear ligament*. These passages are called *scala tympani* and *scala vestibuli*. But another membrane, the *membrane of Reissner*, also arises from a denticulated spiral crest, *limbus* or *crista spiralis*, attached to the vestibular border of the free edge of the osseous spiral lamina, and extends to the spiral ligament at the outer wall of the tube, on the vestibular aspect of the basilar membrane, so as to enclose a passage between it and the basilar membrane, called *scala intermedia* or *ductus cochlearis*. The membrane of Reissner is formed of delicate vascular connective tissue, with an endothelial

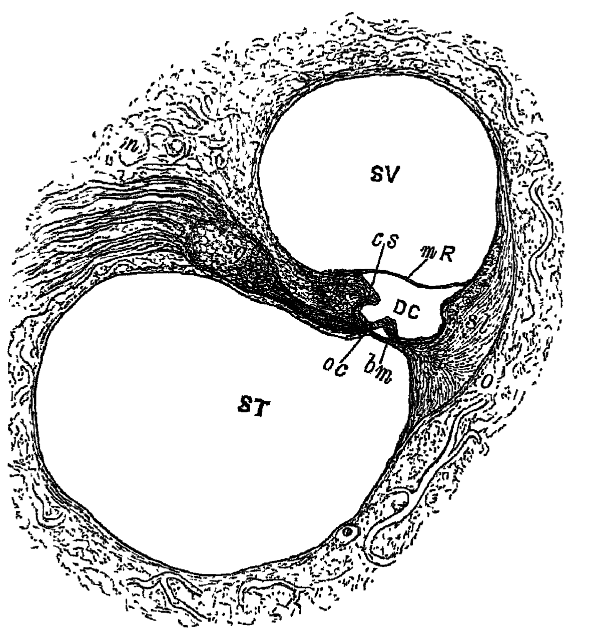


FIG. 83.—Transverse section through the tube of the cochlea. *m*, modiolus; O, outer wall of cochlea; SV, scala vestibuli; ST, scala tympani; DC, ductus cochlearis; *m*R, membrane of Reissner; *bm*, basilar membrane; *cs*, crista spiralis; *sl*, spiral ligament; *sg*, spiral ganglion of auditory nerve; *oc*, organ of of Corti.

layer on each of its two surfaces. The scala tympani or lower passage, widest at the base of the cochlea, begins at the inner wall of the tympanum, into which it would have opened through the fenestra rotunda, had not the fenestra been closed up by a membrane. The scala vestibuli or upper passage, also widest at the base, communicates with the cavity of the osseous vestibule. At the apex of the cochlea these two scalæ communicate with each other through a small hole, the *helicotrema*. As the scala vestibuli opens into the osseous vestibule, the perilymph is continued into it, and through the helicotrema into the scala tympani. The ductus cochlearis is the membranous cochlea, and its walls are formed of the basilar membrane next the scala tympani, of the membrane of Reissner next the scala vestibuli, and of the spiral ligament next the wall of the cochlea, which connects the two membranes together. It follows the spiral windings of the cochlea, terminates at the apex of the spiral in a closed end, whilst at the base it communicates with the sacculus of the membranous vestibule by a slender tube, the *canalis reuniens;* hence the membranous cochlea contains endolymph. The termination of the cochlear branches of the auditory nerve and the arrangement of the peripheral end-organs in relation to them are to be looked for in the basilar membrane. These parts have been repeatedly investigated and described in elaborate monographs, the titles of which are given as an appendix to Waldeyer's article on the cochlea in Stricker's *Handbuch der Lehre von den Geweben*, Leipsic, 1872. The general results only of these investigations will be given here, and the original memoirs may be referred to for further details.

Organ of Corti.

On the surface of the basilar membrane directed to the ductus cochlearis a remarkable arrangement of cells exists, which presents an appearance that has been compared with the key-board of a pianoforte, and has been named the *organ of Corti ;* it consists of the following parts:—Some of these cells, distinguished by their elongated curved form, are arranged in two groups, an inner and an outer. The cells of the inner group rest by a broad foot on the inner part of the basilar membrane, close to its attachment to the spiral lamina, project obliquely forwards and outwards, and expand into a dilated head : the cells of the outer group also rest by a broad foot on the same membrane, incline forwards and inwards, and fit into a depression in the head of the cells of the inner group : these two groups of cells form the *rods* or *pillars of Corti*, and by their juxtaposition arch over an excessively minute canal enclosed between them and the basilar membrane, which may be named the *canal of Corti*. The inner rods are, however, more numerous than the outer, and Pritchard has shown that the rods increase in length from the base to the apex of the cochlea. Immediately internal and almost parallel to the inner group of these rods, and adjacent therefore to the crista spiralis, is a row of compressed conical cells, which possess at their anterior ends short stiff hair-like processes; they are the *inner hair cells* of Deiters. Immediately external and almost parallel to the outer group of rods are four or five rows of hair cells, the *outer hair cells*, which are attached by their bases to the basilar membrane, whilst from the opposite extremity a brush of hairs projects through the reticular membrane. The outer hair cells are, according to Waldeyer, relatively of large size in man. The *reticular membrane* of Kölliker is a delicate framework perforated

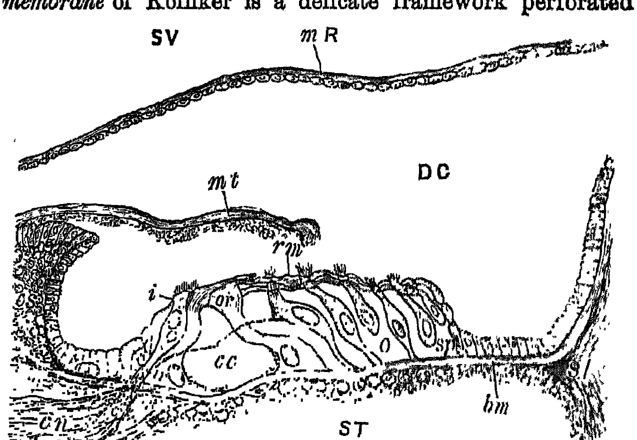


FIG. 84.—Vertical transverse section through the basilar membrane and organ o Corti. *bm*, *cs*, *sl*, &c., as in fig. 83; *i*, inner hair cell; *ir*, inner, and *or*, out rod of Corti; *o*, outer hair cells; *sp*, supporting cells; *cn*, cochlear nerve; *c*. canal of Corti; *rm*, reticular membrane; *mt*, membrana tectoria. (*Adapted from Waldeyer.*)

by rounded holes. It extends parallel to the basilar membrane from the inner rods of Corti to the external row of outer hair cells, and through the holes in it the hairs of the latter project. It obviously acts as a support for the anterior ends of these cells, and binds together these important elements of the organ of Corti. The interval between the outer hair cells and the spiral ligament is occupied by cells of a more or less columnar form, the *supporting cells* of Hensen. Covering over the organ of

Corti, and separating it from the endolymph of the ductus cochlearis, is the *membrana tectoria*, which springs from the crista spiralis close to the attachment of the membrane of Reissner, passes outwards superficial to the membrana reticularis, and ends externally at the spiral ligament.

Nerve of hearing.

The origin, course, and distribution of the auditory nerve in the labyrinth will now be considered. The auditory nerve is the *portio mollis* of the *seventh* cranial nerve. It appears at the base of the brain at the lower border of the pons Varolii. Traced to its origin its roots wind round the restiform body to the floor of the 4th ventricle, where they form the striæ acousticæ, and sink into the grey matter of the floor. Some of the fibres arise from an inner, others from an anterior collection of nerve cells, whilst others again are connected with the cells in the restiform body, and probably with the flocculus of the cerebellum. Where the nerve emerges at the lower border of the pons it contains a cluster of nerve cells. The auditory nerve passes down the internal meatus, and divides into a vestibular and a cochlear division. The *vestibular* division enters the vestibule, and divides into five branches for the sacculus, utriculus, and three ampullæ of the membranous semicircular canals. Each branch enters a crista acoustica and forms a plexus, in the meshes of which nerve cells are imbedded. From this plexus fine non-medullated fibres arise, which enter the layer of cells on the surface of the crista, where they anastomose and form a very delicate plexus, from which fibres spring that in all probability join the central processes of the auditory cells.

The *cochlear* division enters a canal in the axis of the modiolus, and gives off lateral branches, which pass into the canals situated in the osseous spiral lamina. Here they radiate outwards to the membranous spiral lamina, and have connected with them collections of nerve cells forming the spiral ganglion. Beyond the ganglion they form a flat plexiform expansion, from which delicate nerves pass through a gap in the edge of the osseous lamina into the organ of Corti. In this organ the nerves, as Gottstein and Waldeyer have described, are arranged in two groups of fibres; the inner group become continuous with the deep end of the inner hair cells; the outer group pass across the canal of Corti and end in the outer hair cells. Hence these cells are the peripheral end-organs of the cochlear branch of the auditory nerve, or the *auditory cells of the cochlea*.

The perilymph of the labyrinth is set in vibration by the movements of the tympanic ossicles and the fenestra ovalis; motion is thus communicated to the membranous labyrinth and the endolymph which it contains. The auditory hairs and cells would thus be set in motion, and the vestibular branches of the auditory nerve would be stimulated to conduct sound-impulses to the brain. The movements of the perilymph in the scala tympani and of the endolymph in the ductus cochlearis would set in vibration the basilar membrane, and the auditory cells resting on it, by which the cochlear branches of the auditory nerve would be stimulated to conduct sound-impulses to the brain. It has been customary for physiologists to regard the vestibule as the part of the labyrinth by which sound or mere noise is determined; the cochlea, as the part which determines variations and degrees of sound, as musical notes or harmony; the semicircular canals, as determining the directions from which sound proceeds. But within the last two years experiments and arguments have been advanced almost simultaneously by Crum Brown and Mach in favour of the view that the semicircular canals act as peripheral end-organs for the sense of rotation, by which sense the axis about which rotation of the head takes place, the direction of that rotation, and its rate, are determined.

Development of ear.

In the account of the development of the skeleton, p. 831, it was stated that the external meatus, tympanum, and Eustachian tube are the remains of the first branchial cleft of the embryo, that the tympanic ossicles are formed in the first and second visceral arches, and that the petrous bone is ossified in the cartilaginous basis cranii. The membranous labyrinth apparently arises as an invagination of the integument at the upper end of the second branchial cleft. The invaginated fold then closes in to form a shut sac, the *primary auditory vesicle*. Out of this vesicle the three divisions of the labyrinth are successively produced, and become enclosed by the petrous cartilage, which when ossified forms the osseous labyrinth. The epidermal investment of the invaginated tegumentary sac becomes transformed into the special cell structures within the membranous labyrinth, and the sub-epidermal connective tissue forms its fibrous wall. The cochlear and vestibular nerves form at the same time as the labyrinth, and become connected through the trunk of the auditory nerve with the brain.

Tongue.

The TONGUE, situated on the floor of the cavity of the mouth, is the chief organ provided for the excitation of the special sense of taste, but the under surface of the soft palate participates to some extent in this property. The tongue is also highly endowed with the sense of touch. The structures concerned in the excitation of taste and touch are situated in the mucous membrane which envelopes the tongue. The tongue is also a muscular organ, and plays an important part in articulation, mastication, and deglutition. Its shape is flattened from above downwards, so that it presents an upper surface or dorsum and a lower surface. Its posterior part is broad, forms the base or root of the organ, and is attached to the hyoid bone. Its anterior extremity or tip is more or less pointed, and its lateral margins or sides are rounded.

The muscles connected with the tongue are arranged in pairs, and form three distinct groups, viz., accessory, extrinsic, and intrinsic muscles. The *accessory* muscles are the stylo-hyoid, digastric, mylo-hyoid, genio-hyoid, omo-hyoid, sterno-hyoid, and thyro-hyoid, already referred to on page 836, which act upon the hyoid bone, and thus indirectly are concerned in the movements of the tongue. The *extrinsic* muscles pass from adjacent parts into the substance of the tongue, and are as follows:—The stylo-glossus arises from the tip of the styloid process and the stylo-maxillary ligament; it runs forwards along the side of the tongue to the tip. The hyo-glossus is divided into three parts; *a*, basi-glossus, which arises from the body of the hyoid; *b*, cerato-glossus, from the great cornu of the hyoid; *c*, chondro-glossus, from the small cornu of the hyoid. The fibres from these origins ascend into the side of the tongue. The genio-hyo-glossus arises from the upper tubercle of the symphysis of the lower jaw, its fibres radiate into the substance of the tongue along its whole length from base to tip; this muscle is separated from the corresponding muscle of the opposite half of the tongue by a mesial septum of fibrous tissue. The palato-glossus arises in the substance of the soft palate, and descends to the tongue in the anterior pillar of the fauces. The *intrinsic* muscles lie in the substance of the tongue itself, and are as follows:—The lingualis superior (noto-glossus), consisting of longitudinal fibres, which extend from the base to the tip beneath the mucous membrane of the dorsum; the lingualis inferior, consisting of longitudinal fibres, which extend from the base to the tip along the under surface between the hyo-glossus and genio-hyo-glossus; transverse muscular fibres, which spring from the mesial fibrous septum and curve outwards and upwards to the sides of the tongue; vertical fibres, which pass through the substance of the tongue from the dorsum to the under surface. The extrinsic and intrinsic muscles can not only

move the entire tongue within the cavity of the mouth, protrude it between the lips, and again retract it, but can modify its form; thus the dorsum can be flattened, made convex or concave, the margins can be raised or depressed, and the tip elevated or depressed.

The mucous membrane of the tongue forms a part of the general mucous lining of the mouth; it covers the dorsum, tip, sides, and under surface; is reflected from the under surface to the floor of the mouth, where it forms the *frænum* or bridle of the tongue, and is reflected also from the base to the epiglottis as the *fræna* of the epiglottis, as well as over the tonsils and anterior palatine pillars. This membrane has its free surface elevated into multitudes of fine processes, called the papillæ of the tongue, some of which are simple, others compound. The *simple papillæ* are situated on the back part of the dorsum and the under surface of the mucous membrane, as well as scattered between the compound papillæ; they are simple conical elevations of the membrane. The *compound papillæ* are arranged in three groups, named filiform, fungiform, and circumvallate papillæ. The *filiform papillæ*, elongated and thread-like, are the smallest and most numerous, and cover the dorsum in front of the circumvallate papillæ. The *fungiform* or club-shaped are scattered over the anterior and middle parts of the dorsum, and at the tip and sides. The *circumvallate papillæ*, seven to twelve in number, form a V-shaped figure on the dorsum towards its base; a depression in the mucous membrane, called *foramen cæcum*, marks the apex of the V. These are the largest papillæ; each is sunk in a vallum or trench-like depression of the mucous membrane, which isolates it from the surrounding surface. The compound character of these papillæ is due to each having projecting from it numerous small secondary papillæ. The epithelial covering of the filiform papillæ is characterised by the peculiar modification which the tessellated epithelium of the mouth has undergone; the cells have become cornified and elongated into dense, imbricated brush-like processes. In the carnivora the epithelium is so hardened as to form sharp spines, with the points turned backwards, which give to the tongues of these animals a rough prickly character. In the fungiform and circumvallate papillæ the inequalities between the secondary papillæ, which project from them, are filled up by the tessellated epithelium, so that the surface of the compound papillæ has a smooth appearance. Both the simple and compound

FIG. 85.—Section through a gustatory lamella of the rabbit's tongue. *G*, gustatory bulbs situated in *Ep*, the epithelial layer of the mucous membrane; V, capillary blood-vessels in the sub-epithelial connective tissue. (*From a preparation by A. B. Stirling.*)

papillæ are highly vascular; the lingual artery not only supplies the muscular substance of the tongue, but gives off fine branches to the mucous membrane. These branches end in capillaries, which form simple loops in the simple papillæ, but in the compound papillæ the capillaries are so multiplied that each secondary papilla has a capillary loop within it. The tongue is provided with several nerves. The hypo-glossal nerve supplies its muscular structure, but the inferior lingualis apparently receives a branch from the chorda tympani of the facial. The lingual branch of the fifth is distributed to the mucous membrane of the anterior two-thirds of the tongue: it breaks up into minute branches, which enter the fungiform and filiform papillæ, but their exact mode of termination has not been precisely ascertained, though end-bulbs and gustatory bodies are said to have been seen in connection with some of the terminal branches. The glossal branch of the glosso-pharyngeal is distributed to the mucous membrane of the root of the tongue and of the circumvallate papillæ. In connection with its terminal branches peculiar flask-shaped organs, called *gustatory bulbs* or *bodies*, have recently been described by Lovén, Schwalbe, and Engelmann, in the sides of the circumvallate papillæ. These have been found in large numbers in lamellated folds of the mucous membrane of the posterior part of the side of the rabbit's tongue, which folds may appropriately therefore be called *gustatory lamellæ*. When sections are made through one of these folds, or through a circumvallate papilla and the trench which surrounds it, numerous flask-shaped gustatory bulbs may be seen in the epithelium, which covers the side of the papilla and the opposite side of the trench. The bottom of each flask is next the sub-epithelial tissue, whilst its short neck opens on the surface by a mouth, the *gustatory pore*; similar bodies, though in much smaller numbers, have also been seen in the fungiform papillæ. Each gustatory body consists of two different forms of cells, named *covering cells* and *gustatory cells*. The covering cells are elongated, nucleated spindles, which, arranged in layers, form the envelope of each gustatory bulb, and reach from the bottom to the mouth of the flask; they enclose the gustatory cells. The gustatory cells are attenuated, homogeneous, and highly refractile cells, which possess an elliptical nucleated body with two processes, a central and peripheral. These cells occupy the axis of the gustatory bulb. The peripheral process, broader than the central, sometimes ends in a short hair-like tip, which almost reaches the gustatory pore; the central process extends to the base of the flask, and often divides into small branches. This process is varicose, and not unlike the axial cylinder of a nerve fibre. The branches of the glosso-pharyngeal nerve, which are distributed to the back of the tongue, enter the circumvallate papillæ, and form a minute plexus, with groups of nerve cells interspersed in it, from which bundles both of medullated and non-medullated fibres pass to the basis of the gustatory bulbs; and it is believed that the finest non-medullated fibres are continuous with the peripheral processes of the gustatory cells, which are therefore regarded as the peripheral end-organs of the nerve of taste, and by the excitation of these bodies gustative or taste sensations are produced. As the glosso-pharyngeal is the nerve distributed to the circumvallate papillæ, where these gustatory bulbs are especially found, it is therefore the special nerve of taste; but as these bulbs have also been sparingly seen in the other papillæ, where the lingual nerve is distributed, that nerve probably acts in a minor degree as a nerve of taste, though its special function is undoubtedly that of a nerve of touch. The gustatory bulbs are not penetrated by blood-vessels, but, as Fig. 85 shows, the vascular sub-epithelial tissue is prolonged upwards along the sides of the bulbs almost as far as the plane of the gustatory pore. Key, Beale, and other observers have described special modifications of the epithelium in connection with the terminations of the gustatory nerves in the frog. The mucous membrane of the

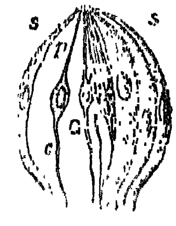


FIG. 86.—*s*, superficial covering cells of a gustatory bulb; *G*, gustatory cell, with *p*, its peripheral, and *c*, its central process.

Nerve of taste

tongue contains numerous small tubular or branched glands, more especially on the dorsum near its root, which secrete mucus. Depressions also occur in this part of the mucous membrane, around the walls of which groups of lymphoid cells are collected in the sub-epithelial connective tissue, which have an arrangement closely resembling the structure of the adjacent tonsils, and form an example of adenoid tissue.

The SKIN, or Integument, invests the entire outer surface of the body, and contains structures by the excitation of which the properties of things are determined by the sense of touch. The skin also contains accessory structures, as the nails, hairs, sebaceous glands, and sweat glands. The skin consists of a non-vascular cuticle or epidermis, and of a vascular and sensitive corium, or cutis vera.

The *Cuticle*, *Epidermis*, or *scarf skin*, forms the outer covering of the skin, and protects the cutis. It is a laminated structure, and consists of numerous layers of cells superimposed on each other. As these cells cover a free surface exposed to the air, they belong to the epithelium group. The thickness of the cuticle varies in different localities from $\frac{1}{10}$th to $\frac{1}{200}$th inch; where the skin is frequently exposed to pressure, as in the soles of the feet, the cuticle is the thickest and hardest; and the hands of those accustomed to manual labour have a hard and horny cuticle. The increase in thickness in these localities is for the purpose of protecting the highly sensitive cutis from injury. The outer surface of the cuticle in many parts of the body, especially the palm of the hand and the fingers, is marked by ridges and furrows; the ridges indicate the position and arrangement of the papillæ of the cutis, whilst the furrows are due to the sinking of the cuticle into the spaces between the rows of papillæ. The mouths of the sweat glands open on the surface of these ridges. The cuticle is divided into two strata. The *superficial horny stratum* consists of layers of flat, polygonal scales like a tessellated epithelium; the cells in the superimposed layers firmly adhere to each other by their surfaces, and in vertical sections this stratum presents a fibrous appearance; but the cells may be readily isolated by digestion in a caustic alkali. The *deeper* or *mucous stratum*, or *rete Malpighii*, lies next the cutis, and closely follows the undulations of its papillary surface. The cells forming the layer next the cutis are columnar in shape, those in the layers immediately succeeding are rounded or cubical, whilst those next in order are polygonal, and not unfrequently possess pointed processes or prickles projecting from them, hence the name, *prickle cells*, employed by Schultze. The cells which lie next the horny stratum assume the scale-like form. It is in the cells of the mucous stratum that the colouring matter of the skin is found, which in the fair races of men forms the isolated coloured spots called freckles and moles, but in the dark races the pigment granules are uniformly distributed through the cells of this stratum. The superficial cells of the horny stratum of the cuticle are continually being shed, so that the cells of the deeper layers gradually approach the surface, and new cells are continually being formed in the deeper part of the rete Malpighii. The cuticle is closely adherent to the cutis in the healthy living skin, but on the application of a blister, or when putrefaction sets in after death, it separates from it.

The *Cutis vera*.—When the cuticle is removed the surface of the cutis is seen to be studded with multitudes of minute elevations, the papillæ of the skin. These papillæ are either simple conical structures, or compound with two or three branches. They are largest in the palm and sole, being from $\frac{1}{100}$th to $\frac{1}{200}$th of an inch high, and are arranged in ridges, but more usually they are much shorter and irregularly distributed. The cutis is formed of connective tissue, in which stellate connective tissue corpuscles and elastic fibres are abundant. The deeper surface of the connective tissue of the cutis is reticulated, and is continuous with the bundles of connective tissue that form the areolar subcutaneous tissue. In the papillæ themselves the fibres of the connective tissue are not so well marked, and the surface of the papillæ possesses more of a homogeneous aspect, which gives rise to the appearance described as a basement membrane. The cutis is highly vascular; the small arteries which go to the skin give off branches to the lobules of fat in the subcutaneous tissue, then penetrate the cutis, and form a plexus from which capillaries arise, which enter the papillæ, and form vascular loops within them. The lymphatic vessels of the skin are numerous; they form a plexus in the cutis, which lies beneath the vascular plexus, forms, as Neumann's injections show, a network around both the sebaceous and sweat glands, and gives off capillary loops into the papillæ. The nerves of the skin are the cutaneous branches both of the spinal and of certain of the cranial nerves, the origin and distribution of which have already been described. They run through the subcutaneous tissue, and enter the deep surface of the cutis, where they divide into branches. As these pass towards the papillæ they unite to form a nerve plexus, from which smaller branches arise to enter the papillæ, and terminate, more especially in the skin of the palm of the hand, fingers, and sole, which are the surfaces most sensitive to touch impressions, in the *tactile* or *touch corpuscles*. The touch corpuscles discovered by Wagner and Meissner are the peripheral end-organs of the nerves of touch. They may be single or compound; are usually ovoid in form, not unlike a minute fir cone; and are transversely marked, from the transverse direction of the nuclei of fusiform cells which form an investing capsule. Each single corpuscle and each division of a compound corpuscle is penetrated by one, and, according to Thin, by never more than one, medullated nerve fibre, but the exact mode of termination of the axial cylinder of the fibre has not been ascertained. Virchow and other German observers have stated that the papillæ which contain capillaries do not contain nerves or touch corpuscles, and *vice versa*; but Dalzell and Thin have shown that certainly the majority of papillæ that contain nerve fibres and touch corpuscles are also vascular papillæ. Non-medullated nerve fibres ascend to the surface of the cutis, and, according to Langerhans, pass into the rete Malpighii between the cells of the mucous layer.

Nerves of touch.

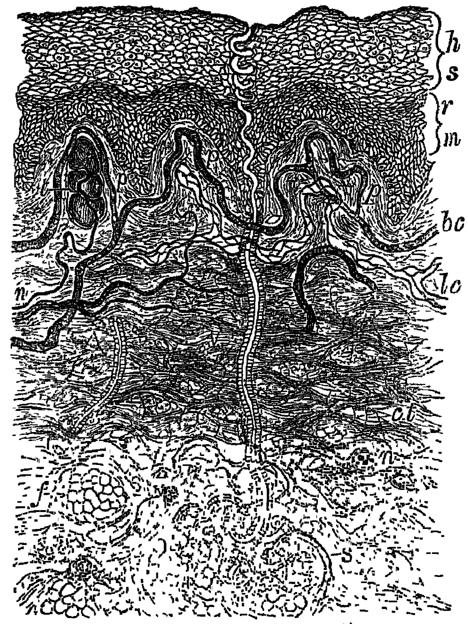


FIG. 87.—Vertical section through the skin and subcutaneous tissue. *hs*, horny stratum, and *rm*, rete Malpighii of cuticle; *pp*, papillæ of cutis; *t*, a touch corpuscle with *n*, a nerve fibre; *bc*, a blood and *lc*, a lymph capillary; *ct*, connective subcutaneous tissue; *f*, fat lobule; *s*, a sweat gland with its duct.

Nails.—On the back of the last phalanx of each thumb, Nails.

finger, and toe is situated a firm horny curved plate, the nail. Each nail rests on a bed, the surface of which is formed of the cutis, which also overlaps the side and root of the nail; thus the nail fits into a groove formed of the cutis something after the manner in which a watch-glass fits into its rim. A nail is merely a special modification of the cuticle, the cells of the superficial stratum of which are more horny, harder, and more firmly adherent to each other than in the cuticle proper. Deeper than the horny stratum is the rete Malpighii of the nail, the cells of which are soft, as in the cuticle itself. The cutis forming the bed of the nail is studded with papillæ, which are arranged in almost parallel rows, and are highly vascular. Nails grow both in length and thickness: the increase in thickness is due to the formation of nerve cells on the bed of the nail; the increase in length takes place through the formation of nail cells at its root, and as the nail is thus slowly pushed forward it requires to be cut at intervals. At the root, sides, and below the free border of the nail the cuticle is continuous with the substance of the nail itself.

Hair. *Hair.*—Projecting from the surface of the skin are multitudes of elongated cylindrical horny structures, the hairs. In the skin of the scalp, the armpits, and the pubis, they are long and numerous; but in the eye-brows, eye-lashes, vibrissæ of the nostrils, and surface of the body generally, they are short. They are stronger and thicker in the skin of man than of woman, more especially on the cheeks, lips, and chin. Hairs do not grow from the skin of the palms and soles, the back of the ungual phalanges, and the surface of the upper eye-lids. Each hair is partially embedded in a depression of the skin, called a *hair follicle.* The deeper end of the follicle is somewhat dilated, and has in it a papilla, the *hair papilla.* The wall of the hair follicle is formed of the constituent structures of the skin; the outer part of the wall belongs to the cutis, and has been described as arranged in three layers, the external, middle, and inner layer of the hair follicle. The external and middle layers are formed of connective tissue, with blood-vessels; whilst the inner, sometimes called the *vitreous layer,* is transparent and homogeneous, and continuous with the so-called basement membrane of the cutis. The inner part of the wall of the hair follicle, or the *root-sheath,* belongs to the cuticle, and consists of two layers, the outer and inner root-sheaths. The *outer root-sheath* is continuous with the rete Malpighii, and consists of cells similar to those of that stratum. The *inner root-sheath* is continuous with the horny stratum of the cuticle, and consists of elongated scale-like translucent cells in which no nuclei can be seen.

A hair possesses a root, a shaft, and a tip; the root is embedded in the hair follicle, whilst the shaft and tip form the free projecting part of the hair. In the human hair the substance of the hair is composed of a *fibrous*-looking horny material, which by the action of strong sulphuric acid is resolved into elongated, closely compacted, fusiform cells, which in coloured hairs contain pigment granules. In the thicker hairs the cells in the axis of the hair are polygonal, contain air, and form a central pith or *medulla.* The hair is invested by imbricated scale-like cells, which form the *hair cuticle.* In different animals the size and relative proportion of the cells of the cuticle, medulla, and fibrous part of the hair present many modifications. The wool of the sheep has its cuticle scales, with well-defined serrated margins, so that the hair of this animal is well adapted for felting into cloth; in the bat, also, the cuticle cells are large and strongly serrated. The bristles of the pig, again, have the fibrous part of the hair largely developed. In the deer tribe the hair consists of polygonal medulla-like cells, which contain air. The root of the hair dilates at its deeper end into a bulb which embraces the hair papilla. It is softer in texture than the shaft, so that the cellular structure of the hair is more easily demonstrated. Next the papilla the cells are like those of the rete Malpighii, but when traced onwards to the shaft they are seen to become differentiated, both in structure and composition, into the proper hair cells. The root is enveloped in a special sheath, termed the *sheath of Huxley,* composed of nucleated cells, which sheath, in the more superficial part of the follicle, blends with the internal root-sheath. The hair papilla bears to the hair the same relation as a papilla of the cutis has to its investing cuticle, so that a hair is to be regarded as a specially modified cuticular structure. The human hair papilla is vascular, but no nerves have been traced into it. In the tactile hairs of the mammalia, however, nerves have been traced into their papillæ.

The bristles, feathers, claws, hoofs, the horny envelope of the horn cores in the hollow horned ruminants, and various tegumentary spines and scales, present in many animals, are, like hairs and nails, special modifications of the tegumentary system.

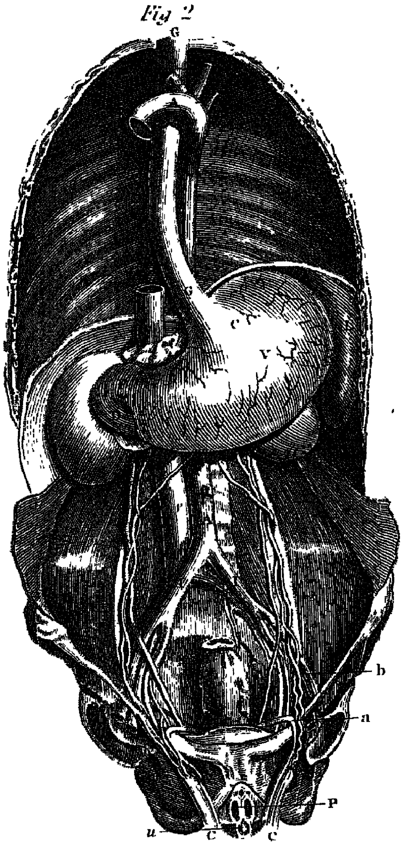
Each hair follicle has opening into it the excretory duct of a small gland, named a *sebaceous gland.* This gland consists of the excretory duct, and of from two to twenty grape-like saccular expansions which open into the duct. The wall of the sacculi and of the duct is continuous with the vitreous layer of the outer wall of the hair follicle. Capillary blood-vessels are distributed on the outer wall of the sacculi. The sacculi are almost entirely filled with polygonal cells containing drops of fat, which cells are continuous with the epithelial lining of the gland duct and the cells of the outer root-sheath. These glands secrete a fatty material, which lubricates the surface of the hair. Sometimes a small parasite, called *Acarus folliculorum,* is found in a sebaceous gland.

Some years ago Kölliker described one or two bundles of smooth muscular fibres extending from the wall of the hair follicle to the deep surface of the cutis; these muscles, named *arrectores pili,* by their contraction erect the hairs, that is, cause them to become more prominent, and produce the condition of skin, called *cutis anserina* or goose skin, well known to occur when cold is applied to the surface of the body.

Hairs are developed about the 4th month of embryo life, within depressions in the cutis, which form the future hair follicles, filled with cells similar to, and continuous with, those of the rete Malpighii. A papilla forms at the bottom of this depression, around which the cells become arranged in a bulbous expansion. The cells, in line with the bulb, elongate and harden, and group themselves so as to form the shaft of the young hair, which at this stage is completely buried within the follicle. A rapid production of new cells takes place at the bulb, the hair consequently increases in length, and is pushed outwards through the superficial horny stratum of the cuticle, which had closed in the mouth of the depression or follicle in which the hair is produced. At the same time, the more external cells within the follicle are pushed outwards towards its wall, and form the cells of the root-sheath. When a hair is pulled out of its follicle the cells of the root-sheath are drawn out along with it. A new hair will be developed at the bottom of a follicle from which the hair has been shed as long as cells continue to be formed around the papilla. When the growth of cells ceases within the hair follicles then permanent baldness is the result.

The sebaceous glands are developed as bud-like offshoots from the hair follicles, filled, like the follicles themselves, with cells continuous with those of the rete Malpighii. Instead of the cells in these buds differentiating into a hair, they become filled with fatty particles, and the wall of the bud assumes the characteristic sacculated form of the gland.

Fig 2

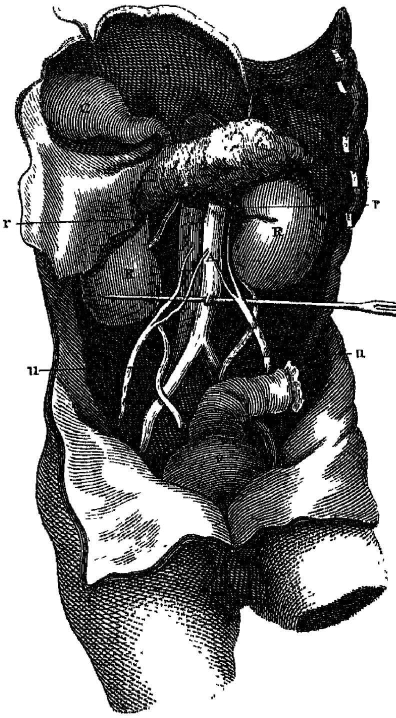


Aorta

Fig 1

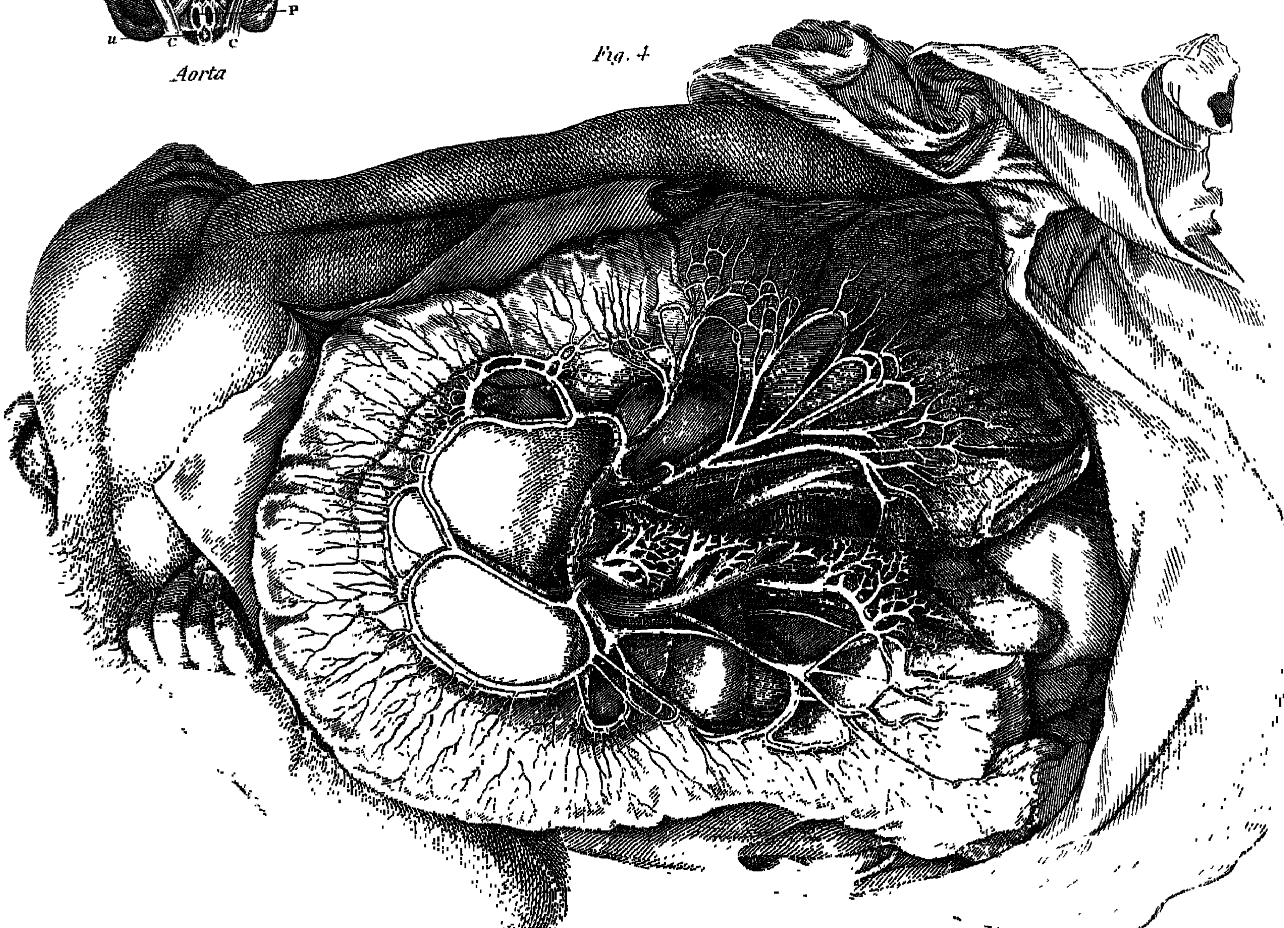
Viscera of Chest & Abdomen

Fig 3.



Liver & Kidneys

Fig. 4



Blood Vessels of Intestines

Sweat Glands.

Sweat Glands, or sudoriparous glands, are found generally distributed throughout the skin, but are most abundant in the palms and soles, where they number 2500 to 3000 in each square inch. In the skin of the back, again, there are only between 400 and 500 in the square inch. Each gland consists of a ball-like body lying in the subcutaneous tissue, from which a tubular duct proceeds through the skin to open on its free surface. The ball is composed of a convoluted tube continuous with the tubular duct, and terminating in a blind end. The wall of the gland tube consists of a delicate nucleated membrane lined by columnar secreting cells. It is surrounded by connective tissue containing capillary blood-vessels. As the gland-duct pierces the cutis it passes between the papillæ; in its course through the cuticle it pursues a spiral direction, and has its walls formed, not of a distinct membrane, but of the cuticle cells themselves. The epithelial lining of the duct is continuous with the cells of the rete Malpighii of the cuticle. In the axilla and groin the sweat glands are much larger than in the skin generally. The sweat glands arise as flask-shaped pouches of the rete Malpighii projecting into the cutis, which in course of time become elongated into tubes, and the cells contained in which become the secreting cells of the gland.

Vascular System.

Vessels.

The human body and the bodies of all the more highly organized animals are traversed by numerous tubes or pipes, technically called Vessels, some of which in man are nearly an inch in diameter, others so small as to require a microscope for their examination, others again of every intermediate size. In connection with the vessels is a central organ, the Heart. The heart and the vessels collectively constitute the Vascular System. Of these vessels some contain blood, and form the Blood-vascular system; others contain lymph, and form the Lymph-vascular system. The lymph-vascular system is not independent of the blood-vascular system, but communicates with it at several points. The vascular system is a hydraulic apparatus, possessing a pump, pipes, and valves. The heart is the pump, which works, not by the movements of a piston, but by the contraction of its muscular walls; the vessels are the pipes, which convey the contained fluid, and they are provided in certain localities with valves for modifying its flow.

Circulation of the blood.

Blood-Vascular System.—The movement of the blood in the blood-vascular system is called the *circulation of the blood*. In the lower Vertebrata the heart is a single organ, and the blood flows from it through the vessels back again into the part of the heart from which it had proceeded, forming a *simple circulation*. In man and the higher vertebrates the heart is a double organ, *i.e.*, it consists of a right and left portion, intimately united to, but not directly communicating with, each other. The blood which flows from its right side passes through vessels which traverse the lungs, and is conveyed to the left side of the heart; whilst the blood which flows from the left side passes through vessels which traverse the body generally, and is conveyed to the right side of the heart. This is called a *double circulation*; that which appertains to the lungs is the *pulmonic circulation*; that which appertains to the body generally is the *systemic circulation*. The vessels which carry the blood away from the heart are called *arteries*; those which convey it back to the heart are *veins*. The arteries and veins do not communicate directly with each other, but through the intermediation of a network of extremely minute vessels, the *capillaries*. Hence, both in the pulmonary and systemic circulation, the blood in its passage from the arteries into the veins must go through capillaries. The blood which flows from the left side of the heart into the systemic arteries is pure or arterial blood; as it traverses the systemic capillaries it parts with certain of its constituents to nourish the organs and tissues, and as it receives from them waste products it becomes impure blood; in which condition it flows back to the right side of the heart by the systemic veins as venous blood; hence the right side of the heart is often called the venous side. The blood which flows from the right side of the heart along the pulmonary artery is this impure blood; as it traverses the pulmonary capillaries it is purified by the action of the air in the lungs, and is changed into arterial or pure blood, in which condition it flows back by the pulmonary veins to the left side of the heart, which consequently is called the arterial side. The object of the pulmonary circulation, therefore, is to reconvert into pure blood the blood which has been rendered impure during its passage through the systemic capillaries.

Heart.

The Heart.—The heart is a hollow muscle contained in the cavity of the chest, and enclosed within a bag called the *Pericardium*. The pericardium, with its enclosed heart, occupies the space called *mediastinum*, between the two lungs; it lies therefore behind the sternum, and in front of the spinal column, but projects more to the left than to the right side of the mesial plane. The bag of the pericardium is formed externally of a strong fibrous membrane, which is attached below to the central tendon of the diaphragm, but blends above with the sheaths of the great vessels which pass to and from the heart. When the bag is cut open its inner surface is seen to possess a smooth glistening serous aspect, for it is lined by a layer of squamous endothelium, which layer is continuous with the serous membrane that invests the heart, and forms the visceral layer of the pericardium. The continuity of the serous lining of the bag with the serous investment of the heart takes place where the great blood-vessels pierce the fibrous bag.

The heart lies obliquely from above downwards, from right to left, and from behind forwards. For descriptive purposes it may be regarded as possessing a base, an apex, an anterior and a posterior surface, a right and left border. The base lies backwards, upwards, and to the right, opposite

Fig. 88.—The Thoracic Viscera.

In this diagram the lungs are turned to the side, and the pericardium removed to display the heart. *a*, upper, *a'*, lower lobe of left lung; *b*, upper, *b'*, middle, *b''*, lower lobe of right lung; *c*, trachea; *d*, arch of aorta; *e*, superior vena cava; *f*, pulmonary artery; *g*, left, and *h*, right auricle; *k*, right, and *l*, left ventricle; *m*, inferior vena cava; *n*, descending aorta; 1, innominate artery; 2, right, and 4, left common carotid artery; 3, right, and 5, left subclavian artery; 6, 6, right and left innominate vein; 7 and 9, left and right internal jugular veins; 8 and 10, left and right subclavian veins; 11, 12, 13, left pulmonary artery, bronchus, and vein; 14, 15, 16, right pulmonary bronchus, artery, and vein; 17 and 18, left and right coronary arteries.

the 4th to the 8th dorsal vertebræ. The apex is directed forwards, downwards, and to the left, opposite to the interval between the 5th and 6th left ribs. The heart has on its surface grooves which indicate its division internally into four chambers, two in its right half, two in its left half. The right chambers are the right auricle and right ventricle. The left chambers are the left auricle and left ventricle. All these chambers are lined by a smooth membrane, the *endocardium*, which is continuous on the one hand with the lining membrane of the veins, on the other with the lining membrane of the arteries.

The *Right Auricle* occupies the right part of the base of the heart. It consists of a large dilated portion, the *sinus venosus*, and of a small ear-shaped appendage, the *auricula*. Its muscular wall is smooth internally, except in the auricula and adjacent anterior wall of the sinus venosus, where it is thrown into parallel ridges like the teeth of a comb, and named *musculi pectinati*. Into the sinus venosus open the great systemic veins or venæ cavæ. The *superior vena cava* conveys to the auricle the systemic blood that has been circulating in the body above the diaphragm; it opens by a patent mouth into the upper and back part of the sinus venosus. The *inferior vena cava* conveys to the auricle the blood that has been circulating in the parts of the body below the diaphragm; it opens into the lower and back part of the auricle, and at its mouth is a rudimentary valve, the *Eustachian valve.* Close to its orifice is the mouth of another large vein, the *coronary venous sinus*, which also possesses a small valve. Several minute openings, the *foramina Thebesii*, scattered over the inner wall of the auricle, are the mouths of small veins ramifying in the wall itself. Through these various orifices the venous blood pours into the auricle, and then flows into the right ventricle through a large orifice of communication between them. The right auricle is separated by a partition, the *auricular septum*, from the left auricle. On the surface of this septum is a depression, the *fossa ovalis*, surrounded by a raised border, the *annulus ovalis*, with which border the inner end of the Eustachian valve is continuous. Before the birth of the child the septum is perforated by a hole, called *foramen ovale*, through which the blood flows directly into the left auricle, but this foramen is obliterated after the birth of the child.

The *Right Ventricle* forms the right border, a large part of the anterior surface, but only a small part of the posterior surface of the heart. It is shaped somewhat like a flattened cone, its apex being directed downwards towards the apex of the heart, its base to the corresponding auricle. The inner surface of its wall is very irregular, owing to the muscular bundles being elevated into strong ridges, called *columnæ carneæ*. Two, or it may be three, of these fleshy columns project like nipples or big papillæ into the cavity of the ventricle, and are called *musculi papillares*. Attached to the free apex of each papillary muscle are several fibrous threads, the *chordæ tendineæ*, which, by their opposite extremities, are connected to the segments of a large valve situated around the opening between the right auricle and ventricle. The right auriculo-ventricular opening, situated at the base of the ventricle, is sufficiently large to admit three fingers, and possesses a valve which consists of three large pointed segments or cusps (hence the name *tricuspid* given to it), between which three small intermediate cusps lie. One of the large cusps lies opposite the anterior wall of the ventricle, another opposite the posterior, whilst the third is between the auriculo-ventricular and pulmonary openings. The cusps are flattened triangular folds of membrane connected by their bases around the opening; when the valve is not in action the apex of each cusp hangs pendulous in the ventricle: one surface is smooth, and looks to the cavity of the ventricle, the other surface is rough and directed to its wall; to this rough surface, to the apex, and to the edges of the cusp, the chordæ tendineæ are attached. As the musculi papillares, from which the chordæ tendineæ spring, lie opposite the intervals between the cusps, the chordæ tendineæ from any given papillary muscle divide themselves into two groups, one for each of the two cusps between which it is situated. Attention has recently been

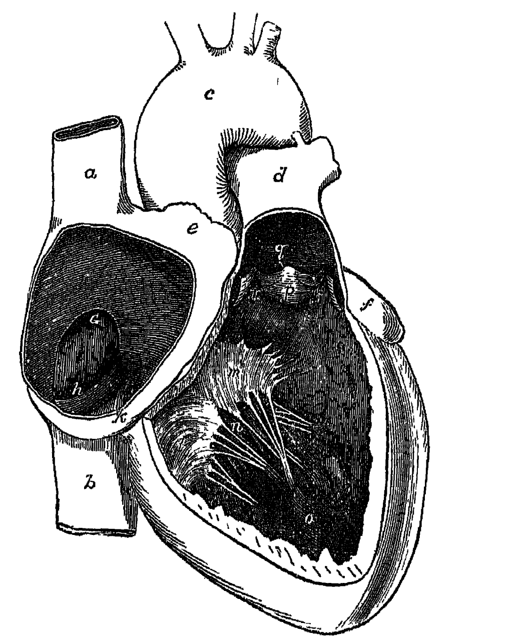


FIG. 89.—Cavities of the right side of the Heart.

a, superior, and *b*, inferior vena-cava; *c*, arch of aorta; *d*, pulmonary artery; *e*. right, and *f*, left auricular appendage; *g*, fossa ovalis; *h*, Eustachian valve; *k*, mouth of coronary vein; *l*, *m*, *n*, cusps of the tricuspid valve; *o*, *o*, papillary muscles; *p*, semilunar valve; *q*, corpus Arantii; *r*, lunula.

drawn by Rolleston to a band which passes from the base of the anterior papillary muscle to the septal wall of the ventricle. As it prevents over-distension of the ventricle, he has named it the *moderator band.* The base of this ventricle forms to the left and in front of the auriculo-ventricular opening, a funnel-shaped prolongation, the *conus arteriosus*, from which the *pulmonary artery* arises, through the intermediation of a strong fibrous ring. Surrounding the mouth of this artery is a valve called *semilunar*, which consists of three semilunar segments. Each segment is attached by its convex border to the artery where it springs from the ventricle. The opposite border is free, and possesses at its centre a minute nodule, the *corpus Arantii*, from which slender threads curve outwards at the free border and in the substance of the valve to strengthen it. A thin lunated portion lies immediately within the free border. One surface of the valve is convex, and directed to the lumen (*i.e.*, the space contained by the walls) of the artery; the other is concave, and directed to the wall of the artery, and between it and the wall is a pouch named *sinus of Valsalva.* The pulmonary artery extends upwards and to the left for about $1\frac{3}{4}$ inch, and then divides into two branches, one for each lung. The right ventricle is completely separated from the left by the *ventricular septum*, which passes obliquely from left to right, and from before backwards, so that it forms the posterior wall of the right ventricle and the anterior wall of the left.

The *Left Auricle* occupies the left part of the base of the heart, and, like the right auricle, consists of a dilated *sinus venosus* and an ear-shaped *auricula.* Its muscular wall forms a smooth surface internally, except in the auricula, where the ridge-shaped *musculi pectinati* occur. Opening into the sinus are the orifices of the four *pulmonary veins*, two from the right, two from the left lung; these

orifices are without valves. At the lower part of the auricle is the large orifice of communication between it and the base of the left ventricle.

The *Left Ventricle* forms the left border, the apex, a large part of the posterior surface, but only a small part of the anterior surface of the heart. It is conical in form, its apex is at the apex of the heart, the base at the corresponding auricle. As in the right ventricle, the inner surface of its wall is elevated into fleshy columns, two of which project like nipples into the cavity and form *musculi papillares*, which have *chordæ tendineæ* connected with them. The left auriculo-ventricular opening is large enough to admit two fingers. It possesses a valve, which consists of two large pointed segments or cusps, between which two small intermediate cusps lie, hence it is called the *bicuspid valve;* and as these cusps are placed one in front of the other like the segments of a bishop's mitre, the name *mitral valve* is often given to it. The cusps agree in shape, general arrangement, and mode of attachment with those of the tricuspid valve, but they are stronger; and as the more anterior segment lies obliquely between the auricular and aortic orifices, both its surfaces are smooth. From the base of this ventricle the great systemic artery or *aorta* arises through the intermediation of a strong fibrous ring. The mouth of the aorta is surrounded by a three segmented *semilunar valve*, similar to the semilunar pulmonary valve, but with thicker and stronger segments, and possessing more strongly marked *sinuses of Valsalva.* The base of each ventricle has therefore two openings in it, one for communication with the auricle, the other with the great artery arising from the ventricle. The auriculo-ventricular openings are the most posterior, and almost in the same plane; the aortic opening lies in front of the interval between the two auriculo-ventricular, and the pulmonary opening is in front of the aortic.

The walls of the cavities of the heart are formed of striped muscular fibre, over the contractions of which the will exercises no control. The fibres are collected into fasciculi, which have a reticulated arrangement, and the fibres themselves branch and again unite to form a complicated network. The fibres of the walls of the auricles are distinct from those of the ventricles, so that the auricular and ventricular compartments are connected together, not by an interchange of muscular tissue, but by an intermediate ring-like arrangement of fibres of connective tissue. The muscular fasciculi of the auricles are arranged in two strata. The deeper stratum consists of fibres proper to each auricle, some of which run obliquely in the wall, others form the musculi pectinati, surround the auricula, and are prolonged in rings into the coats of the venæ cavæ and pulmonary veins, whilst fibres extend longitudinally and obliquely along the wall of the coronary venous sinus. The superficial stratum consists of fasciculi, which run obliquely from one auricle to the other on both the anterior and posterior surfaces, and are said to be prolonged into the auricular septum.

The muscular wall of the ventricles is much thicker than that of the auricles, and the wall of the left ventricle is about three times thicker than the right. The fibres vary in their direction in different parts of the thickness of the ventricular walls. The superficial external fibres run obliquely from above downwards, and from right to left, and on the anterior surface of the ventricles dip into the anterior ventricular groove to enter the septum, whilst on the posterior surface they extend across the posterior ventricular groove; at the apex of the heart they turn inwards in a whorl-like manner, and, as was known to Lower and Gerdy, become continuous with superficial fibres on the inner wall of the ventricle; at the base of the ventricles they turn round the border of the auriculo-ventricular openings, and, as Pettigrew has shown, become continuous with these superficial internal fibres, which run in the reverse direction. The internal fibres are also prolonged into the musculi papillares, the chordæ tendineæ springing from which serve therefore as tendons of insertion for these muscles. If the substance of the wall be now dissected the fibres situated in the centre of the wall are seen to lie in the horizontal plane. Various anatomists have described these fibres of the ventricles as arranged in layers. Lower recognised two layers spirally crossing each other; Haller, three; Wolff, three in the right and six in the left ventricle. Pettigrew at one time believed he could dissect nine layers, but has subsequently reduced the number to seven—three external, a fourth or central, and three internal. He conceives that the fibres of the three external layers run in a spiral direction from left to right downwards, the first layer being more vertical than the second, and the second than the third, whilst the fibres of the fourth or central layer are horizontal. The three internal layers also run spirally, but in the reverse direction from the external, with which they become continuous both at the base and apex. The subdivision of the ventricular wall into such precise and determinate layers as is implied in the descriptions of Pettigrew is, however, to some extent an artificial procedure. There can be no doubt, as his dissections so beautifully show, that the direction of the fibres in the ventricular wall varies at different depths; but owing to the reticulated arrangement of the fibres, not only are those connected together which lie in one of the so-called layers, but they also anastomose with the fibres in the layer contiguous to it on either aspect. Hence when one layer is peeled off, that immediately subjacent exhibits, not a smooth face, which it would have done had the definition of the layers been distinct, but a rough appearance, due to the tearing through of intermediate connecting muscular fibres. Owing to these connections the substance of the wall of the ventricle, as Henle's dissections show, may, with the exception of the superficial internal and external fibres, be split up into lamellæ, which extend either horizontally, obliquely, or in an arched manner through the wall between its two surfaces; and the surfaces of those lamellæ are not parallel to the wall of the ventricle, but are directed upwards and downwards.

Except at the fibrous rings, where both the white and yellow fibres are distinct, the connective tissue of the heart is small in quantity. The endocardial lining consists of connective tissue with elastic fibres, with a layer of endothelium on the free surface; and Schweigger-Seidel has also described smooth muscular fibres in it. Hence, as Luschka has stated, the endocardium represents not merely the inner coat of the blood-vessels but all the structures of the vascular wall. Purkinje described fibres beneath the endocardium, which are now regarded as imperfectly formed striated muscular fibres. The valves are folds of the endocardium, enclosing fibres continuous with those in the fibrous rings: the cuspidate auriculo-ventricular valves receive fibres from the chordæ tendineæ.

The heart is well supplied with blood, not by the blood which flows through its cavities, but by two special coronary arteries which ramify in its walls, and end in numerous capillaries lying between the fibres. From these capillaries the coronary veins arise, which join to form the coronary venous sinus. Lymphatic vessels occur both in the endocardium and pericardium, and apparently ramify in the muscular wall. The nerves of the heart have been dissected especially by Scarpa, Remak, Lee, and Pettigrew, and numerous small ganglia described in connection with them (see p. 883).

The blood flows along the great veins into the auricles.

and is forced by the contraction of their muscular walls through the auriculo-ventricular openings, the valves of which open outwards, into the ventricles. When the ventricles are distended their muscular walls contract and force the blood into the arteries—the right ventricle into the pulmonary artery, the left into the aorta—the valves at the mouth of each artery opening outwards to allow of the free passage of the fluid. To prevent, during the ventricular contraction, the regurgitation of blood into the auricles, the auriculo-ventricular valves are floated away from the sides of the ventricle across their respective openings, and by the apposition and slight overlapping of their edges temporarily close the openings. The tilting upwards of the valves into the auricles is prevented by the contraction of the musculi papillares, and their connection with the cusps of the valve through the chordæ tendineæ. Pettigrew has shown that casts of the ventricular cavities, more especially of the left, have the form of a double cone, spirally twisted from right to left, and has described the blood as forced in spiral streams against the under surface of the segments of the valve, which are twisted and wedged into each other so as to prevent regurgitation. The propulsion of the blood into the arteries distends the elastic walls of those tubes; but when the ventricular contraction has ceased, the elastic wall recoils, and the blood is propelled onwards in the circulation. The regurgitation of the blood into the ventricles is prevented by the closure of the semilunar valves, the segments of which are thrown across the arterial orifices through the pressure exercised on the column of blood in the lumen of the artery and in the sinuses of Valsalva.

Arteries. *The Arteries.*—These vessels were named arteries by the older anatomists, on the supposition, now known to be erroneous, that they contained air. The term is now employed to express a blood-vessel, which, arising either directly or indirectly from the heart, conveys blood away from that organ. Arteries divide and subdivide into smaller vessels in their course, and to the individual branches descriptive names are applied. Some of these names express the position of an artery, as subclavian, axillary; others, the organ in which it is distributed, as pulmonary, hepatic; others a peculiarity in its course, as circumflex, coronary. The branches of arteries may be either *collateral* or *terminal.* The collateral branches arise from the sides of the parent artery either at an acute, a right, or an obtuse angle. Terminal branches arise at an acute angle by the bifurcation of the parent artery, which is the most common form, or by the breaking up of the artery into a cluster of branches. Branches which arise either from the same artery or from different arteries may be distributed in a common locality, may there unite together, and form what is called an *inosculation* or *anastomosis,* so that the blood from one artery may thus flow from it into another. The most common anastomosis is by the formation of loops between adjacent branches, but sometimes, as when the two vertebral arteries join to form the basilar, a convergence of two almost straight arteries takes place; and in other cases, as where the two anterior cerebral arteries are joined together by the anterior communicating, a connecting branch passes transversely across the mesial plane. A more complex form of anastomosis is when an artery (and a similar arrangement is sometimes found in veins) rapidly subdivides into numerous branches, which may again join to form a trunk either with or without the formation of a plexus. This is called a *rete mirabile,* an arrangement not uncommon in the cetacea, in the internal carotid arteries of ruminants, in the mesenteric arteries of the pig, in the arteries of the limbs of the sloths and lemurs, and in the arterial system of fishes. The only examples of a rete in the human body are the convoluted Malpighian tufts of the kidney and the arterial distribution in the coccygeal body.

The distribution of the pulmonary artery will be considered in the anatomy of the lungs. That of the aorta will now be briefly described.

The *Aorta* (Plate XX. figs. 2, 3, A) lies in the cavities of the thorax and abdomen, and arises from the base of the left ventricle. It ascends forwards, upwards, and to the right as far as the level of the second right costal cartilage, then runs backwards and to the left to reach the left side of the body of the 4th dorsal vertebra, and then descends almost vertically to reach the left side of the body of the 5th dorsal vertebra. It forms, therefore, an arch, well known as the *arch of the aorta,* which arches over the root of the left lung, and which has attached to its concave surface a fibrous cord, known as the obliterated *ductus arteriosus,* which connects it with the left branch of the pulmonary artery. The aorta continues its course downwards in close relation to the bodies of the lower dorsal vertebræ, then passes through an opening in the diaphragm, enters the abdomen, and descends in front of the bodies of the lumbar vertebræ as low as the 4th, where it is usually described as dividing into the two terminal branches, the common iliac arteries. At the angle of bifurcation, however, a long slender artery, called the *middle sacral,* is prolonged downwards in front of the sacrum to the end of the coccyx. In animals with long tails this artery can be recognised as a direct continuation of the aorta, prolonging it downwards in front of the caudal vertebræ, whilst the iliacs are seen to be collateral branches; but in man, where the coccyx is rudimentary, and the lower limbs largely developed, the iliac arteries which supply those limbs are so big as to obscure the true signification of the middle sacral artery, and appear themselves to be the terminal branches of the aorta. The branches which arise directly from the aorta may be arranged in four groups.—1st, Branches for the supply of the viscera of the thorax and abdomen proper; 2d, branches for the walls of the thorax, abdomen, and pelvis; 3d, branches for the head, neck, and upper limbs; 4th, branches for the lower limbs, pelvic walls, and viscera.

Aorta.

The branches of the aorta which supply the viscera of the thorax are the coronary, the œsophageal, the bronchial, and the pericardial. The *coronary* arteries, two in number, are the first branches of the aorta, and arise opposite the right and left segments of the semilunar valve, from the wall of the aorta, where it dilates into the sinuses of Valsalva. The mouths of these arteries are closed by the opening outwards of the aortic valves during the ventricular contraction. The elastic recoil of the aorta following that contraction not only closes the aortic valves, but drives the blood into the coronary arteries. These arteries break up into branches in the muscular walls of the heart, and the sudden turgescence of its walls, which results from the filling of these vessels, is, according to Brücke and Garrod, the cause of the dilatation of the ventricular cavities.

Viscera branches.

The *bronchial* arteries are two in number; one accompanies each bronchial tube, and supplies the tissues of the lung.

The *œsophageal* arteries, three or four in number, supply the coats of the œsophagus.

The *pericardial* branches are very small arteries which supply the back of the bag of the pericardium.

The branches of the aorta which supply the viscera of the abdomen arise either singly or in pairs. The single arteries are the cœliac axis, the superior mesenteric, and the inferior mesenteric, which arise from the front of the aorta; the pairs are the capsular, the two renal, and the two spermatic or ovarian, which arise from its sides. The single arteries supply viscera which are either completely or almost completely invested by the peritoneum, and the veins corresponding to them are the roots of the vena portæ. The pairs of arteries supply viscera developed

behind the peritoneum, and the veins corresponding to them are rootlets of the inferior vena cava.

The *cœliac axis* is a thick, short artery, which almost immediately divides into the coronary, hepatic, and splenic branches. The *coronary* artery subdivides into an œsophageal branch for the lower end of the œsophagus, and a *gastric* branch for the coats of the stomach. The *hepatic* artery ends in the substance of the liver; but gives off a *cystic* branch to the gall bladder, a *pyloric* branch to the stomach, a *gastro-duodenal* branch, which divides into a *superior pancreatico-duodenal* for the pancreas and duodenum, and a *right gastro-epiploic* for the stomach and omentum. The *splenic* artery ends in the substance of the spleen; but gives off *pancreatic* branches to the pancreas, *vasa brevia* to the great end of the stomach, and a *left gastro-epiploic* to the stomach and omentum.

The *superior mesenteric* artery gives off an *inferior pancreatico-duodenal* branch to the pancreas and duodenum; about twelve *intestinal* branches to the small intestines, which form in the substance of the mesentery a series of arches before they end in the wall of the intestines; an *ileocolic* branch to the end of the ileum, the cæcum, and beginning of the colon; a *right colic* branch to the ascending colon; and a *middle colic* branch to the transverse colon.

The *inferior mesenteric* artery gives off a *left colic* branch to the descending colon, a *sigmoid* branch to the sigmoid flexure of the colon, and ends in the *superior hæmorrhoidal* artery which supplies the rectum. The arteries which supply the coats of the alimentary tube from the œsophagus to the rectum anastomose freely with each other in the wall of the tube, or in its mesenteric attachment, and the anastomoses are usually by the formation of arches or loops between adjacent branches.

The *capsular arteries*, small in size, run outwards from the aorta to end in the supra-renal capsules.

The *renal* arteries pass one to each kidney, in which they for the most part end, but in the substance of the organ they give off small *perforating* branches, which pierce the capsule of the kidney, and are distributed in the surrounding fat.

The *spermatic* arteries are two long slender arteries, which descend, one in each spermatic cord, into the scrotum to supply the testicle. The corresponding arteries in the female, called the *ovarian*, do not leave the abdomen; they supply the ovaries.

Parietal branches. The branches of the aorta which supply the walls of the thorax, abdomen, and pelvis, are the intercostal, the lumbar, the phrenic, and the middle sacral.

The *intercostal* arteries arise from the back of the thoracic aorta, and are usually ten pairs. They run down the sides of the vertebral bodies as far as the commencement of the intercostal spaces, when each divides into a *dorsal* and a *proper intercostal* branch; the dorsal branch passes to the back of the thorax to supply the deep muscles of the spine; the proper intercostal branch runs outwards in the intercostal space to supply its muscles, and the lower pairs of intercostals also give branches to the diaphragm and wall of the abdomen.

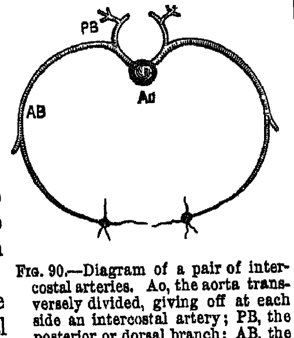


FIG. 90.—Diagram of a pair of intercostal arteries. Ao, the aorta transversely divided, giving off at each side an intercostal artery; PB, the posterior or dorsal branch; AB, the anterior or proper intercostal branch; IM, a transverse section through the internal mammary artery.

The *lumbar* arteries arise from the back of the abdominal aorta, and are usually four pairs. They run down the sides of the lumbar vertebræ, and divide into a *dorsal* branch, which supplies the deep muscles of the back of the loins, and an *abdominal* branch which runs outwards to supply the wall of the abdomen. The distribution of the lumbar and intercostal arteries exhibits a transversely-segmented arrangement of the vascular system, similar to the transversely-segmented arrangement of the bones, muscles, and nerves met with in these localities, but more especially in the thoracic region.

The *phrenic* arteries, two in number, pass to supply the under surface of the diaphragm.

The *middle sacral* artery, as already stated, is rather the continuation of the aorta than a branch. As it runs down the front of the sacrum it gives branches to the back of the pelvic wall.

The statement has frequently been made that the visceral and parietal branches of the aorta do not anastomose with each other. Injections made by Turner have, however, shown that, both in the thoracic and abdominal cavities, slender anastomosing communications exist between the two sets of branches. In the abdominal cavity a wide meshed plexus of small arteries, named by him *sub-* or *extra-peritoneal* plexus, lies in the fat outside the peritoneum. It communicates, on the one hand, with the perforating branches of the renal arteries and with slender branches of the capsular, spermatic, colic, and pancreatic arteries, and in the region of the diaphragm with the hepatic artery. On the other hand, it communicates with the phrenic arteries, the lower intercostals, the lumbar branches of the aorta, and with the ilio-lumbar, circumflex ilii, and epigastric branches of the iliac arteries, which also go to the wall of the abdomen. In the pelvis also the visceral superior hæmorrhoidal artery anastomoses with the middle and lateral sacral arteries. The extra-peritoneal plexus supplies the fat and lymphatic glands lying outside the peritoneum, and it also gives origin to *vasa vasorum* for the coats of the aorta and vena cava. This plexus may, when the visceral branches of the aorta are obstructed, aid in an important manner in carrying on the circulation. In a subject examined by J. Chiene, in the dissecting room of the University of Edinburgh, where the cœliac axis and the superior and inferior mesenteric arteries were obliterated at their origins, the blood flowed into these arteries and the viscera they supplied through a great enlargement of the arteries of this plexus. In the thoracic cavity a similar plexus, named the *extra-pleural* plexus, lies between the pleura and pericardium, which communicates on the one hand with the internal mammary arteries, and on the other passes in front of the root of the lung to join the bronchial system of vessels. Another portion of this plexus joins on the one hand the intercostal arteries near the dorsal vertebræ, and on the other passes to the lung at the back of its root.

The branches for the head, neck, and upper limbs arise as three large arteries from the transverse part of the aorta; they are named arteria innominata, left common carotid, and left subclavian. The *arteria innominata* is the largest; it passes, upwards and to the right, to the root of the neck, and then divides into the right common carotid and the right subclavian. The carotid arteries supply the two sides of the head and neck; the subclavian arteries the two upper extremities.

The *subclavian* artery is the commencement of the great arterial trunk for the upper limb. It passes across the root of the neck and under the clavicle, when it enters the armpit, and becomes the *axillary* artery; by that name it extends as far as the posterior fold of the axilla, when it enters the upper arm, takes the name of *brachial* or *humeral* artery, and courses as far as the bend of the elbow, where it bifurcates into the *radial* and *ulnar* arteries. From the subclavian part of the trunk the following branches arise:—*a*, *Vertebral*, which enters the foramen at the root of the transverse process of the 6th cervical vertebra, ascends through the corresponding foramina in Subclavian system.

the vertebræ above, lies in a groove on the arch of the atlas, and enters the skull through the foramen magnum, where it joins its fellow to form the *basilar* artery; it gives off *muscular* branches to the deep muscles of the neck, *spinal* branches to the spinal cord, *meningeal* branches to the dura mater, and an *inferior cerebellar* branch to the under surface of the cerebellum. The *basilar* artery, formed by the junction of the two vertebrals, extends from the lower to the upper border of the pons Varolii; it gives off collaterally *transverse* branches to the pons, *auditory* branches which accompany the portio mollis to the internal ear, *inferior cerebellar* branches to the under surface of the cerebellum, whilst it breaks up into four terminal branches, viz., two *superior cerebellar* to the upper surface of the cerebellum, and two *posterior cerebral* which supply the tentorial aspect of the temporo-sphenoidal lobes, the occipital lobes, and the posterior convolutions of the parietal lobes. *b*, *Thyroid axis*, which immediately divides into the *inferior thyroid*, the *supra-scapular*, and the *transverse cervical* branches; the *inferior thyroid* supplies the thyroid body, and gives off an *ascending cervical* branch to the muscles of the neck; the *supra-scapular* supplies the muscles on the dorsum scapulæ; the *transverse cervical* supplies the trapezius and the muscles attached to the vertebral border of the scapula. *c*, *Internal mammary*, supplies the anterior surface of the walls of the chest and abdomen, and the upper surface of the diaphragm. *d*, *Superior intercostal* supplies the first intercostal space, and by its deep *cervical* branch the deep muscles of the back of the neck.

The *axillary* artery supplies *long* and *short thoracic* branches to the wall of the chest and the pectoral muscles; an *alar thoracic* branch to the fat and glands of the axilla; an *acromial thoracic* to the parts about the acromion; *anterior* and *posterior circumflex* branches to the shoulder joint and deltoid muscle; a *subscapular* branch to the muscles of the posterior fold of the axilla.

The *brachial* artery supplies *muscular* branches to the muscles of the upper arm; a *nutrient* branch to the humerus; *superior* and *inferior profunda* branches and an *anastomotic* to the muscles of the upper arm and the region of the elbow joint.

The *ulnar* artery extends down the ulnar side of the front of the fore-arm to the palm of the hand, where it curves outwards towards the thumb, and anastomoses with the superficial volar and radial index branches of the radial artery to form the *superficial palmar arterial arch*. In the fore-arm the ulnar gives off the *interosseous* arteries, which supply the muscles of the fore-arm and give *nutrient* branches to the bones; two *recurrent* branches to the region of the elbow; *carpal* branches to the wrist joint: in the hand it gives a *deep* branch to the deep muscles of the hand, and from the superficial arch arise *digital* branches to the sides of the little, ring, and middle fingers, and the ulnar border of the index finger.

The *radial* artery extends down the radial side of the front of the fore-arm, turns round the outer side of the wrist to the back of the hand, passes between the 1st and 2d metacarpal bones to the palm, where it joins the deep branch of the ulnar, and forms the *deep palmar arterial arch*. In the fore-arm it gives off a *recurrent* branch to the elbow joint; *carpal* branches to the wrist joint; and *muscular* branches, one of which, named *superficialis volæ*, supplies the muscles of the thumb and joins the ulnar artery: in the hand it gives off a *digital* branch to the thumb, and one to the radial side of the index, *interosseous* branches to the interosseous muscles, *perforating* branches to the back of the hand, and *recurrent* branches to the wrist.

Carotid system.

The *common carotid* artery runs up the neck by the side of the windpipe, and on a level with the upper border of the thyroid cartilage divides into the internal and external carotid arteries.

The *internal carotid* artery ascends through the carotid canal in the temporal bone into the cranial cavity. It gives off an *ophthalmic* branch to the eyeball and other contents of the orbit, and then divides into the *anterior* and *middle cerebral* arteries. The middle cerebral artery extends outwards into the Sylvian fissure, and supplies the island of Reil, the orbital part, and the outer face of the frontal lobe, the parietal lobe, and the temporo-sphenoidal lobe; it also gives a choroid branch to the choroid plexus of the velum interpositum. The anterior cerebral artery supplies the inner face of the hemisphere from the anterior end of the frontal lobe as far back as the internal parieto-occipital fissure. At the base of the brain not only do the two internal carotids anastomose with each other through the *anterior communicating* artery, which passes between their anterior cerebral branches, but the internal carotid on each side anastomoses with the posterior cerebral branch of the basilar, by a *posterior communicating* artery. In this manner a vascular circle, the *circle of Willis*, is formed, which permits of freedom of the arterial circulation by the anastomoses between arteries not only on the same side, but on opposite sides of the mesial plane. The vertebral and internal carotid arteries, which are the arteries of supply for the brain, are distinguished by lying at some depth from the surface in their course to the organ, by having curves or twists in their course, whereby the force of the flow of blood is retarded, and by the absence of large collateral branches. Further, as the ophthalmic artery is a branch of the internal carotid, the circulation in the eyeball is in sympathy with that in the brain.

The *external carotid* artery ascends through the upper part of the side of the neck, and behind the lower jaw into the parotid gland, where it divides into the internal maxillary and temporal branches. This artery gives off the following branches:—*a*, *Superior thyroid* to the larynx and thyroid body; *b*, *Lingual* to the muscles and mucous membrane of the tongue, and to the sublingual gland; *c*, *Facial* to the face, palate, tonsil, and sub-maxillary gland; *d*, *Occipital* to the sterno-mastoid muscle and back of the scalp; *e*, *Posterior auricular* to the back of the ear and the adjacent part of the scalp; *f*, *Superficial temporal* to the scalp in front of the ear, and by its *transverse facial* branch to the back part of the face; *g*, *Internal maxillary*, giving *muscular* branches to the muscles of mastication, *meningeal* branches to the dura mater, *dental* branches to the teeth, and other branches to the nose, palate, and tympanum; *h*, *Ascending pharyngeal*, which gives branches to the pharynx, palate, and tonsils.

Iliac system.

The *common iliac* artery, after a short course, divides into the internal and external iliac arteries. The *internal iliac* enters the pelvis and divides into branches for the supply of the pelvic walls and viscera, including the organs of generation, and for the great muscles of the buttock. The *external iliac* descends behind Poupart's ligament into the thigh, where it takes the name of *femoral* artery. The femoral descends along the front and inner surface of the thigh, gives off a *profunda* or deep branch, which, by its *circumflex* and *perforating* branches, supplies the numerous muscles of the thigh; most of these extend to the back of the limb to carry blood to the muscles situated there. The femoral artery then runs to the back of the limb in the ham, where it is called *popliteal* artery. The popliteal divides into two branches, of which one, called *anterior tibial*, passes between the bones to the front of the leg, and then downwards to the upper surface of the foot; the other, *posterior tibial*, continues down the back of the leg to the sole of the foot, and divides into the *internal* and *external plantar* arteries; branches proceed from the external plan-

tar artery to the sides of the toes, and constitute the *digital* arteries. From the large arterial trunks in the leg many branches proceed, to carry blood to the different structures in the limb.

Structure of arteries. The wall of an artery consists of several coats. The outermost is the *tunica adventitia*, composed of connective tissue; immediately internal to this is the *yellow elastic* coat; within this again the *muscular coat*, formed of involuntary muscular tissue, the contractile fibro-cells of which are for the most part arranged transversely to the long axis of the artery; in the larger arteries the elastic coat is much thicker than the muscular, but in the smaller arteries the muscular coat is relatively strong; the vaso-motor nerves terminate in the muscular coat. Internal to the muscular coat is the *elastic fenestrated coat*, formed of a smooth elastic membrane perforated by small apertures. Most internal of

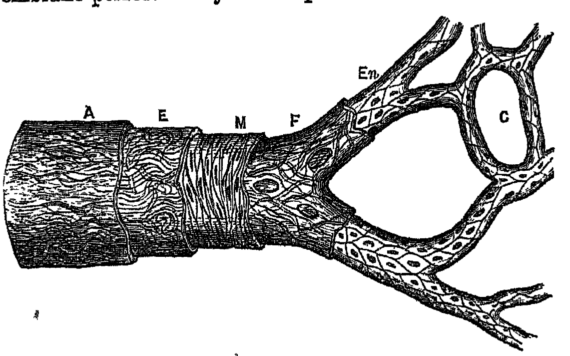


FIG. 91.—Diagram of the structure of an artery. A, tunica adventitia; E, elastic coat; M, muscular coat; F, fenestrated coat; En, endothelium continuous with the endothelial wall of C, the capillaries.

all is a layer of *endothelial cells*, which form the free surface over which the blood flows. The arteries are not nourished by the blood which flows through them, but by minute vessels, *vasa vasorum*, distributed in their external, elastic, and muscular coats.

Capillaries. *The Capillaries.*—These are the minute tubes which connect together the terminal branches of the arteries and the rootlets of the veins. They vary in diameter in different localities from $\frac{1}{1500}$th to $\frac{1}{3500}$th inch. They are arranged in more or less compact networks, which lie in the interstices between the tissues of the part or organ. The vascularity

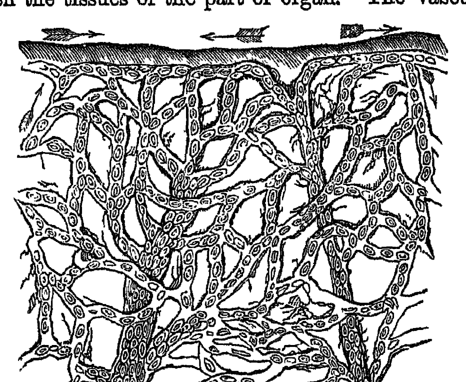


FIG. 92.—Capillary Network in the Web of the Foot of the Frog (A. Thomson).

of a tissue depends upon the relative proportion of the capillaries that it contains. Some tissues, as adult cartilage, the cornea, epithelium, and endothelium, are destitute of capillaries, *i.e.*, are non-vascular. The capillary wall is very simple in structure; in the smallest capillaries it consists merely of a layer of endothelial cells, continuous with the endothelial lining of the arteries and veins; in the larger capillaries a delicate tunica adventitia is superadded. The transition from a capillary to a small artery or a small vein is marked by the development of a muscular and an elastic coat in the wall of the blood-conveying tube.

Veins. *The Veins.*—The veins convey the blood from the periphery back to the heart, and in their course increase in size, by junction or anastomosis with each other. In most of the veins delicate valves are found, each of which consists of two semicircular segments, and a pouch-like dilatation of the wall of the vein is opposite each segment. When the blood flows along the veins, the valves lie against the wall of the vessel, but if pressure be applied to a vein so as to obstruct the onward flow of the circulation, then the blood passes into the pouch between the wall of the vein and the valve adjacent to the seat of pressure, when the valve closes so as to stop regurgitation. The valves are found especially in those veins where the circulation is likely to be interfered with either by the pressure of the muscles on the veins during their action, or by the pressure of blood caused by gravity, and are usually seated at the points of confluence of veins. They are absent in the veins of the lungs, of the brain, and of several of the abdominal viscera. Some of the veins lie in the subcutaneous fat, and are called *superficial* veins, others lie amidst the muscles, and form the *deep* veins. The deep veins accompany the arteries and are named after them; the superficial veins do not accompany arteries; frequent anastomoses take place between the superficial and deep veins.

The veins are arranged primarily into two groups—the Pulmonary veins and the Systemic veins. The distribution of the pulmonary veins will be given in the anatomy of the lungs.

The Systemic veins consist of the coronary venous system; of the system of the superior vena cava; of the system of the inferior vena cava; and associated with the inferior vena cava is the portal venous system. The arrangement of the *coronary vein* has been described in the anatomy of the heart.

The system of the *Superior Vena Cava* consists of both superficial and deep veins, and is arranged as follows :—

The superficial veins of the hand commence at the tips and sides of the fingers, from which they proceed along the back of the hand, beneath the skin of which they may be distinctly seen. They then ascend along the fore-arm, forming three large veins: the *radial*, on the outer side; the *ulnar*, on the inner; and the *median*, in the middle of the front of the fore-arm. At the bend of the elbow the median divides into two branches, of which one joins the radial to form the *cephalic*, the other joins the ulnar to form the *basilic*. Into one or other of the two branches of the median the surgeon generally makes an opening when he is desirous of drawing blood from the patient. The cephalic and basilic veins terminate by joining the deep or *axillary* vein. The communications between the superficial and deep veins are not, however, confined to the point of termination of the former, but occur at various parts of their course.

The deep veins of the hand commence at the tips of the fingers, and pass as *digital* veins up the sides of the fingers to the palm of the hand, where they form an arch corresponding to the arterial arch of the palm; from this they extend upwards along the front of the fore-arm, as far as the bend of the elbow, closely accompanying the arteries of the fore-arm, and receiving from the muscles numerous small branches corresponding to the small arteries sent to those muscles. At the bend of the elbow two *brachial* veins result from the junction of these different veins of the fore-arm, which pass up the inner side of the upper-arm, closely accompanying the brachial artery as far as the armpit, where they join to form a single large vein, the

axillary. They receive in their course many small branches from the muscles. The axillary vein also receives the cephalic and basilic veins. Thus, a single large trunk conveys away all the blood that has been circulating through the upper limb. This large vein passes as the *subclavian* vein behind the clavicle, and reaches the lower part of the side of the neck, where it is joined by the large veins that return the blood from the head and neck.

The veins that return the blood from the inner and outer parts of the head and neck are called the *external* and *internal jugular* veins. The external is the smaller, and may commonly be seen beneath the skin on the side of the neck. It returns the blood that has been circulating on the outer part of the head, and must be regarded as a superficial vein. The internal jugular returns the blood that has been circulating on the face, in the brain, and cranial blood-sinuses, and in the deeper parts of the neck. It accompanies the carotid artery, and must thus be regarded as a deep vein. By the junction of the jugular and subclavian veins at the root of the neck a large *brachio-cephalic* vein on each side is formed; these gradually converge, join, and form a single trunk, the superior vena cava, which, after a short course, enters the upper part of the right auricle of the heart. The veins corresponding to the intercostal arteries, which run between the ribs, do not open directly into either the superior or inferior vena cava, but pass to form the *azygos* vein, which begins in the cavity of the abdomen, then enters the cavity of the chest, and, as it courses upwards, gradually increases in size by receiving the various intercostal veins, until it finally terminates by joining the superior vena cava.

The system of the *Inferior Vena Cava* consists of both superficial and deep veins, and is arranged as follows:—The superficial veins of the foot are separated from the deep veins by the strong membrane or fascia which binds down the muscles. They commence by very fine branches arising from the capillaries of the skin. On the back of the foot the digital veins proceeding from the skin of the toes form an arch, from the inner side of which a vein, called the *long saphena*, arises. This passes upwards along the inner side of the leg and thigh, increasing considerably in size in its course, owing to the number of veins joining it from the extensive surface of the skin of the limb. It terminates, at the upper part of the thigh, by passing through a hole in the fascia, and joins the femoral vein. From the outer side of the same arch arises the *external saphenous* vein, which runs up the back of the leg to the ham, and pierces the fascia to join the popliteal vein. The deep veins begin both on the back of the foot and in the sole. Those which arise on the back of the foot form the *anterior tibial* veins, and accompany the anterior tibial artery; they receive a considerable number of branches in their upward course, which proceed from the great mass of muscles lying on the outer side of the leg. The veins which begin in the sole of the foot accompany the plantar arteries, and then pass upwards, along the inner side of the ankle-joint, to reach the back of the leg, along which they ascend as the *posterior tibial* veins, closely accompanying the posterior tibial artery, and receiving in their course numerous small veins that proceed from the muscles of the calf of the leg. At the upper part of the leg the anterior tibial veins pass to the back of the leg, and join the posterior tibial veins. The large *popliteal* vein, formed by their junction, ascends behind the knee-joint, lying in the ham, along with the popliteal artery. It leaves the upper part of this space, and, passing to the inner side of the thigh, ascends as the *femoral* vein along with the femoral artery as far as Poupart's ligament, when it enters the cavity of the abdomen. At the upper part of the thigh it receives the *profunda* vein, corresponding to the deep artery of the thigh, which conveys back the blood that has been carried by that vessel to the numerous large and important muscles of the thigh. The femoral vein is also joined at this spot by the long saphena vein. When the femoral vein enters the cavity of the abdomen it becomes the *external iliac* vein. The external iliac vein receives the smaller veins which ramify in the lower part of the walls of the abdomen, as well as the large *internal iliac* vein, which corresponds to the internal iliac artery, and by their junction the *common iliac* vein is formed. The two common iliac veins gradually converge, and, about the level of the last vertebra of the loins, join to form a single large vein, the inferior vena cava. The inferior vena cava ascends at the back of the abdominal cavity lying on the right side of the aorta. Several veins open into it; some corresponding with the parietal branches of the abdominal aorta, others with the capsular, renal, and spermatic arteries. The greater number of the veins proceeding from the organs contained in the cavity of the abdomen do not open directly into the vena cava, but form a large vein called *portal*. The vena cava passes through the diaphragm, enters the cavity of the chest, and terminates by opening into the right auricle of the heart.

The *Portal* system of veins is formed by the veins which proceed from the large and small intestines, from the stomach, pancreas, and spleen; they form the *inferior mesenteric, superior mesenteric, splenic,* and *gastric* veins, which join together in the neighbourhood of the pancreas to form the portal venous trunk. The portal vein then ascends to the under surface of the liver, which it enters at the portal transverse fissure. In the substance of the liver it subdivides into branches just like an artery, and the finest branches terminate in the lobules of the liver in a plexus of capillaries. From this plexus the rootlets of the hepatic veins arise, which joining together form the large *hepatic* vein, which opens into the inferior vena cava before it pierces the diaphragm. Retzius has pointed out that an extra-peritoneal venous plexus exists in the abdominal cavity, which connects the rootlets of the portal vein with those of the veins of the parietes of the abdomen.

The wall of a vein possesses the same number of coats as that of an artery, but the coats are thinner. Veins are also extensively provided with valves, which are absent from the arteries except at the mouths of the aorta and pulmonary artery.

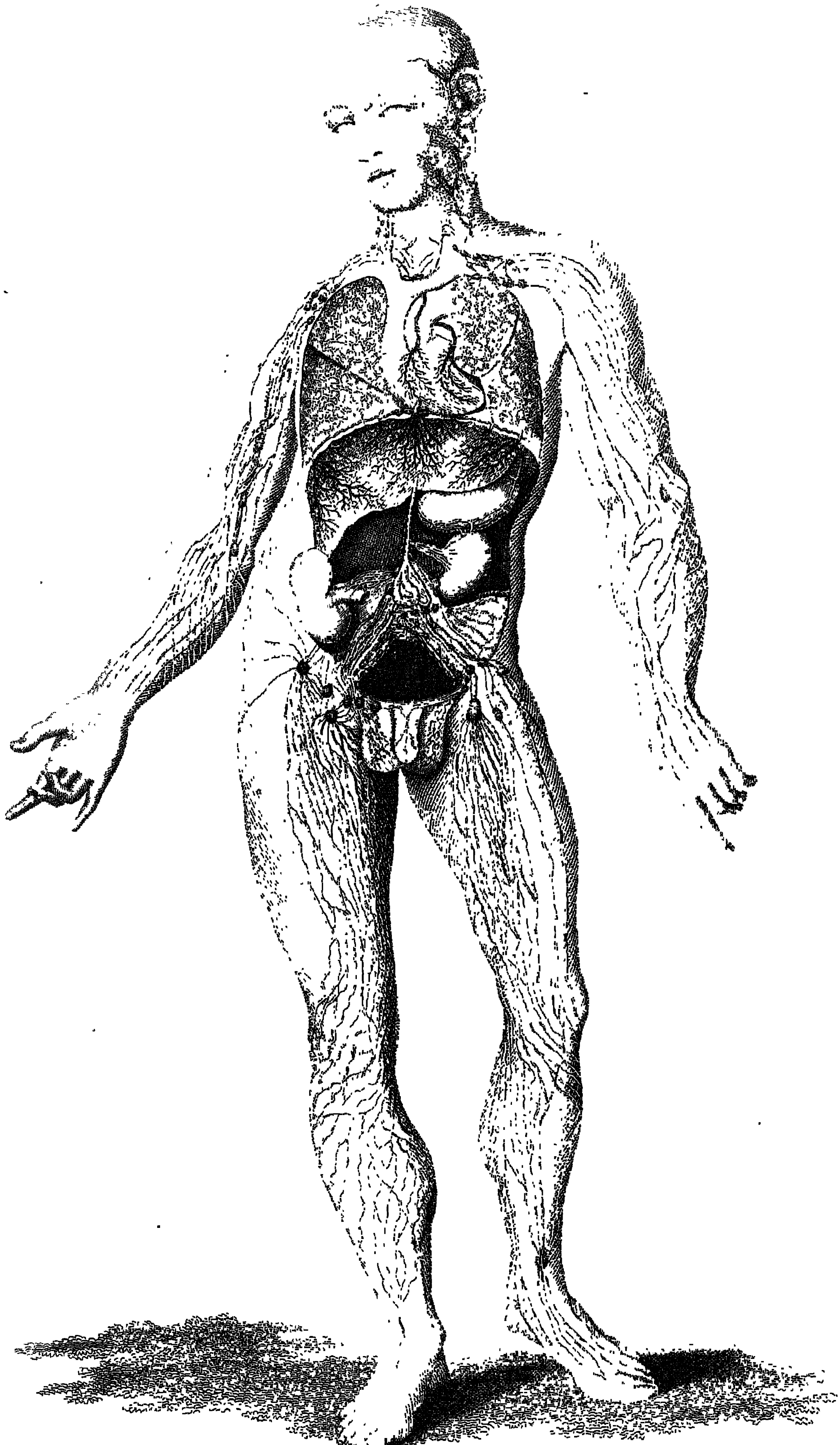
Lymphatics.

LYMPH-VASCULAR SYSTEM.—This subdivision of the vascular system consists partly of small tubes or vessels, the *lymph vessels*, and partly of collections of lymphoid or adenoid tissue (p. 849), the *lymph glands*. The lymph vessels or lymphatics are tubes with delicate transparent walls, which convey the fluid called lymph and chyle. They arise in the tissues and terminate by joining the venous system, so that their contained fluid flows towards the heart. They resemble veins in having a course from periphery to centre; in possessing valves, which are generally two in number and semilunar in shape; in being divided into a superficial and a deep set—the superficial lymphatics being situated, like the superficial veins, in the subcutaneous tissue; the deep lymphatics accompanying the arteries and deep veins. Lymphatics differ, however, from veins in possessing in their course glandular enlargements, in having thinner coats, in being almost uniform in size, and not uniting into larger vessels as they pass onwards in their course. As a rule they are like fine threads, and their main trunk, the thoracic duct, is not bigger than a crow-quill. The lymph-vessels are divided into lacteal or chyle vessels and lymphatics proper.

The *lacteal* or *chyle vessels*, named from the milk-like chyle which they contain, arise in the minute processes called *intestinal villi*, which project from the free surface

ANATOMY

Lymphatic Vascular System



W & A K Johnston

of the mucous membrane of the small intestine into the lumen of the bowel. The lacteals from adjacent villi form a network in the submucous coat of the intestine, from which larger lacteals arise, which pierce the muscular coat, and then run between the folds of the mesentery to the posterior wall of the abdomen, where, opposite the body of the first lumbar vertebra, they join the deep lymphatic vessels of the abdomen to form the thoracic duct.

The *lymphatic vessels proper* correspond so closely in their distribution in the extremities and in the head and neck with the veins of those parts, that a special description of their arrangement is not necessary, the more so as a general representation of these vessels is given in Plate XXI. The superficial and deep lymphatics of the lower limbs enter the abdominal cavity, and are joined by the lymphatics of the pelvis. They ascend in front of the bodies of the lumbar vertebræ, join the lacteal vessels to form the thoracic duct, the place of junction being marked by a dilatation of the duct called *receptaculum chyli*. The *thoracic duct* passes through the opening in the diaphragm which transmits the aorta, ascends in front of the bodies of the dorsal vertebræ, receives in its course the deep lymphatics of the left half of the chest, reaches the root of the neck on the left side, is joined there by the deep and superficial lymphatics of the left upper limb and left side of the head and neck, and opens into the great veins at the angle of junction between the left internal jugular and subclavian. This duct conveys, therefore, the chyle during digestion, and the lymph contained in the lymph-vessels below the diaphragm and in the lymph-vessels situated to the left side of the mesial plane in the parts of the body above the diaphragm. The lymph-vessels on the right side of the supra-diaphragmatic parts of the mesial plane do not join the thoracic duct, but converge to the root of the neck on the right side, where they join to form the *right lymphatic duct*, which opens into the angle of junction of the right internal jugular and subclavian veins.

Thoracic duct.

The mode of origin of the lymph-vessels has long been a vexed question amongst anatomists. The lacteal vessels were at one time supposed to arise by open mouths on the free surface of the intestinal villi, and this idea has been revived in a modified form by some recent observers, who conceive that the lacteals are continuous with a network formed by the anastomoses of processes proceeding from the deep ends of the goblet cells, the mouths of which cells open on the free surface of the villus. The lymph-vessels proper are in some localities continuous with the serous cavities (p. 848); in others they arise within the textures and organs. The most minute lymph-vessels, called lymph-capillaries, like the blood-capillaries, have walls formed of a single layer of elongated endothelial cells. These capillaries take their rise in the connective tissue of a part or organ, and probably spring from spaces, or juice-canals, between the bundles of the connective tissue, which bundles are invested by an endothelial layer of cells. The juice canals are, therefore, a network of minute canals, situated outside the blood-vessels, which allow the tissues to be permeated by a nutrient juice derived from the blood.

In some localities, as the brain and eyeball, the blood-vessels have been described as enclosed in tubular spaces, called *peri-vascular canals*, in which cells like the corpuscles of the lymph have been seen, and which are believed to be continuous with the lymphatic system. The researches of Ludwig and some of his pupils into the minute structure of the lachrymal gland, the glands of the skin, and the testis, have shown that lymph-capillaries lie in close relation to the secreting structures of these glands.

The coats of the lymph-vessels resemble in structure those of the veins, but they are thinner and more transparent. The valves are small and numerous.

The *lymphatic glands* are small bodies, varying in size from a pea to an almond, situated in the course of the lymph-vessels in several regions of the body. They are found especially in the groin, armpit, mesentery, back of the abdomen, roots of the lungs, and side of the neck (Plate XXI.) Entering one end of each gland are lymph-vessels, named *vasa afferentia*, and emerging from the opposite end of the gland are the lymph-vessels named *vasa efferentia*. Each gland is invested by a capsule of connective tissue, which sends processes into the substance of the gland to divide it into compartments; it consists of adenoid tissue, and the meshes of its retiform connective tissue contain multitudes of lymph corpuscles. Each gland is permeated by a network of minute canals, which are continuous with both the vasa afferentia and efferentia; the gland, therefore, is traversed by a stream of lymph which washes the lymph corpuscles out of the meshes of the reticulum, and in this manner these corpuscles find their way into the lymph. The lymph glands are, therefore, centres of origin for the lymph corpuscles. The collections of adenoid tissue, forming the solitary and Peyer's glands of the intestine, and found in the tonsils and other localities (p. 849), are also without doubt centres of formation for the lymph corpuscles.

Blood vascular glands.

Blood-Vascular Glands.—Intimately associated with the vascular system are certain organs to which the names of blood-vascular glands, or glands without ducts, are applied. These organs are the spleen, the thyroid gland, the thymus gland, the suprarenal capsules, and portions of the pituitary and pineal glands. The *Spleen* is situated in the cavity of the abdomen between the stomach and the diaphragm. It is invested by peritoneum, and has a fibro-elastic coat in which involuntary muscular fibro-cells are formed. This coat sends multitudes of fine trabeculæ into the interior of the organ, which subdivide it into numbers of minute compartments, in which the red, highly vascular spleen pulp is contained. This pulp consists of collections of small spherical masses of adenoid tissue, forming the Malpighian corpuscles, of the terminal branches of the splenic blood-vessels, and of the lymph-vessels, together with numerous cells, some of which are red blood corpuscles, others lymph corpuscles, others contain pigment granules or fat, others contain in their interior numerous blood corpuscles. The arteries of the spleen in part end in capillaries from which the veins arise, but more frequently they open into lacunæ or blood spaces, which give origin to the veins. The *Thymus gland*, best seen in infancy and childhood, lies in the cavity of the thorax near the base of the heart. It consists of two lobes, each of which is composed of lobules of adenoid tissue, to which numerous lymph-vessels may be traced. In the adult it is converted into a mass of fat. The *Thyroid gland* is situated in the neck at the front and sides of the windpipe. It consists of multitudes of minute closed follicles, each of which is lined by a layer of cells. The *Suprarenal capsules*, two in number, lie in the abdomen one above each kidney. They contain cells, some of which are arranged in columns, others in a reticulated manner, and are well provided with blood-vessels, nerves, and lymphatics.

Development of vascular system.

Development of the Vascular System.—The vascular system is formed in the middle or mesoblast layer of the early embryo. The cells of the mesoblast lose their original spherical form and become stellate, the processes of adjacent cells unite together and form a network, and the nuclei rapidly increase in numbers. The peripheral part of the protoplasm of the stellate cells differentiates into a wall of nucleated protoplasm, and forms the wall of the blood-vessels, whilst the central part of the protoplasm liquefies, and the nuclei contained in it become the blood-corpuscles. If the vessel remains as a capillary, its wall assumes merely the character of a single layer of endo-

thelial cells; but if it becomes an artery or a vein, a further differentiation of the mesoblast cells into the muscular and elastic coats and the tunica adventitia takes place. The heart appears immediately below the head in the form of a collection of cells in the splanchnopleure layer of the mesoblast. It is believed that these cells form in the first instance a solid mass, the central part of which liquefies to form blood and blood-corpuscles, whilst the peripheral cells form the wall of a tube. The heart tube now presents two constrictions, which indicate its division into an *auricle*, a *ventricle*, and a *bulbus arteriosus*. The single ventricle then subdivides into two by the gradual growth of the septum from the apex to the base, and about the eighth week of embryo-life the right and left ventricles are completely separated from each other. A septum then begins to form in the originally single auricle, but its growth is not completed until after the birth of the child, so that during fœtal life the cavities of the right and left auricles communicate with each other through a hole in the septum, named *foramen ovale*. The *primitive aortæ*, right and left, arise from the ductus arteriosus, and extend upwards to the 1st pair of visceral arches, into which they pass and arch backwards to the sides of the spinal column, where they form the *dorsal aortæ*. Four additional pairs of arterial arches then spring from the primitive aortæ below the 1st pair, and the whole are enumerated from above downwards as the 1st, 2d, 3d, 4th, and 5th pairs of vascular arches. Each arch communicates behind with the dorsal aorta of its own side. The two dorsal aortæ then approximate and blend with each other to form the descending thoracic and the abdominal aorta. A longitudinal septum also forms within the bulbus arteriosus itself, which divides it into two vessels: the one, the ascending aorta, becoming continuous with the cavity of the left ventricle and with the 1st, 2d, 3d, and 4th pairs of vascular arches; the other, the pulmonary artery, becoming continuous with the cavity of the right ventricle and with the 5th pair of vascular arches. The 4th left vascular arch enlarges to form the transverse part of the arch of the aorta, and the left subclavian artery springs as a collateral branch from it. The 4th right arch forms the innominate, and the commencement of the right subclavian artery. The 3d pair of arches form the two internal carotid arteries; each common carotid is formed from the part of the primitive aorta which connects the 3d and 4th arches with each other; whilst the external carotid is an enlargement of that part of the primitive aorta which runs upwards from the 3d to the 1st visceral arch. From the 5th left vascular arch, which is now continuous with the pulmonary artery, two collateral branches arise, which proceed one to each lung, and form the right and left pulmonary arteries, whilst the terminal part of this arch joins the end of the transverse part of the arch of the aorta, and forms the *ductus arteriosus*. During fœtal life, the lungs being inactive, the blood of the right ventricle which passes into the pulmonary artery almost entirely flows through the ductus arteriosus into the aorta. But when the child is born, and the lungs come into play as respiratory organs, then the blood of the right ventricle flows into the lungs through the right and left pulmonary arteries, and the ductus arteriosus, being no longer required, shrivels up into a slender fibrous cord. The capillaries, veins, and lymphatics are also produced by a histological differentiation of the cells of the mesoblast.

In order to complete the exposition of the subject, the Digestive, Respiratory, Reproductive, and Urinary systems of organs have still to be considered. These will be dealt with in detail under other headings in the succeeding volumes.

(W. T.)

Alphabetical Contents.

END OF VOLUME FIRST.

Encyclopædia Britannica.

Vol. I.—(A–ANA).

Total number of Articles, 966.

PRINCIPAL CONTENTS.

A General Index *to the* Encyclopædia *is now in preparation, and will refer in detail to the various subjects embodied in the articles throughout the Work.*